

What you Know is What you Parse

How situational knowledge affects
sentence processing

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What you Know is What you Parse

How situational knowledge affects sentence
processing

Wat je Weet is Wat je Ontleedt

Hoe situationele kennis zinsverwerking beïnvloedt
(met een samenvatting in het Nederlands)

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Chapter 1

Introduction

1.1 Research questions

You will never believe what happened at the party yesterday! Ellen kissed Ruben and Peter.... Suppose this is the last thing you read in your friend's e-mail before your computer breaks down. If you have some prior knowledge regarding the situation described, you would be able to guess how the interrupted sentence could continue without great difficulty. For example, if you know that Ellen was secretly in love with both Peter and Ruben and you know she has a certain reputation, she may have kissed them both, but if you know she has a crush on Ruben, but definitely not on Peter, the remaining part of the sentence would more likely be something like *(Ellen kissed Ruben and Peter) smiled his approval from a distance*. Hence, your knowledge of the situation described is likely to affect your expectations regarding the structure of the interrupted sentence.

This study investigates whether readers can immediately use their prior knowledge about a certain state of affairs in the process of structurally analyzing a sentence (i.e. parsing). This knowledge will be called *situational knowledge*. It is usually acquired through taking part in events, witnessing these events in real life or through media, or by hearing or reading about them. More generally, the question is whether non-syntactic factors immediately affect the initial parse of a sentence or whether it is solely determined on the basis of syntax-based parsing preferences.

Syntactic ambiguity has often been used as a window on sentence processing (see section 1.2.). In particular, garden path sentences, i.e. syntactic ambiguities that always seem to cause processing to break down, have proven to be a useful tool for investigating the parsing process. Therefore, syntactic ambiguity, specifically, the NP-/S-coordination ambiguity is used as a tool in the current study as well.

The exact issues that the present study aims to investigate are the following. (1) Does situational knowledge immediately affect the initial parse of a sentence? The aim is to already demonstrate effects of this

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factor at the onset of the ambiguity. Previous research has produced results that can be reconciled with both a modular and an interactive approach to parsing. In the current study, the aim is to optimize the chance of obtaining unequivocal data, i.e. data that unambiguously support one model of parsing. It is believed that this can be accomplished by showing effects of situational knowledge on the onset of the NP-/S-coordination ambiguity. This is further explained in Chapter 2.

(2) How does situational knowledge interact with other, particularly syntactic factors? In order to investigate this question, the influence of situational knowledge is not only investigated in isolation, but also in contrast to the influence of another factor, viz. subject-verb agreement. In particular, it is investigated which factor outweighs the other if both factors conflict.

(3) Does the effect of situational knowledge and subject-verb agreement depend on readers' working memory capacity? Working memory capacity was defined by using the Daneman and Carpenter (1980) reading span task (cf. Just & Carpenter, 1992).

The working hypothesis of this study is that sentence processing is a *strongly* interactive process in which different sources of information are brought to bear on decisions regarding the structure of the sentence immediately. More specifically, situational knowledge is expected to immediately guide the initial parse of a sentence. If and how situational knowledge and subject-verb agreement interact and whether the working memory capacity of readers affects the degree of interaction between different constraints is investigated from an explorative angle.

The structure of this study is as follows. In the present chapter, some of the most prominent theories of sentence processing are briefly described (section 1.2.1-1.2.4). This is followed by an overview of experimental studies on how and when different sources of information determine parsing (section 1.3). In Chapter 2, the NP-/S-coordination ambiguity is explained, previous research on the resolution of this ambiguity is described and the manipulation of situational knowledge and subject-verb agreement is explained. In Chapter 3, the impact of situational knowledge on the (on-line) processing of temporarily ambiguous S-coordinations is investigated. This is done in an off-line completion study, an off-line judgment study and an on-line moving window self-

paced reading experiment. Furthermore, it is investigated whether the effect of this factor depends on readers' reading span. In Chapter 4 and 5, the influence of situational knowledge is investigated in isolation as well as in contrast to the influence of subject-verb agreement. This is done in two off-line completion studies and an off-line judgment study and in an on-line moving window self-paced reading experiment (Chapter 4). In these experiments, temporarily ambiguous NP-coordinations are used. Chapter 5 describes an eye movement study that partly replicates the on-line self-paced reading experiment of Chapter 5 and partly elaborates on it. Finally, in Chapter 6 the experimental findings of the current study are summarized and discussed. Furthermore, the findings are embedded in the existing literature on the "interaction or modularity"- debate.

In the remainder of this chapter, a theoretical background is presented to position the current study in the field. This elaborate review is used to demonstrate how the current study complements the existing knowledge regarding the "interaction or modularity"- issue.

1.2 Theories of sentence processing

In the process of understanding language, perceivers have a range of different knowledge sources at their disposal: knowledge concerning the properties of words (lexicon), the structural aspects of a sentence (syntax), the meaning of words and constituents (semantics) and knowledge regarding the discourse context and real life situations to which sentences refer (pragmatics). No one will dispute that all these sources of information are eventually used in order to assign a (correct) structure and meaning to an utterance. However, exactly when each source exerts its influence in the course of this process is still a highly debated issue. Moreover, (the influence of) some factors has been investigated in considerably more detail than others.

The aim of the present study is to contribute to answering the question of how and when different sources of information determine the parsing process. In doing so, a source of information is investigated that has not received much attention yet, viz. situational knowledge. In order to reveal the impact of this factor, syntactic ambiguity is used. This type of ambiguity has proven to be a useful tool for investigating the time course of the structural analysis of a sentence (i.e. parsing). More

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specifically, it can reveal which attachment decisions are made and which factors eventually determined this decision. Furthermore, investigating sentences that are locally syntactically ambiguous can clearly show when processing fails, i.e. when readers initially misanalyze the sentence. One of the most famous examples of a garden path sentence is the sentence *The horse raced past the barn fell* (Bever, 1970). Problems arise in this sentence, because the verb *raced* is ambiguous between a past tense main verb (with *the horse* as its subject) and a past participle (producing a reduced relative clause). As *fell* turns out to be the main verb of this sentence, *raced* should be interpreted as a past participle. However, readers prefer the main verb interpretation of *raced*, leading to a breakdown upon encountering *fell*.

Finally, and not unimportantly, judging by the huge amount of experimental research that used this phenomenon as a window on sentence processing, syntactic ambiguity seems to be easy to manipulate.

1.2.1 Modular versus interactive models

A great deal of research on sentence processing has focused on the comparison of models that range from being highly modular to fully interactive (for overviews, see e.g. Singer 1990; Mitchell, 1994; Tanenhaus & Trueswell 1995; Crocker, 1999; Rayner & Clifton, 2002). Even though these models seem highly contrasting, differences among them are more subtle than one might expect.

One basic characteristic of modular models is that the human language processor is seen as subdivided into different components or submodules, each responsible for one specific aspect of language processing (i.e., lexical, syntactic, semantic or pragmatic processing). However, interactivity does not exclude the possibility of different components being dedicated to different tasks (see e.g. Crain & Steedman, 1985; Singer, 1990). On the other hand, an important characteristic of interactive models is that the different sub modules communicate in order to achieve a correct interpretation of an utterance. Nevertheless, proponents of modularity agree that this must be the case in order for a sentence to be processed successfully. What, then, are the exact differences between both views on sentence processing?

The modularity debate can be divided into two different sub issues (see e.g. Trueswell, Tanenhaus and Garnsey (1994, p. 307). The first concerns whether distinct types of linguistic representations (grammatical,

semantic, et cetera) can be distinguished. This is called *representational modularity*. The second concerns whether there are informationally encapsulated subsystems within the language processing system, corresponding to levels of linguistic structure, and is called *processing modularity* (see Fodor, 1983). This latter type of modularity is most likely to entail representational modularity as well. After all, informationally encapsulated subsystems are most likely to produce distinct types of linguistic representations. Conversely, it is not inconceivable that different linguistic representations are produced by one single (nonmodular) processing system.

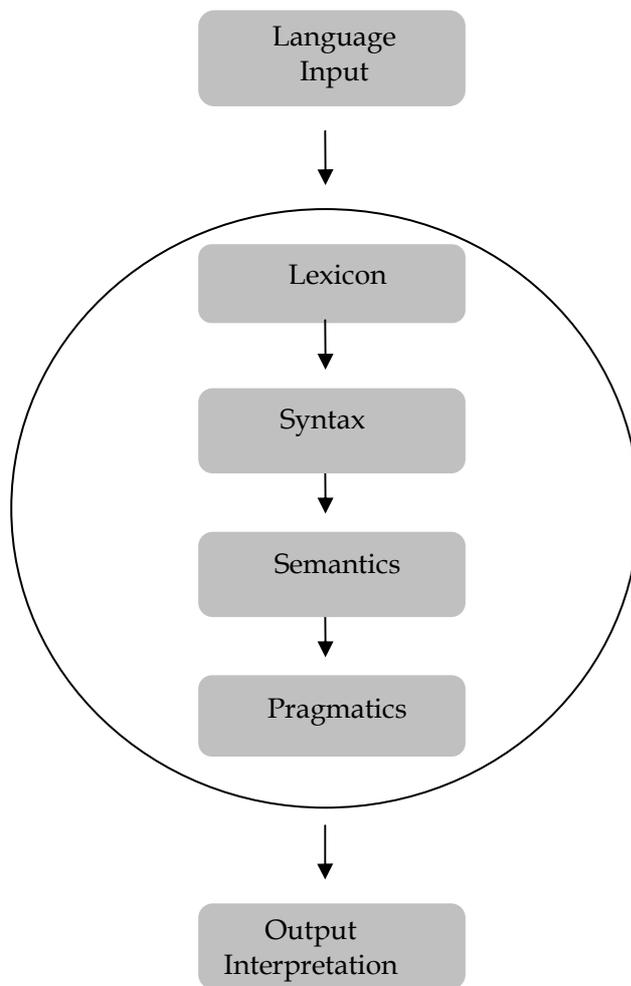
The “modularity or interaction”-discussion focuses on processing modularity. The various accounts differ with respect to the exact moment of interaction: modular models allow components to share only (semi-) complete analyses (see Figure 1), whereas strong interactive ones allow different components to exchange information at every processing stage (see Figure 2).¹

In the following, a concise outline is presented of some well-known modular and interactive approaches to sentence processing. Instead of presenting a complete overview of all models that have been proposed over the past decennia, some subtle but crucial differences will be outlined.

¹ It should be noted that if one argues that the syntactic analysis of a sentence is not a freely interactive process, but rather a modular one, one must determine when exactly the syntactic processor shares its product with other components (see Crain & Steedman 1985, p. 322-325, Frazier, 1987; Singer 1990, p. 87).

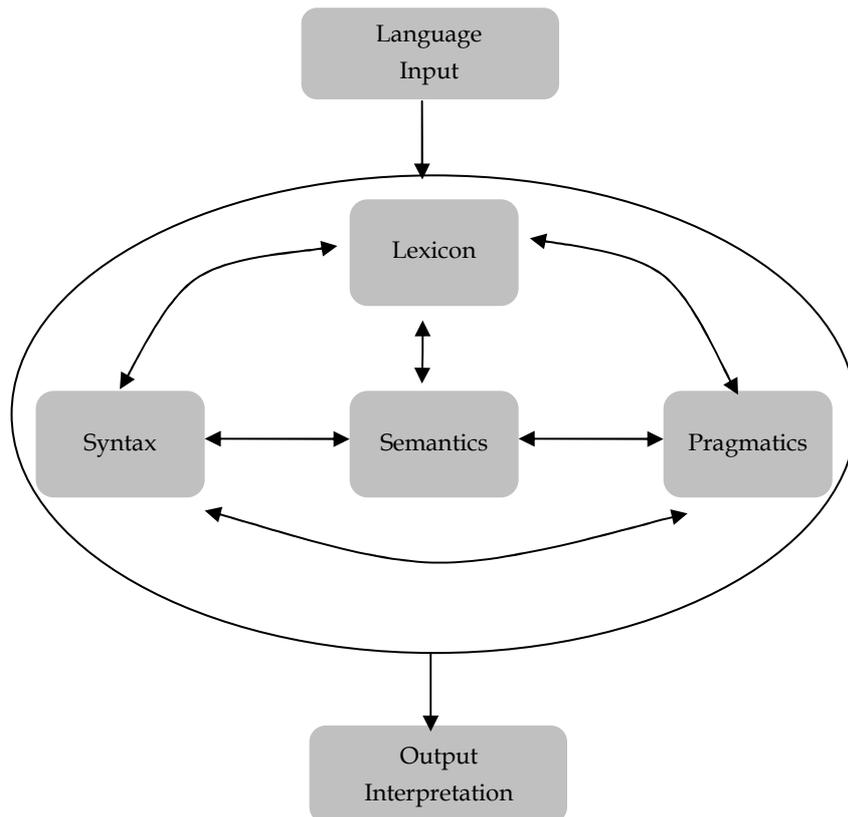
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Figure 1: A modular model of language processing



Note: the arrows that connect the different sources of information within the circle indicate in what order the corresponding subsystems share their output. Specifically, only (semi-) complete analyses are shared with the next component.

Figure 2: An interactive model of language processing



Note: the arrows that connect the different sources of information within the oval indicate that the different components exchange information at every processing stage.

1.2.2 Modular models

A clear proposal of what modularity entails is presented by Fodor (1983; see also Clifton & Ferreira, 1987; Marslen-Wilson & Tyler, 1987 for a discussion of this model). He argues that the language system involves at least two different kinds of processing. In their discussion of modularity, Marslen-Wilson and Tyler (p. 37) give a description that covers the fundamental features of these processes quite well:

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“A modular, highly constrained, automatized “input system” operates blindly on its bottom-up input to deliver, as rapidly as neurally possible, a shallow linguistic representation to a second kind of process, labeled by Fodor a “central process.” This relates the output of the modular input system to the listener’s knowledge of the world, of the discourse content, and so on” (quotation marks in the original).

Some characteristics that distinguish the Fodorian input systems from the central processes are that they are domain specific, mandatory, fast, informationally encapsulated and that they produce a shallow linguistic output. For the current discussion, the most important of these is that the input systems are informationally encapsulated from the central processes. What this implies is that the central processes cannot directly affect processing within the input system.

However, Fodor makes no claims for autonomous processing *within* the language processor (see p. 76). He argues that the idea of informational encapsulation of the so-called language-recognition module as a whole must be carefully distinguished from the idea that certain information can have top-down influence *within* this system. Fodor acknowledges that evidence for the latter phenomenon has been provided, but no evidence has been provided against the idea that the language module as a whole is autonomous: it cannot be influenced by information that is not linguistically specified. Specifically, syntactic parsing cannot be guided by factors such as semantics and general world knowledge. As Fodor puts it: “there are, in general, so many syntactically different ways of saying the same thing that even if context allowed you to estimate the content of what is about to be said, that information wouldn’t much increase your ability to predict its form” (p. 78). Fodor does acknowledge the possibility of some “context analyzer” that uses semantic information to either accept or reject the analysis that the language processor proposed. However, this contextual analyzer is still not capable of telling the language processor which analysis it should try next.

Even though Fodor is often seen as the founding father of modern modularity, his work was actually antedated by Forster (1979), who proposed an even stricter account of modularity (see also Frazier, 1987c). Contrary to Fodor, Forster does pay attention to the internal architecture

of the language processor. His model consists of four separate processing systems. The language processor is represented by a linear chain of three so-called *microprocessors*, viz. a lexical processor, a syntactic processor and a message processor (which converts the linguistic representation to a representation of the intended message). Each microprocessor has access to the lexicon only, and exclusively accepts input from the microprocessor that precedes it (i.e. the next lowest microprocessor). Its output is sent to the next highest microprocessor. As a consequence, the operations of a particular microprocessor cannot be intervened or altered by any higher level microprocessor. This implies total autonomy of processing.

The output of a microprocessor is also sent to the remaining system: the general problem solver (GPS), which can be seen as the “decision maker”. The GPS cannot directly interfere with the operations of any of the microprocessors and has no information of the microprocessors other than their output. It acts upon this output using conceptual knowledge (i.e. a person’s general knowledge and beliefs about the (real) world), to which the different microprocessors have no access.

The best-known example of an actual parser that was elaborated on the basis of Fodor’s ideas of modularity is Frazier’s *garden path model* (Frazier, 1987a). In this model, sentence processing comprises two stages, which are organized into two different processing modules: a syntactic processor (i.e. the parser) and a thematic processor. The syntactic processor initially constructs one possible structure on the basis of syntax-based parsing strategies like *minimal attachment* (always initially construct that structure of the sentence that creates the least number of nodes in the parse tree) and *late closure* (if possible, attach new items within the clause or phrase currently being processed). At this stage of processing, there is no top-down influence of non-syntactic factors like semantics and pragmatics.

During the next stage, the thematic processor evaluates the proposed structure with regard to semantic and pragmatic plausibility and, if necessary, proposes an alternative structure. The thematic processor is assumed to operate concurrently with the syntactic processor. This implies that, even though there is no top-down influence of the thematic processor on the initial analysis of the sentence, it can reject an inappropriate analysis immediately after it is proposed (Crocker, 1999).

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Over the years, considerable evidence has been provided for the garden path model and modularity in general (see e.g. Ferreira & Clifton, 1986; Clifton & Ferreira, 1987; Frazier, 1987a, b, c; Clifton & Ferreira, 1989; Mitchell, Corley & Garnham, 1992; Rayner, Garrod & Perfetti, 1992; Murray & Liversedge, 1994; Binder, Duffy & Rayner, 2001; Clifton Jr., Traxler, Mohammed, Williams, Morris & Rayner, 2003). However, the evidence for interactive models of language processing seems to be mounting up at a faster pace. This results in models that advocate a more direct communication between different processing components and the use of multiple sources of information at the same time. In the following section, a number of different interactive accounts are discussed.

1.2.3 Interactive models

1.2.3.1 Referential theory

In general, the evidence for syntax-first models of parsing comes from studies in which garden path sentences were used as a research tool. Often, these sentences were provided to participants in isolation. However, the idea that garden path sentences are a phenomenon in itself has been disputed. The *referential theory*, which has been proposed by Crain and Steedman (1985; see also Altmann & Steedman, 1988), assumes that “there may be no such thing as an intrinsically garden path sentence structure, but rather that for a given sentence, certain contexts (...) will induce a garden path effect, while others will not” (p. 322). The basic principles of the theory are the *principle of referential success* (“If there is a reading that succeeds in referring to an entity already established in the hearer’s mental model of the domain of discourse, then it is favored over one that does not”, p. 331) and the *principle of parsimony* (“If there is a reading that carries fewer unsatisfied but consistent presuppositions² or entailments than any other, then (...) that reading will be adopted as most plausible by the hearer (...)”, p. 333).

To illustrate this idea, consider the famous sentence *The horse raced past the barn fell* (Bever, 1970). Readers prefer to analyze the verb *raced* as a past tense main verb (with *the horse* as its subject), but it turns out to be a

² Crain and Steedman’s (1985) presuppositional account of modified NP’s has been called into question. The current study leaves no room to further discuss this issue, but see e.g. Sedivy (2003). The term *implicatures* will be used here instead of the term *presuppositions*.

past participle (producing a reduced relative clause). Crain and Steedman claim that whether readers are garden pathed by this particular structure depends on the preceding context. If the context contains more than one equally plausible referent for *the horse*, readers need to restrict the set of possible referents when they encounter this phrase. Since a restrictive relative clause is a good way of doing this, readers immediately choose this (correct) analysis. However, if the preceding discourse contains only one possible referent for *the horse*, there is no set of possible referents that needs to be restricted. Therefore, readers are expected to initially select the main clause analysis, causing a garden path effect. In other words, the relative degree of referential success of the possible analyses of a sentence predicts which one is preferred.

Importantly, a scenario in which the above sentence is presented in isolation or embedded in a context in which no horses have been mentioned whatsoever is not assumed to be neutral. Even though such *null-contexts* do not provide a referent for either the main clause or the reduced relative clause reading, these readings may still differ in the number of implicatures they invoke and, therefore, in the ease with which their referents can be set up. More specifically, the reduced relative reading is considered to be more complex in a null-context than the main clause reading. The reason for this is that the former structure implies the existence of several horses in the discourse context rather than one and some further facts about how these horses can be distinguished (here: only the intended horse was raced past the barn). On the basis of the larger number of implicatures for the reduced relative reading, this interpretation is considered to be more difficult in a null-context than the main clause interpretation.

Referential theory is often referred to as a *weak interactive* account of ambiguity resolution. The term *weak interaction* is used to describe models that support the idea that information about the plausibility of a certain interpretation cannot *guide* the syntactic analysis of the sentence, but it can *evaluate* or *correct* the proposed alternative(s). Models that advocate the idea that plausibility information can in fact guide the parse of a sentence are called *strong interactive* and are discussed in section 1.2.3.3.

However, the term *weak interactive* is somewhat confusing, because weakly interactive models are fully consistent with modular accounts

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like the garden path model (see e.g. Altmann & Steedman, 1988; Clifton & Ferreira, 1989). First, both theories assume that the language processor consists of different sub modules, with lower-level ones passing their output on to higher-level ones. Second, both classes of theories deny a form of strong interaction. Thus, both theories subscribe to the modular “propose and filter” architecture (Tanenhaus & Trueswell, 1995). Third, both theories claim that the semantic evaluation of the structural alternatives is done incrementally.

Then, why refer to the referential theory as being an interactive account rather than a modular one? The crucial difference between the referential theory and the garden path model is that the former permits a closer interaction between the syntactic and the semantic/referential modules than the garden path model (i.e., according to the referential theory, the purely syntactic processes propose their analyses for disposal by semantics on a word-by-word basis; see e.g. Crain & Steedman, 1985; Altmann & Steedman, 1988). Another important difference is that the garden path model proposes that one possible structure is constructed at a time, whereas the referential theory claims that multiple alternative structures are offered in parallel in order to be evaluated (even though only one preferred reading is put forward for full analysis).

1.2.3.2 *Constraint-based models*

The basic features of the *constraint-based approach* are that (a) the most likely syntactic alternatives of a structural ambiguity are activated, that (b) multiple sources of information provide evidence for these alternatives, and that (c) the alternatives compete with one another during processing, until the structure remains that is eventually most supported by the available constraints (see e.g. Tanenhaus & Trueswell, 1995; Rayner & Clifton, 2002 for an overview; see also e.g. Spivey-Knowlton & Sedivy, 1995; Spivey & Tanenhaus, 1998). Processing difficulty occurs when different alternatives receive equal support or when particular input is incompatible with the alternative that received the most support up to that point. A conscious garden path arises when the correct structure is no longer available by the time the disambiguating information is encountered.

The constraint-based approach differs from the garden path model in that no sharp distinction is made between a first stage of structure building and a second stage of evaluation and, if necessary, revision.

Rather, ambiguity resolution is considered a continuous process in which multiple sources of information help to select one syntactic analysis among several alternatives. A clear difference between the constraint-based approach and both the garden path model and referential theory is that in constraint-based models different types of constraints generally do not a priori overrule others, like syntax-based constraints in the garden-path model and discourse/referential factors in case of referential theory. Instead, the constraint-based approach underlines the importance of the strength of different constraints. More specifically, the effectiveness of one constraint depends on the strength of others. Moreover, the effects of non-syntactic factors are predicted to be found at the earliest measurable point after the start of an ambiguity.

With respect to representational and processing modularity, proponents of constraint-based models generally subscribe to both, as they agree with the notion of distinct types of linguistic representations and with the idea of language being (at least partially) processed within informationally encapsulated subsystems (Trueswell, Tanenhaus & Garnsey, 1994). However, the constraint-based approach is non-modular in that the different subsystems are not considered to be completely informationally encapsulated. There is a very close interaction between the different sub modules, and some types of information do not overrule others in advance. Rather, information from all possible sources is optimally integrated in order to achieve a correct interpretation of a sentence.

A considerable amount of evidence has been reported in favor of the constraint-based account of sentence processing (see, among many others, Altmann, Garnham & Henstra, 1994; MacDonald, 1994; MacDonald, Pearlmutter & Seidenberg, 1994; Spivey-Knowlton & Sedivy, 1995; Spivey & Tanenhaus, 1998; Altmann, Van Nice, Garnham & Henstra, 1998; Van Berkum, Brown & Hagoort, 1999a). However, even though several instances of constraint-based models ultimately make the same predictions, the approaches of these models are often quite different.

An example of a rather detailed constraint-based model is the *competition-integration model* (McRae, Spivey-Knowlton & Tanenhaus, 1998; Spivey & Tanenhaus, 1998; see also Elman, Hare & McRae, 2004; Van Gompel, Pickering, Pearson, Liversedge, 2005). This model is argued to realize an account of sentence processing in which alternative

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structures are computed in parallel and compete with one another for activation, using multiple constraints. In Spivey and Tanenhaus' (1998) version of the model, it is estimated to what degree a certain constraint biases towards one of the alternative structures. Consider the following sentence, taken from Spivey & Tanenhaus:

- (1) The actress selected by the director believed that her performance was perfect.

The string *The actress selected* is temporarily ambiguous between a main clause reading (e.g. *The actress selected some scripts*) and a reduced relative reading (hereafter: MC/RR ambiguity). In a corpus, 124 sentences were found in which a *by*-phrase immediately followed upon the *ed*-form of a verb. In 99 of these sentences the *by* phrase introduced an Agent in a passive construction, as in sentence (1). On the basis of this information, the bias of the *by* phrase is set to 99/124 for the RR reading and to 25/124 for the MC reading.

However, whereas the probabilistic support of a constraint can vary, the weight of each constraint is kept constant. For example, the influence of the thematic fit of a potential argument on the resolution of the MC/RR interpretation is considered of the same weight as the influence of frequency information. McRae et al. (1998) take this one step further by assigning weights to each of the tested constraints as well. In order to do this, sentence completion data are collected for fragments that are compatible with both the MC and the RR reading. Subsequently, the weights of the constraints are set in such a way that a model is obtained that can simulate the completion data. Finally, the resulting model is used to predict on-line reading times.

Given each input element (word), there are several processing cycles in the model. During each cycle, evidence is computed in support of the different alternatives. Competition ends when the activation of one of the alternative analyses reaches a threshold. After this, the processor moves to the next word. In other words, the model can be incrementally provided with information, i.e. in the same manner as readers process the words of a sentence. Therefore, the model's changing interpretation of a sentence can be measured.

The competition process is long-lived if different possible analyses of a sentence are approximately equally supported by the various

constraints. In such a case, many processing cycles are needed for one of the alternatives to reach the threshold. As a result, processing the sentence will be relatively slow and hence difficult. On the other hand, if one possible analysis is strongly favored by all constraints, competition is short-lived and processing will be easy.

It is important to note that the competition-integration model solely makes predictions about how different constraints influence the resolution of syntactic ambiguity, i.e. how one structure is selected among several alternatives. The question how these syntactic alternatives are generated in the first place is left out of consideration. More specifically, different alternative structures are equally (un)activated before they enter the computational model, i.e. before one structure is selected on the basis of all available constraints.

All in all, the competition-integration model is argued to account for superficially conflicting data patterns in the ambiguity resolution literature. It shows “how graded variation in context effects, across stimulus items as well as across experiments, can be due to informational biases inherent in the stimulus materials, not the architectural constraints on the processing system” (p. 1541). See section 1.3.5 for more details on Spivey and Tanenhaus’ study.

A model that shows similarities with the computation-integration model, but focuses more on which alternative syntactic structures are initially considered, is the *visitation set gravitation* model of Tabor, Juliano and Tanenhaus (1997; see also Tabor & Tanenhaus, 1999). They support a so-called *dynamical systems approach* to parsing, in which syntactic alternatives are represented as attractors in a metric space. This model can be considered a self-learning system. As it learns to process the input of words, it places words that are likely to be followed by similar constructions close to each other in the space. Therefore, the eventual performance of the model strongly depends on this learning process. In order to model reading times, the information of each successive word is used to place the processor somewhere in the so-called attractor space. If there is strong probabilistic evidence for a certain reading, the word is positioned nearby the appropriate attractor. On the other hand, if the probabilistic evidence is supportive of, for example, two interpretations, the word is placed at an intermediate position between the two corresponding attractors. Reading times correspond to the time it takes the processing system to gravitate to an attractor from where it was

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initially placed in the space. In other words, if the probabilistic evidence is highly supportive of the correct structure of a sentence, gravitation time is short, whereas gravitation time is long if the constraints show mixed evidence or if they initially strongly support the wrong structure of the sentence.

Tabor et al. examined the role of lexical and syntactic frequency and leave the role of, for example, semantics and the discourse context out of consideration. However, in a follow-up study, Tabor and Tanenhaus (1999) model reading times for thematic effects on sentence processing as well. This resulted in a competition mechanism similar to that of McRae et al. (1998).

A class of constraint-based models that emphasize the role of lexical factors in syntactic ambiguity resolution is the class of *constraint-based lexicalist models*. This class of models considers syntactic ambiguity resolution to be a process that is “contextually constrained but lexically dominated” (MacDonald, Pearlmutter and Seidenberg (1994), p. 697; see also Trueswell, Tanenhaus and Garnsey (1994)). In particular, contextual knowledge can be used to decide between a small number of interpretations that are yielded by lexical processing, but it is less effective in selecting one single analysis in advance.

An important characteristic of the constraint-based lexicalist account is that both lexical and syntactic ambiguities are governed by the same types of knowledge representations and processing mechanisms. Specifically, syntactic ambiguities are based on ambiguities at the lexical level. Additionally, MacDonald et al. argue for a richer lexical representation. For example, the lexical entry of a verb not only includes orthographic, phonological and semantic information, but also information about its argument structure, which encodes the relationships between the word and the phrases that typically occur with it. The verb form activates the thematic roles that are associated with the verb. The assignment of thematic roles is argued to take place immediately, with the thematic fit of a potential argument being evaluated with respect to the active alternatives.

Boland & Blodgett (2001) aimed at investigating the process of constructing a syntactic structure rather than the selection of a structure among several possible alternatives. In order to do this, they investigated syntactically unambiguous sentences that contained noun/verb homographs (e.g. *They saw him sign*). The authors argue that some of the

different constraint-based approaches that were described above make different predictions about this linguistic phenomenon. Therefore, it is considered a good tool for determining how different constraints affect the process of syntactic generation (see p. 393 for further details).

In an eye-movement study, the effects of lexical frequency and discourse congruency were investigated. The results provide evidence for a constraint-based lexicalist model with two different categories of constraints. The first includes lexical bias effects and affects the generation of syntactic alternatives. The second includes the first category, as well as discourse bias and affects the selection of one structure among the constructed alternatives.³

A framework that does not so much concentrate on how different sources of information interact, but does share several properties with models like the competition-integration model is Gibson's (1998) *Syntactic Prediction Locality Theory* (SPLT). According to this model, each possible analysis of an input-string is associated with a level of activation, which indicates how highly rated this structure is according to different constraints. These constraints include the memory and integration cost associated with each of the alternatives, as well as factors like lexical frequency, plausibility and context. Only highly ranked structures, i.e. above some threshold, are pursued, whereas alternatives below this threshold are discarded. If all constraints favor one structure for the input, it will quickly receive a high activation. If there are two analyses that receive similar support, it will take longer for one of the structures to exceed the threshold, due to a limited pool of computational resources. More than one possible structure can be retained in parallel, as long as the activation level of the least preferred alternative is close to that of the highly preferred interpretation.

The models that were described so far consider the modularity-or interaction issue one that concerns the architecture of the sentence processing system. However, Just & Carpenter (1992) introduce the *capacity constrained comprehension theory*, which assumes that there is a positive correlation between readers' working memory capacity and the extent to which non-syntactic information can affect the initial analysis

³ For further research on the influence of lexical frequency information, see e.g. Gibson (2006). In this paper, several self-paced reading experiments are discussed that suggest that lexical frequency information is independent of syntactic information in on-line processing, and strongly interacts.

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of a sentence. Specifically, only readers with a large working memory capacity are argued to be sensitive to non-syntactic constraints during the initial syntactic analysis of the sentence.

In sum, even though constraint-based models generally consider different constraints as equally affecting the *selection* of one structural analysis among several possibilities, the question which factors influence the *generation* of the structural alternatives is often either left out of consideration, or considered to be a lexical/syntactic affair. As Van Berkum, Brown and Hagoort (1999a) put it: “we do not deny that sentence processing is “syntax-first” in the sense that it is driven by word class and other central syntactic information associated with the incoming words. After all, it is this information that defines (...) a structural ambiguity in the first place” (p. 179; quotation marks in the original). In other words, as soon as a structural ambiguity emerges, all different kinds of information can help to immediately resolve it. However, to define a particular word or constituent as being structurally ambiguous, some lexical/syntactic information is necessary. Thus, non-syntactic factors are assigned an evaluative rather than a guiding role. Accounts of sentence processing that support the notion that non-syntactic factors can guide/predict the initial analysis are described in the following section.

1.2.3.3 *Strong interactive models*

Strong interactive models are interactive models that hold that different sources of information guide which alternative syntactic analyses are constructed in the first place. According to these models, all different sources of information are used to co-determine the initial analysis of a sentence (see e.g. Mitchell, Corley & Garnham, 1992; Tanenhaus & Trueswell, 1995). Hence, in the case of strong interactive models, different sources of information, such as situational knowledge, do not *evaluate* possible syntactic analyses (as in the case of constraint-based models), rather these sources directly control which alternative(s) is (are) *proposed* in the first place.

One account that proposes this kind of strong interaction is the *parallel distributed processing account* (see e.g. McClelland, St. John & Taraban, 1989). This account even goes beyond strong interaction in assuming that “the syntactic and conceptual aspects of processing are in fact inextricably intertwined” (p. 329). McClelland et al. propose to call this

approach an integrative instead of an interactive one, because “interactivity suggests that separate systems exert simultaneous and mutual influence (...), even though they construct separate representations of different kinds of information. In the present approach, there is but a single integrated system in which syntactic and other constraints are combined in the connection weights, to influence the construction of a single representation reflecting the influences of syntactic, semantic and lexical constraints.” In other words, this theory denies both representational modularity and processing modularity: it assumes one single processing system combines all different constraints to build one single representation.

The parallel distributed processing account represents a quite extreme idea of what strong interaction entails. A less strict idea of strong interaction is proposed by Grodner, Gibson and Watson (2005). In particular, their idea of strong interaction does seem to subscribe to the idea of both representational modularity and processing modularity. However, they share the idea of McClelland et al. that non-syntactic information can immediately influence the parsing process. Grodner et al. tested the so-called *Strongly-Interactive Mental Model Hypothesis*, which states that whenever discourse factors can predict the syntactic structure of a sentence, they will be used to do so. In other words, non-syntactic factors can in fact co-determine which analysis of a sentence is built in the first place, rather than only help to evaluate possible syntactic alternatives. Results of a self-paced reading study, which investigated the influence of referential context, provided evidence for this idea (see section 1.3.2).

Kim and Osterhout (2005) also argue for a strong interactive framework. More specifically, on the basis of the results from several ERP experiments, they propose a model in which syntactic and semantic systems function independently, but can nonetheless influence each other. Each system recognizes attractive analyses. The more attractive (i.e. plausible) an analysis, the higher the chance that it will dominate the analysis that is put forward by other systems (see also section 1.3.1).

That discourse information can predictively activate a particular representation of the upcoming information has been suggested by Altmann, Van Nice, Garnham & Henstra (1998) as well. They argue that it is impossible to predict the exact form of any sentence following a particular discourse context. However, “the language user will

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continually adjust his or her predictions on the basis of what has been encountered so far of the following sentence” (p. 479). In section 1.3.4, some studies on the predictive influence of non-syntactic constraints factors are presented.

1.2.3.4 Summary

Over the years, various approaches to the on-line resolution of syntactic ambiguities have been proposed. By and large, they can all be classified under four frameworks. The first is the syntax-first approach, which maintains that the initial analysis of a sentence is guided by syntax-based principles only. An example of such an approach is the garden path model. The second is referential theory, which gives a special status to referential/discourse factors: among the proposed syntactic alternatives the structure is selected that best fits the discourse model. In short: syntax proposes and discourse disposes. The third is the constraint-based approach, which prescribes that several syntactic alternatives are computed in parallel and that different sources of information are immediately used to select among them. How much weight different factors exert during the generation of the different structural alternatives is an issue that is often considered a lexical/syntactic matter, or is left out of consideration. In the present study, the term “constraint-based model” is used to refer to approaches that share the central claim that processing preferences are determined by the interaction of multiple constraints, including aspects such as frequency and plausibility, and that the different possible analyses compete for activation in parallel. The fourth is the strong interactive account, which claims that all sorts of information are used to guide the parsing process. More specifically, instead of being used to choose among possible interpretations (i.e. syntactic selection), different constraints can co-determine or predict which alternative(s) should be generated in the first place (i.e. syntactic generation).

Summarizing, the main focus has been on the question whether non-syntactic factors can immediately influence the initial analysis of a sentence. Specifically, whether non-syntactic factors immediately affect the *selection* of an initial structure from a set of the most plausible syntactic alternatives or even immediately direct the *construction* of the most plausible structure(s). However, it is important to not only show *that* this is the case, but also to investigate the process of *how* this works.

In particular, instead of focusing solely on the question whether a particular non-syntactic factor immediately affects parsing, it is important to gain more insight in how this factor interacts with other (non-syntactic) factors. What happens if the constraints converge and what if they conflict? The computation-integration model (Spivey & Tanenhaus, 1998; McRae et al, 1998) is an example of a model that looks into the interaction of several factors. In section 1.3.5, two studies that investigated several constraints at the same time are discussed in more detail.

1.2.4 Serial versus parallel processing

Although not necessary, most syntax-first models that have been proposed are serial in nature, and most interactive models have been parallel. In case of a serial model, the syntactic processor initially constructs one possible structure, which is subsequently evaluated by a thematic processor (the terminology is derived from the garden path model). Rejection leads to the proposal of one alternative structure. Because only one structural analysis is retained at each parse state, reanalysis is an important aspect of serial models. Parallel models, on the other hand, maintain that several structural alternatives are constructed at the same time and compete for activation until one interpretation remains. Therefore, reanalysis is not a fundamental aspect of parallel models. A conscious garden path only arises when the correct structure is no longer available by the time the disambiguating information is encountered.

Several different types of serial models can be distinguished. First, so-called *fixed-choice reanalysis models* assume that readers always follow the same principles and therefore always initially adopts the same analysis of a particular syntactic ambiguity (see e.g. Van Gompel, Pickering & Traxler, 2001; Van Gompel, Pickering, Pearson, Liversedge, 2005). Both the garden path and referential theory can be considered fixed-choice reanalysis models. According to the garden path model readers follow the principles of minimal attachment and late closure in all circumstances. Even though the referential theory assumes that several alternatives are proposed in parallel, the same principles (i.e. the principle of referential success and the principle of parsimony) are used every time to select the interpretation that best fits the discourse model that has been constructed so far.

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Second, so-called *variable-choice reanalysis models* (or *probabilistic serial models*) assume that one interpretation is initially pursued in some cases and another interpretation in other cases (see e.g. Lewis, 2000). Which interpretation is pursued depends on the amount of support of information prior to the ambiguity: the stronger the support for a particular analysis, the more likely it is that it will be adopted. If two alternative interpretations are equally supported, each of them is adopted approximately half of the time.

One example of this kind of model is the *unrestricted race model*, which has been proposed, among others, by Van Gompel and his colleagues (2001; 2005). According to this model, there are no restrictions on the kind of information that can provide support for alternative analyses of a sentence. Which structure is initially adopted depends on item characteristics as well as individual characteristics. As a consequence, preferences may differ for each sentence that is read by a particular person. The basic underlying principle of the model is that “the alternative structures are engaged in a race, with the structure that is constructed fastest being adopted” (Van Gompel et al., 2001, p. 227). The processor attempts to construct multiple analyses in parallel, but only one of these is adopted. If this analysis turns out to be incorrect, the processor has to reanalyze, leading to processing difficulty.

Another example of a variable-choice reanalysis model is the *tuning hypothesis*, which has been proposed by Mitchell and his colleagues (see e.g., Mitchell, Cuetos, Corley & Brysbaert, 1995; see also Van Gompel et al., 2001, 2005 for a description). This exposure-based model predicts that parsing decisions are determined by the frequency with which alternative analyses are used in the language. As readers differ in their exposure to different structures, they also differ in the analysis they initially select when they encounter a syntactic ambiguity. On the other hand, as only frequency information is used, any given person will have a fixed preference for a particular alternative.

The notion that several structural alternatives are constructed in parallel and that they compete for activation is generally maintained by interactive models. However, it is generally agreed that considering *all* possible alternatives in parallel is psychologically impossible, because of the limited capacity of working memory. The best-known instances of competition-based models are constraint-based models (MacDonald, 1994; MacDonald, Pearlmutter & Seidenberg, 1994; McRae, Spivey-

Knowlton & Tanenhaus, 1998; Spivey-Knowlton & Sedivy, 1995; Trueswell, Tanenhaus & Garnsey, 1994). Van Gompel and his colleagues (2001; 2005) make a further distinction between *long-lasting competition models* and *short-lasting competition models*. The former type of model predicts that the competition between structural alternatives lasts until disambiguating information is encountered. Thus, until this point, all alternatives remain activated. The latter type of model predicts that competition occurs only at the start of the ambiguity. After this point, one of the alternatives quickly receives considerably stronger activation than the others. As a consequence, competition rapidly decreases.

The competition-integration model can be considered an example of a short-lasting competition model. In this model the final activation levels of one word are taken as one of the constraints determining the activation of the alternatives at the subsequent word. Therefore, competition decreases from one word to the next.

In sum, serial and parallel models make quite different predictions with respect to on-line ambiguity resolution. Serial models predict that one syntactic structure is retained at each parse state. If this structure turns out to be incorrect, reanalysis is necessary. In contrast, parallel models predict that multiple possible analyses are retained in parallel and compete for activation until one correct analysis remains. Therefore, reanalysis is never required, unless all sources of information support the wrong structure of the sentence. In this scenario, the disambiguating information indicates that the competition between the different alternative structures produced an incorrect structure.

In spite of the different predictions, experimental evidence has often turned out to be compatible with both serial and parallel accounts. Even though this is an important issue, the current study was not designed to adjudicate between serial and parallel parsing. Therefore, this issue will not be further elaborated here, but see e.g. Lewis (2000) and Gibson and Pearlmutter (2000) for a thorough discussion.

Serial and parallel models not only differ in their predictions concerning the course of the initial analysis, but concerning the process of recovering from a misanalysis as well (see e.g. Crocker, 1999). A serial parser could, for instance, flag the point in the sentence where its initial analysis was determined. If the initially selected analysis turns out to be incorrect, the parser undoes everything up to the last choice point and tries again with selecting an alternative structure.

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A parallel parser could simply discard the alternatives that turn out to be incorrect and forget about them, because it assumes that the correct structure will be among the remaining alternatives. In case of a difficult garden path, this assumption turns out wrong and the correct structure of the sentence is among the discarded alternatives. By contrast, if the preferred analysis is discarded, but the less preferred analyses have remained somewhat activated, readers can quite easily choose an alternative analysis, leading to a relative small processing cost. Gibson's syntactic prediction locality theory (1998), for instance, assumes that if alternative structures are not being considered anymore, their activation decays over time. However, they do remain in a somewhat activated state and can therefore be reactivated during a possible stage of reanalysis.

From the point of view of developing a complete model of sentence processing, it is important to account for both the initial phase of sentence processing and the process of reanalysis. The current study does not aim at the development of a complete model of sentence processing, but rather on the on-line coordination of multiple sources of information during this process. Therefore, the focus is on the initial analysis of a sentence rather than on its reanalysis.

1.3 The effect of non-syntactic constraints on parsing

As was illustrated in the previous sections, many different models of sentence processing have been proposed. Numerous of these have considered the initial analysis of the sentence a process that is solely based on syntax-based parsing preferences. More specifically, these parsing principles are argued to operate autonomously during the initial analysis of a sentence, i.e. without taking non-syntactic information into account.

However, other studies have refuted these syntax-first approaches; they have shown that non-syntactic factors immediately affect the parsing process. In doing so, numerous different non-syntactic factors have been investigated, yielding several interactive models of sentence processing. In the following sections, an overview is presented of some of the most frequently investigated non-syntactic factors.

1.3.1 Semantics

One factor that has received considerable attention is lexical semantics, which is often investigated by manipulating the animacy of a noun. Many experiments that showed an immediate influence of this factor on parsing were replications of an experiment conducted by Ferreira and Clifton (1986).

Ferreira and Clifton monitored eye movements while participants read word strings that were ambiguous between a reduced relative clause and a main clause sentence. Examples of such strings are the following:

- (2) The defendant examined by the lawyer turned out to be unreliable.
- (3) The evidence examined by the lawyer turned out to be unreliable.

The verb *examined* can express both a past tense form as well as a passive participial form. Therefore, a noun phrase (*the defendant/the evidence*) followed by this kind of verb will be temporarily ambiguous between a main clause reading (hereafter MC reading; past tense) and a reduced relative clause (hereafter RC reading; participial). Both syntax-first accounts and constraint-based accounts predict a preference for the MC interpretation in sentence (2). The first because of the syntactic simplicity of the MC reading as compared to the RC reading. The latter for example because the semantic properties of the phrase *the defendant* make it a good Agent of the verb (i.e., it is animate), promoting an MC interpretation.

In sentence (3), the semantic properties of the phrase *the evidence* make it an implausible Agent, because it is inanimate. The garden path model nonetheless predicts a preference for the MC interpretation, because semantic information is ignored during the initial analysis of the sentence. However, a constraint-based model predicts that an inanimate noun that is both a poor Agent and a good Patient or Theme will support the RR reading of the sentence (see e.g. Trueswell, Tanenhaus & Garnsey, 1994). According to this account, the crucial question is whether the factor animacy can override the strong frequency-based preference for the MC interpretation.

Ferreira & Clifton's results showed no impact of animacy on the initial analysis of the RR sentences, providing evidence for a syntax-first model.

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Trueswell et al. (1994) however, argue that Ferreira and Clifton's experiment has several shortcomings, one of which being the rather weak manipulation of animacy. In fact, many of the test sentences with inanimate nouns could still have been plausibly continued as a main clause, because the inanimate noun could play the role of, for example, an Instrument, as in the phrase *The car towed the trailer*.

For this reason, Trueswell et al. conducted two eye-movement experiments, in which several adjustments were made. Interestingly, the results of these experiments did show immediate effects of animacy. Furthermore, post-hoc regression analyses showed that the effect of the contextual constraint depended upon its strength: RR clauses that started with an inanimate noun that was both a poor Agent and a good Patient or Theme behaved similarly as unambiguous RR clauses, whereas the items with a weaker semantic fit showed results similar to those of Ferreira and Clifton. Over the years, such strong effects of animacy have been replicated several times (see e.g. MacDonald, 1994; Mak, Vonk & Schriefers, 2002; Hagoort, Hald, Bastiaansen & Petersson, 2004).

In several ERP-experiments, Kim and Osterhout (2005) investigated sentences that contained phrases such as *the meal was devouring*.... In this phrase, the syntactic cues unambiguously indicate an Agent interpretation of the noun preceding the finite verb, whereas the semantic cues support a Theme interpretation. The Agent interpretation would result in an semantically anomalous sentence (meals do not devour things), whereas the Theme interpretation results in a syntactic anomaly (*devouring* should be *devoured*). The results seem to indicate that semantic information can dominate syntactic cues. On the basis of this, the authors propose a strong interactive framework (see section 1.2.3.3 for a description).

However, others have defended an intermediate position, for instance by arguing that animacy can reduce, but not completely eliminate garden path effects. Hoeks, Hendriks, Vonk, Brown & Hagoort (2006) investigated the influence of animacy on the processing of S-coordinations. Consider the following example sentence:

- (4) Jasper sands the board and the carpenter scrapes the paint from the doors.

In this sentence, there is a conflict between the ambiguous NP *the carpenter* being animate and the thematic requirements of the verb *sands*. Because of this, the parser must at some point reject *the carpenter* as part of a complex object NP (*Jasper sands [the board and the carpenter]*) and analyze it as the subject of a conjoined sentence instead (*[Jasper sands the board] and [the carpenter...]*).

The results of an eye movement study showed that thematic information was used rapidly and that the processing difficulty for S-coordinations was reduced greatly in case of a bad thematic fit between the ambiguous NP and the verb, i.e. if the verb needed an inanimate object NP and the NP was animate. However, Hoeks et al. still found some residual processing difficulty at the disambiguating verb. Therefore, they conclude that animacy can facilitate processes of reanalysis, reducing the garden path effect, but cannot guide the initial analysis of the sentence (cf e.g. Clifton Jr., Traxler, Mohammed, Williams, Morris & Rayner, 2003).

Others argue that the issue whether semantic information affects the initial parse of a sentence depends on the working memory capacity of the reader. Just and Carpenter (1992) replicated Ferreira and Clifton's experiment as well. They made similar improvements to the materials as Trueswell et al. (1994) did and separated the data for subjects with low and high reading spans (as measured by the Daneman and Carpenter (1980) reading span task). The results for participants with low reading spans were similar to those of Ferreira and Clifton, whereas the results for high-span readers showed that they were sensitive to the semantic cue during the initial syntactic analysis of the sentence. These results are consistent with Just and Carpenter's capacity constrained comprehension theory (see section 1.2.3.2). However, Just and Carpenter's claims have been disputed again by for instance Clifton, et al., 2003. They argued that Just and Carpenter's results did not convincingly show the interaction between animacy, working memory span and ambiguity. Therefore, the results did not support the conclusion that there is a positive correlation between a reader's working memory capacity and to what extent non-syntactic information can affect the initial analysis of a sentence. Rather, the results showed that high-span participants used animacy information regardless of sentence ambiguity. This, according to Clifton et al., rather indicates that animacy

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information facilitated the interpretation of the experimental sentences than that it guided parsing decisions.⁴

In sum, experiments investigating the impact of the semantic factor animacy clearly illustrate the inconsistency of the results in the “modularity or interaction”-debate. The experimental studies that were summarized in this section suggest several explanations for these inconsistencies. For example, the strength of the semantic influence may depend on the strength of its manipulation or on participants’ reading span. These issues require further investigation.

1.3.2 Referential context

A factor that has been argued to have strong effects on sentence processing is referential context. In particular, the number of referents that the context embodies for a critical noun has been assumed to immediately affect parsing (see e.g., Crain & Steedman, 1985; Altmann & Steedman, 1988; Altmann, 1989; Altmann, Garnham & Dennis, 1992; Altmann, Garnham & Henstra, 1994; Grodner, Gibson & Watson, 2005; Ni, Crain & Shankweiler, 1996; Spivey and Tanenhaus, 1998; Van Berkum, Brown & Hagoort, 1999a; Sedivy, 2002). Many studies that investigated this factor focused on the RR/MC ambiguity and the prepositional phrase attachment ambiguity. Consider the following example sentences (taken from Ferreira and Clifton (1986) and Altmann & Steedman (1988) respectively; see also example sentences (2) and (3)):

- (5) The editor played the tape and agreed the story was big. (main clause)
- (6) The editor played the tape agreed the story was big. (reduced relative clause)

⁴ Pearlmutter and MacDonald (1995) aim to clarify the inconsistent picture that previous research has produced of the role of individual reading span differences in the comprehension of syntactic ambiguities. One of their main conclusions is that there are indeed individual differences in the use of constraints during the resolution of syntactic ambiguities. However, these differences appear not to be attributable to differences in constraint knowledge, but rather to differences in the ability to use these constraints during reading. Because there is no room in this study to do full justice to their paper, the reader is referred to Pearlmutter and MacDonald (1995) for further details.

- (7) The burglar blew open the safe with the dynamite (high VP attachment).
- (8) The burglar blew open the safe with the diamonds (low NP attachment).

Syntax-based parsing principles like minimal attachment would predict that readers prefer to interpret the ambiguities as in example sentence (5) and (7) respectively. This would lead to a garden path in the examples (6) and (8), requiring reanalysis. Crucially, this preference for the minimal structure is predicted to apply irrespective of the context. However, proponents of interactive accounts would predict that whether readers are garden pathed or not depends on the referential properties of the context: embedding sentence (6) and (8) in referentially supportive contexts would eliminate the garden paths for these structures (see also section 1.2.3.1 on referential theory).

A supportive context for sentence (6) would be one that contained more than one potential referent for *editor*. In this case, readers need to restrict the set of possible referents for *editor* when they encounter it. Since this can be done by interpreting the sentence as a relative clause, readers would immediately interpret the sentence accordingly, yielding the correct interpretation. However, if the preceding discourse contains only one possible referent for *editor*, there is no set of possible referents that needs restriction. Therefore, readers are expected to initially select the minimal analysis, causing a garden path effect.

Crucially, proponents of interactive models have the same prediction for the MC sentence (5): embedding it in a RR supportive context (i.e. containing more than one potential referent for *the editor*) would induce a garden path, because readers would restrict the set of possible referents by analyzing the sentence as a reduced relative clause. This would never be the case according to syntax-first models. After all, according to such models the MC interpretation is initially preferred under all circumstances. To sum up, interactive models argue that the preferred structure is determined by which of the alternatives is referentially speaking most successful.

The same predictions apply to the PP attachment ambiguity. On the basis of syntax-based principles like minimal attachment, there is a preference for high attachment of the PP (as in sentence (7)). However, from a referential point of view, things are not so straightforward. If only

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one referent is available for *boxes*, it does not need any further specification. In this case, sentence (7) is preferred on the basis of the referential context as well. However, if several boxes in other locations have been mentioned in the preceding discourse context, further specification is required to determine which box is referred to in sentence (7). Attaching the PP low, as in sentence (8), is a good way to do this. Thus, again, proponents of interactive models predict that the referential properties of the discourse context can either eliminate or induce a garden path. The crucial question is how the pragmatic need to establish reference interacts with the syntax-based preference for minimal attachment.

Many experiments have tested these predictions. A large number of studies have showed elimination of the garden path in a referentially appropriate context (see e.g. Crain & Steedman, 1985; Altmann & Steedman, 1988; Altmann, Garnham & Dennis, 1992; Altmann, Garnham & Henstra, 1994; Grodner, Gibson & Watson, 2005, for unambiguous sentences; Spivey-Knowlton & Sedivy, 1995; Spivey and Tanenhaus, 1998; Van Berkum, Brown & Hagoort, 1999a, using event-related brain potential (ERP) measures). However, considerable evidence has been reported in favor of syntax-first models as well.

Besides investigating the influence of semantics on parsing, Ferreira and Clifton (1986) also investigated the influence of referential context on the on-line resolution of both the MC/RR ambiguity and the PP attachment ambiguity. On the basis of self-paced reading and eye movement results they conclude that the referential context did not have any initial effects or any effects during recovery. Only the ultimate comprehension of the sentence was influenced by context. Mitchell, Corley & Garnham (1992) investigated the MC/RR ambiguity in a self-paced reading study as well. They conclude that referential factors can be used rapidly (i.e. within the ambiguous region) to reanalyze an initial misanalysis. However, readers are consistently biased in favor of the MC interpretation of the sentence. This conclusion is shared by Britt, Perfetti, Garrod and Rayner (1992) and Rayner, Garrod and Perfetti (1992) and provides evidence in favor of a syntax-first model. Britt et al. further note that, as compared to discourse information, specific types of local semantic information might have earlier effects on attachment decisions, as was shown by for example Trueswell et al. (1994), Just and Carpenter (1992) and Ni, Crain and Shankweiler (1996). Britt et al. explain these different effects by arguing

that local semantic information is available to comprehension more quickly than discourse information, because the former is provided immediately as a particular word is encountered (but see e.g. Van Berkum, Hagoort and Brown (1999) and Van Berkum, Zwitserlood, Hagoort and Brown (2003) for evidence that readers relate a developing sentence as quickly to the wider discourse as to local sentence-level semantic information; see also section 1.3.3).

Besides supposing that different types of information might have different effects, Britt et al. also report different effects for different structures. Both self-paced reading and eye movement results showed that, in contrast to the MC/RR ambiguity, the PP attachment ambiguity was eliminated in a biasing context. Crucially, this suggests that parsing preferences for some structures can be influenced by discourse context, whereas this is not the case for other structures (see p. 310-311 of Britt et al.'s paper for possible explanations for this result).

Ni, Crain and Shankweiler (1996) investigated the influence of referential properties in a different fashion, viz. by manipulating this factor sentence-internally instead of within the discourse context. This was done by replacing the definite determiner *the* by the focus operator *only* in the MC/RR ambiguity, see the following example sentences (Ni et al. (p. 293)):

- (9) Only businessmen loaned money at low interest were told to record their expenses.
- (10) The businessmen loaned money at low interest were told to record their expenses.

The semantic function of the focus operator *only* is to signal that the so called focus element (*businessmen* in the example sentences) is being contrasted with a set of alternatives (here: other businessmen). Therefore, Ni et al. argue, the subject NP *only businessmen* in sentence (9) causes a discourse representation of the context to be established in which a set of businessmen is represented (which is in line with referential theory). To satisfy the need for a contrast set, the sentence is expected to be initially analyzed as an RR clause. The results of a word-by-word grammaticality judgment study and an eye movements study provide evidence that this is indeed what happens. These results were replicated by Sedivy (2002) in a self-paced reading experiment as well.

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In a follow-up experiment Ni et al. investigated the use of general world knowledge (plausibility) on ambiguity resolution.⁵ In a judgment study and an eye-movement study, participants were informed by a priori plausibility information if they had selected the correct interpretation of the sentence or not. This information was presented within the ambiguous region of the target sentence. For example, sentences like the following were compared:

- (11) The man painted the/only doors with new brushes before the festival. (VP-attachment)
- (12) The man painted the/only doors with large cracks before the festival. (NP-attachment)

In these sentences, referential theory predicts a preference for VP-attachment over NP-attachment if the noun *doors* is preceded by *the*. The reason for this is that VP-attachment is easier from a referential perspective. It only requires the mental model to be augmented with a set of doors, whereas NP-attachment requires the parser to further modify the mental model by distinguishing a subset of doors with specifications from other doors. Specifically, the mentioning of *the doors with large cracks* suggests the existence of a set of doors with other properties in the mental model. On the basis of this theory, processing problems were predicted for the NP-attachment sentence: readers initially give the sentence a VP-attachment interpretation, which turns out to be wrong at the word *cracks* (i.e. the plausibility information: cracks are not used to paint doors with).

However, if the noun *doors* is preceded by the focus operator *only*, the referential theory predicts a preference for NP-attachment over VP-attachment. The reason for this is that the focus operator *only* indicates the existence of a set of doors that contrasts with the doors that are referred to and the NP-attachment analysis provides the need for this contrast set. Because it is infelicitous to modify doors with brushes, processing problems are predicted for the VP-attachment sentences.

The results showed that participants used the a priori plausibility information of the noun phrase to decide whether a particular kind of

⁵ General world knowledge is obviously a different source of information than the referential properties of the discourse context. Still, for convenience of clarity the regarding experiment is reported in this section.

attachment was felicitous or not. In other words, the disambiguating factor was real-world knowledge. However, the results from the eye-movement study showed that, whereas the semantic information carried by *only* is used on-line in resolving ambiguity, how quickly the plausibility information was used depended on the memory capacity of the participants (as measured using the task by Daneman and Carpenter (1980)). More specifically, high-span participants could use the plausibility information quickly to recover from a misanalysis, whereas the use of this information was delayed for low-span participants. Moreover, Ni et al. suggest that plausibility information is of lesser value if it is encountered after the onset of the ambiguity (as in their experiment) than before this point (as in the experiments of for instance Trueswell et al., 1994).

In sum, research so far has not produced a clear picture of how exactly referential information affects the resolution of syntactic ambiguities. Evidence ranges from referential information only affecting the ultimate interpretation of the sentence to referential information eliminating a garden path. The intermediate position holds that referential information cannot be used to eliminate a garden path, but only to rapidly reanalyze a sentence after an initial misanalysis. In other studies, referential information turned out to have different effects on the processing of different structures. Clearly, further research is needed to solve these inconsistencies.

Referential context: effects on the processing of preferred and unambiguous structures

In the previous section, evidence was presented in favor of the view that processing difficulty for reduced relative clauses can be modulated if they are embedded in an appropriate referential context. This claim was based on the following reasoning. The recovery from an initial misanalysis is presumed to lead to an increase in processing load, which is reflected in increased reading times. Therefore, if an RR clause is embedded in a supportive context and no increased reading times are found, one could argue that the correct interpretation of the sentence was selected immediately. These results provide evidence against a syntax-first account, which predicts a misanalysis effect for RR clauses in any context.

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However, proponents of syntax-first models maintain that they can account for the above results too. They argue that it may have looked like the RR clause was not initially misanalyzed, but in fact it was. The reason that this was not reflected in the reading times is that reanalysis can occur quickly enough to elude detection by current experimental techniques.

A solution to this problem is to show that the normally preferred parse is misanalyzed, instead of showing that the unpreferred parse is not misanalyzed (see e.g. Crain & Steedman, 1985; Altmann & Steedman, 1988; MacDonald, Pearlmutter and Seidenberg, 1994; Frazier, 1995; Sedivy, 2002 for a similar idea). In other words, whereas the possible inaccuracy of current experimental techniques can explain the *absence* of increased reading times, it can hardly be an explanation for the *presence* of increased reading times. This will be illustrated in the following.

In case of the MC/RR ambiguity, syntax-first models argue that readers initially interpret the sentence as a main clause in all circumstances. Constraint-based models, however, claim that non-syntactic factors can modulate this preference for the MC interpretation to a preference for the RR interpretation, i.e. the dispreferred analysis. Therefore, finding misanalysis effects for the *preferred* MC sentence would provide clear evidence against syntax-first models and in favor of interactive models.

Misanalysis effects for the MC interpretation have been shown by Sedivy (2002). In a self-paced reading experiment, reading times of MC/RR ambiguities and unambiguous MC sentences were compared. As was described above, the presence of the focus operator *only* in an MC/RR ambiguity supports the RR reading over the MC reading. Therefore, if the focus operator *only* was embedded in an ambiguous MC sentence, participants were expected to initially interpret this sentence as an RR sentence. This would lead to an initial misanalysis of the sentence and, therefore, to increased reading times as compared to the unambiguous MC sentence. As this was exactly what the results showed, evidence was provided against syntax-first models: the normally preferred parse was misanalyzed.

Grodner, Gibson and Watson (2005) have aimed to show an even stronger effect of referential factors (see section 1.2.3.3). They argue that an effect of an ambiguous sentence on the preferred analysis can not clearly distinguish between the possibility that referential factors facilitated the rapid selection of one of multiple candidate analyses that

have been initially generated on the basis of syntax-based principles (cf referential theory and some instances of the constraint-based approach; see section 1.2.3.1 and 1.2.3.2) and the possibility that these factors can in fact co-determine which structure (or structures) is generated in the first place (see section 1.2.3.3).

As a solution, Grodner et al. propose to investigate unambiguous structures. They predict that context can direct the construction of a particular syntactic form, if this form is highly predictable from the context. In a self-paced reading experiment, effects were tested of principles analogous to those in referential theory, using unambiguous restrictive and non-restrictive relative clauses like the following:

- (13) The postman that a dog bit on the leg needed seventeen stitches and had a permanent scar from the injury. (Restrictive RC)
- (14) The postman, who a dog bit on the leg, needed seventeen stitches and had a permanent scar from the injury. (Non-Restrictive RC)

These structures were selected because they are identical at the structural and lexical levels apart from the relativizing word, but serve different discourse functions. Restrictive modifiers (as in sentence (13)) indicate that a particular referent has to be identified from a group of other possible referents. Thus, a contrast set, containing other postmen that were not bitten by a dog on the leg, is implicated. In sentences like (14) no such contrast set is implicated.

If discourse complexity (here: the need for a contrast set to be constructed) affects the processing of unambiguous sentences, sentence (14) would be processed faster than sentence (13) in a null context. This prediction is based on the assumption that the construction of a contrast set consumes processing resources. However, in a two referent context, participants were expected to anticipate modification of the noun *postmen*. Specifically, because of the discourse-based requirement for a contrast set, structures that satisfy this requirement should be facilitated. In other words, the processing of the modifier in sentence (13) was expected to be facilitated in the appropriate context.

Results of a self-paced reading experiment confirmed these expectations. Crucially, the effects were found very early in the sentence (i.e., on *dog bit*). This is essential, because it provides evidence for strong interaction,

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i.e. that the referential context can direct parsing decisions. A weakly-interactive model would predict that referential context is used to *evaluate* whether the discourse requirement for a contrast set was satisfied in the initially selected structure. This evaluation cannot take place until the identifying material in the modifier is encountered (i.e. *on the leg*). Therefore, in case of weak interaction, no facilitating effect of referential factors would have been found this early in the sentence. The early effects of referential context lead Grodner et al. to conclude that this factor can immediately guide the parsing process because the two-referent context brought about a strong structural expectation for an identifying modifier. In other words, “there is a strong contingency between the referential context and a restrictive modifier” (p. 288).

1.3.3 Other discourse aspects

Discourse-dependent semantic anomalies

In addition to the effect of referential factors and discourse focus, the effect of some other discourse aspects on parsing has been investigated. In one study, the impact of discourse-level information on the processing of a spoken or written developing sentence was investigated (Van Berkum, Hagoort & Brown, 1999; Van Berkum, Zwitserlood, Hagoort & Brown, 2003). In this study, several ERP experiments participants read or listened to sentences like *Jane told her brother that he was exceptionally quick* while the preceding context in fact stated that Jane’s brother was very slow (*he* referred to Jane’s brother). So, the word *quick* was compatible with the local sentence meaning but not with the semantics of the wider discourse. The results showed that readers and listeners relate the developing sentence extremely rapidly to the wider discourse (i.e. 150-200 ms after acoustic onset of the word *quick*). On the basis of the ERP signature (i.e. the N400) it was concluded that this process is indistinguishable from the way that incoming words are related to local sentence-level semantic information, thereby providing evidence for the idea that local constraints immediately merge with more global constraints.

The effect of topic structure

A pragmatic factor of specific interest for the current study is topic structure. Hoeks, Vonk and Schriefers (2002) tested the effects of this

factor on the processing of NP-/S-coordination ambiguities. Examples of both structures are the following:

- (15) Jane waved at [Pete and his friend] in the park. (NP-coordination)
- (16) [Jane waved at Pete] and [his friend looked the other way]. (S-coordination)

Example (15) and (16) are structurally ambiguous up to and including the NP *his friend*. Specifically, *his friend* can be interpreted as being part of the complex object *Pete and his friend*, as in sentence (15), or as being the subject of a conjoined sentence, as in sentence (16). Evidence has been provided that readers are inclined to initially interpret sentences as (15) and (16) as an NP-coordination (Frazier 1987a; Clifton, Frazier, Rapoport & Radó, 1996, as described in Frazier & Clifton, 1997; Hoeks et al., 2002). This preference can be explained by the minimal attachment strategy (Frazier 1987a; 1987b). In other words, an NP-coordination requires fewer syntactic nodes in the parse tree and is therefore preferred.

However, Hoeks et al. (2002) propose that the preference for an NP-coordination can be explained differently, viz by the *principle of minimal topic structure*. This strategy shows clear similarities to Crain and Steedman's principle of parsimony (see section 1.2.3.1). According to this principle of minimal topic structure, an NP-coordination is preferred because it has a simpler topic structure than an S-coordination. In particular, an NP-coordination has only one topic (*Jane* in sentence (15)), whereas an S-coordination has two (*Jane and his friend* in sentence (16)). Moreover, it is not the topic structure of the sentence in itself that is expected to ultimately determine which structure is preferred. Rather, the preference would depend on the topic structure of the discourse that preceded the ambiguity. More precisely, if the preceding discourse has a one-topic structure, i.e. *two* people have been in the center of attention throughout the preceding discourse, readers are expected to opt for an NP-coordination as this does not alter the existing topic structure. However, if the preceding discourse has a two-topic structure, an S-coordination - which contains two topics - needs to be selected in order not to alter the existing topic structure. As a result, the processing difficulty for S-coordinations should be eliminated.

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The topic structure of the discourse context was manipulated by including “question-contexts” and “sentence-contexts”. Examples of a question-context and a sentence-context are presented in example sentence (17) and (18) respectively.

- (17) a) When she met the fashion designer and the photographer at the party, the model was very enthusiastic. (supportive of NP-coordination)
- b) The party at the end of the fashion show was very exciting. What did the model and the photographer do? (supportive of S-coordination)
- (18) The model embraced the designer and the photographer laughed. (S-coordination target sentence)

Sentence (17a) only introduces *the model* as a discourse entity about which something is going to be said in the following sentence (i.e. as a topic). In this case, participants were expected to select the incorrect NP-coordination interpretation of sentence (18). In fact, they had no reason to select an S-coordination analysis, because the preceding discourse had not introduced *the photographer* as a topic.

The question in (17b), on the other hand, establishes both *the model* and *the photographer* as topics. Therefore, upon encountering the phrase *the photographer* in sentence (18), participants were expected to immediately interpret it as the subject of a conjoined sentence, i.e. as an S-coordination.

Hoeks et al. report evidence for these predictions in an off-line completion study, a self-paced reading experiment and an eye tracking study. Thus, whereas local animacy information did not appear to eliminate processing difficulty for S-coordinations, but only to reduce it (see section 1.3.1), the topic structure of the preceding discourse did.

1.3.4 The predictive effect of contextual and verb-based information

Proponents of strong interactive models argue that the effect of non-syntactic factors goes further than facilitating the *evaluation* of a number of syntactic alternatives of a sentence (as for instance in constraint-based models). Rather, it is argued, they can affect the *construction* of the initial

analysis of a sentence. In other words, non-syntactic factors can guide which syntactic structure of a sentence is constructed in the first place. This is the most immediate effect of non-syntactic constraints possible. In section 1.3.2, results of Grodner, Gibson and Watson (2005) were already described, indicating that referential context had a predictive effect on parsing. Altmann, Van Nice, Garnham & Henstra (1998) conducted a study in which the predictive effect of the wider discourse was manipulated. For example, they investigated sentences such as the following:

- (19) She'll implement the plan she proposed tomorrow, they hope.

The syntax-based strategy late closure predicts a preference for attaching *tomorrow* to *she proposed* (i.e., low) instead of to *implement* (i.e., high) in all circumstances (which yields the wrong structure in case of sentence (19)). Altmann et al. investigated whether this low attachment-preference can be modulated by contexts that explicitly direct readers' attention. This was done by embedding "which" or "when" questions in the context, either directly or indirectly, that supported either high or low attachment in the target sentence. An example of such a question is the following:

- (20) When will Fiona implement the plan she proposed to the committee?

The precise predictions for this example are as follows. After reading question (20), readers might predictively activate a representation corresponding to an adverbial, like *tomorrow* or *today*, even before the following sentence is encountered. This adverbial could occur in the first position of the following sentence. However, in sentence (19), this turns out not to be the case. The representation of an adverbial decreases in activation after *She'll* and *implement*, because neither permits the occurrence of an adverbial directly after it. However, after *the plan*, the representation of an adverbial increases in activation again, because here the context-based prediction for an adverbial could and should be fulfilled, and so on (see Altmann et al., p. 480-481).

The results of several eye movement experiments supported the idea that a context that strongly directs readers' attention can override

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preferences predicted by late closure. These results are interpreted as evidence for the constraint-satisfaction view of sentence processing (cf. MacDonald et al. 1994), which is augmented by emphasizing that “contextual override requires that comprehension is achieved through the satisfaction and interaction of multiple, probabilistic, and hence *predictive*, constraints” (p. 480-481, italics supplied).⁶

1.3.5 How do different constraints interact?

The majority of the studies that were described in the preceding sections focused on demonstrating that a particular non-syntactic factor immediately influences the on-line resolution of syntactic ambiguities. However, it is important to gain more insight in the course of this process as well. It is not sufficient for an interactive approach to just maintain that multiple sources of information interact during the initial analysis of a sentence. In fact, it must specify the strength and exact timing of these constraints as well (see Gibson & Pearlmutter, 1998 for a survey of this and other outstanding issues). In particular, if certain experimental results show that one constraint overrules another, it is important to determine whether this result was caused by the general characteristics of the processing system or by the design of the specific experimental items that were used. Two important studies in this respect were conducted by MacDonald (1994) and Spivey and Tanenhaus (1998) (but see also McRae, Spivey-Knowlton & Tanenhaus, 1998). In the following, both studies are described in more detail.

MacDonald (1994) tested the effects of three types of probabilistic constraints on the processing of the main clause (MC)/reduced relative clause (RR) ambiguity. The first constraint was plausibility information from the context prior to the ambiguity, manipulated through the animacy of the subject noun (hereafter: the “pre-ambiguity” constraint). Whether this constraint provided good or poor support was determined

⁶ Several other studies have shown predictive effects on more general aspects of sentence processing. See, for example, Altmann and Kamide (1999), Kamide, Altmann and Haywood (2003), Koornneef and Van Berkum (2006) and Koornneef (2008) for predictive effects of verb-based information in the process of reference. See, for example, Chambers, Tanenhaus, Eberhard, Filip and Carlson (2002) for restrictive effects of preposition-based information in referential interpretation and Van Berkum, Brown, Zwitserlood, Kooijman and Hagoort (2005) for evidence that readers use their knowledge of the wider discourse quickly enough to anticipate specific upcoming nouns in a developing sentence.

from the perspective of an RR clause. A good pre-ambiguity constraint contained an inanimate noun that made a good Theme and a poor Agent, supporting an RR reading (as in *the shipment transported*). A poor pre-ambiguity constraint contained an animate noun that made a good Agent for the following verb, supporting the MC interpretation (as in *the workers transported*).

The second constraint was information about verb argument structure frequencies. In case of the MC/RR ambiguity, there are four possible verb argument structures:

Active transitive:	The patient heard the music.
Intransitive:	The patient heard with the help of a hearing aid.
Sentential complement:	The patient heard (that) the nurses were leaving.
Reduced relative:	The patient heard in the cafeteria was complaining.

(MacDonald, 1994, p. 162)

Verbs differ in the amount of alternative argument structures they activate and in the relative frequency of these alternatives. For example, the verb *heard* allows all four argument structures, whereas the verb *interviewed* does not take a sentential complement. The more argument structures a verb allows, the more alternative structures compete for activation.

The third constraint arrived after the introduction of the ambiguity but prior to its resolution (hereafter: the “post-ambiguity” constraint). This constraint can be illustrated as follows. In English, verbs are usually adjacent to their direct objects (as in the active transitive sentence *The horse raced the donkey past the barn*). This knowledge, MacDonald argues, could be important for ambiguity resolution. If readers encounter a verb that is followed by something different than a direct object (e.g. *The horse raced past the barn...*), it is highly unlikely that an direct object NP will appear later in the sentence (e.g., **The horse raced past the barn the donkey*). Therefore, if a so called “not-direct object” phrase follows directly after the verb, the active transitive argument structure is inhibited. More specifically, because the active transitive argument structure is inhibited,

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the RR interpretation is facilitated. Moreover, by manipulating the time between the start of the ambiguity and the introduction of the “not direct object” phrase, i.e. either immediately or after two of three words, the strength of this constraint was manipulated as well: the sooner the “not direct object” phrase was introduced, the sooner the active transitive interpretation was inhibited. See MacDonalds’ paper for further details regarding the exact manipulation of the constraints.

In three self-paced reading experiments, reading times for MC/RR ambiguities were compared to reading times of unambiguous control sentences. The results supported the following conclusions. First, the difficulty of resolving the MC/RR ambiguity in favor of the RR reading depends on the amount and the strength of available alternative interpretations (a similar claim is made by for example Trueswell et al., 1994). Second, good constraints are more helpful than weak constraints. Third, constraints operate together (reading time patterns are sensitive to whether constraints converge or conflict). Fourth, reading times in both the ambiguous and the disambiguating region are affected by the strength of the probabilistic constraints.

With respect to this last finding, it is interesting to mention the so-called *reversed ambiguity effect*, which is reported in the results of for instance Altmann, Garnham and Dennis (1992) and MacDonald (1993) as well. In particular, if the processing of an ambiguous and an unambiguous sentence is compared, the following reading time patterns can occur. First, if a structure is supported in the ambiguous condition that is less complex than the structure of the non-ambiguous sentence, shorter reading times are expected in the ambiguous region. However, if the supported structure turns out to be incorrect, the pattern reverses (i.e. longer reading times for the disambiguating region in the ambiguous structure as compared to the unambiguous structure). Second, if the correct interpretation is supported in the ambiguous condition and if this structure is just as difficult as the unambiguous structure, the reading times in the ambiguous sentence resemble those in the unambiguous one at both the ambiguous and the disambiguating regions.

Spivey & Tanenhaus (1998) even tried to model reading time results using a constraint-based competition framework (see also McRae et al., 1998). First, two eye movement experiments were conducted to investigate the effect of referential context on the resolution of the MC/RR ambiguity. Sentences such as the following were tested:

- (21) The actress selected by the director believed that her performance was perfect. (ambiguous reduced relative sentence)
- (22) The actress chosen by the director believed that her performance was perfect. (unambiguous reduced relative sentence)
- (23) The actress who was selected by the director believed that her performance was perfect. (unreduced relative sentence)

The target sentence always started with a definite article followed by an animate noun. In sentence (21), the verb *selected* was morphologically ambiguous between a simple past tense reading and a passive participle reading. This was not the case for the verb *chosen* in sentence (22). In two eye-movement studies, the sentences were embedded in a context that either contained one-referent context (supporting an MC reading) or a two-referent context (supporting an RR reading). The results showed that the referential context immediately affects syntactic ambiguity resolution: in a one-referent context, reading times on the *by*-phrase were longer in the ambiguous RR clauses than in the unambiguous control sentences. In a two-referent context, however, reading times were similar for the ambiguous and unambiguous RR clauses (see section 1.3.2 for similar results).

More importantly, the correlation between referential effects and the relative frequency with which each verb was used as a past participle was tested in a regression analysis. It was hypothesized that if the referential context supported an RR reading and frequency information an MC reading, both structures would receive probabilistic activation and the competition between both structures would lead to increased processing difficulty. If, on the other hand, both factors supported the RR interpretation, this structure would receive the majority of probabilistic interpretation from the start, decreasing the amount of competition and therefore the amount of processing difficulty. Results of a regression analysis provided evidence for this idea. Moreover, context effects turned out to be modulated by lexical frequency effects, a result that supports the constraint-based lexicalist model (cf. MacDonald et al. 1994; Trueswell et al. 1994).

Subsequently, Spivey and Tanenhaus tried to model the reading time results of the first experiments using a constraint-based competition framework in which multiple constraints are immediately integrated to

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resolve the syntactic ambiguity, the so-called *competition-integration model* (see section 1.2.3.2 for further details regarding the working of the model). Besides the referential context and the frequency with which the ambiguous verb occurred as a simple past tense and as a passive participle, two other constraints were modeled. First, paravofeal information: if processed paravofeally, the prepositional phrase *by* that followed upon the ambiguous verb supported an RR interpretation. Second, a probabilistic MC bias: a sentence initial sequence of 'noun phrase-verb-*ed*' is more typically the beginning of a main clause than a reduced relative clause.

The results show that the competition-integration model was able to simulate the results of the first two experiments and other (seemingly conflicting) results from the literature. For example, Spivey and Tanenhaus argue that their model "demonstrates how graded variation in context effects, across stimulus items as well as across experiments, can be due to informational biases inherent in the stimulus materials, not to the architectural constraints on the processing system" (p. 1541). In other words, the standard assumption that increased processing difficulty in case of an ambiguity reflects a garden-path is problematic, because it can indicate severe competition between alternative readings as well. The assumption that a delayed effect means that a certain factor cannot immediately influence parsing, is also problematic. Rather, the effect of a certain constraint depends on its own strength and the strength of other relevant constraints.

1.4 Summary

Over the years, the effects on parsing of a whole range of different factors have been investigated. The results have been argued to support models of sentence processing ranging from highly modular to strongly interactive ones. Even though evidence for an interactive account of processing seems to be mounting up at a faster pace, a review of recent experimental literature still produces evidence in favor of a syntax-first account as well. There are several explanations for these superficially conflicting results.

A first explanation is that results in favor of an interactive account of sentence processing can sometimes be explained by a modular account just as well. This is especially the case when one focuses solely on the processing of the disambiguating part of the sentence and not on the

processing of the ambiguous part as well. In this case, the parser could have changed its initial analysis somewhere between the onset of the ambiguity and its disambiguation. This is particularly the case when several words occur between the start and the end of the ambiguity. As a consequence, one cannot be sure that any effects at the disambiguating point reflect processes of initial analysis instead of early reanalysis. Therefore, to be able to distinguish between several different hypotheses, it is crucial to test structural commitments as early after the start of the ambiguity as possible (as has been emphasized by for instance Mitchell, Corley and Garnham (1992), Altmann, Garnham and Dennis (1992); MacDonald (1993, for lexical category ambiguities; 1994); Ni, Crain & Shankweiler, 1996).

Conversely, some results that are interpreted as being supportive of modularity can be explained by an interactive account as well. According to proponents of interactivity, results that seem in accordance with the modular account occur if the non-syntactic constraints were manipulated too weakly to exert any early effects.

A second explanation is that the “interaction or modularity”-issue must be reinterpreted as being an issue of working-memory capacity rather than of the architecture of the sentence processing system: immediate effects of non-syntactic factors on parsing are preserved for readers with high reading spans only.

Another important thing that the preceding sections show is that it is not enough to show that a certain non-syntactic constraint immediately affects parsing. It is important to investigate the course of this process as well. Specifically, one must determine the relative weight of different constraints and investigate their interaction.

In sum, several matters are important if one seeks to make a clear distinction between different theoretical models of parsing. How these matters are taken care of in the current study is described in the following chapter.

Chapter 2

The current study

2.1 Introduction

Chapter 1 presented an overview of some of the best-known approaches to sentence processing and the evidence that has been reported in support of them. Even though this outline was evidently incomplete, it does allow for some general conclusions. First, most studies to date have concentrated on demonstrating effects of semantics (e.g. the incompatibility of an inanimate subject with certain types of verb) or discourse-structural factors (e.g. the number of referents or topic structure) on parsing. Second, the past decades of research have not produced an unequivocal answer to the question whether nonsyntactic factors can immediately affect parsing decisions. Even though evidence for interactive accounts of sentence processing seems to be mounting up at a faster pace, evidence has been reported in favor of syntax-first accounts as well. Third, several different explanations have been proposed for the often highly contrasting results. Proponents of modularity claim that results that have been reported in favor of an interactive account of sentence processing can be explained by a modular account just as well. For example, the absence of a misanalysis effect for the syntactically unpreferred structure is explained by arguing that the initial (syntactically preferred) analysis of the sentence was already revised prior to the point in the sentence where the effects were measured. In turn, proponents of an interactive account of sentence processing, on the other hand, argue that results that seem in accordance with a modular account of parsing are caused by the fact that the manipulation of nonsyntactic factors was too weak to exert an early influence (see also section 1.4).

Taking these different points into consideration, a number of issues seem necessary in order to demonstrate the effects of nonsyntactic factors on parsing as accurately as possible: (1) manipulating the factor under investigation in the strongest possible way and (2) exploring the effects of this factor at the point of disambiguation as well as exploring these effects (early) in the ambiguous region. Moreover, investigating the

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strength and interaction of multiple factors at the same time can also provide valuable information about sentence processing.

The main purpose of the current study is to contribute to resolving the issue whether nonsyntactic factors can immediately affect parsing or not. In doing so, the aim is to meet the above requirements as well as possible. This study investigates a factor that has not received much attention so far: prior knowledge as provided by means of discourse context.¹ In particular, this study investigates whether on-line parsing decisions are immediately affected by readers' knowledge about the state of affairs described in the text, i.e. readers' mental model of the discourse (see e.g. Johnson-Laird, 1983, p. 377). This knowledge will be referred to as *situational knowledge*.² The research tool that is used to investigate this issue is syntactic ambiguity, viz the NP-/S-coordination ambiguity.

In section 2.2, the NP-/S-coordination ambiguity is explained and some previous studies regarding this structure are described. Subsequently, a study on the effects of domain knowledge on parsing is described in section 2.3. In section 2.4, the manipulation of situational knowledge is explained, as well as the hypotheses regarding the effects of this factor on parsing.

2.2 The NP-/S-coordination ambiguity

2.2.1 Results from previous studies

Consider the following example sentences, taken from Frazier (1987b):

- (1) Piet kuste Marie en haar zusje ook. (NP-coordination)
Pete kissed Mary and her sister too.

¹ Exceptions are, for example, the experiments by Van Berkum, Hagoort & Brown (1999) and Van Berkum, Zwitserlood, Hagoort & Brown (2003). In these experiments, a property of one of the characters as mentioned in the discourse context was contradicted in the target sentence. For example, if a certain character was described as being very slow in the discourse context, it was referred to as being quick in the target sentence (see also section 1.2.5.4).

² The term *situational knowledge* is taken from Garrod and Terras (2000), who used it to refer to the representation that readers form of the situation that is being described in the context. They investigated the influence of situational knowledge as compared to the influence of lexical semantic factors on the establishment of discourse roles during reading.

- (2) Piet kuste Marie en haar zusje lachte. (S-coordination)
Pete kissed Mary and her sister laughed.

Sentences (1) and (2) are structurally ambiguous up to and including the NP *haar zusje* (*her sister*; from now on, the term *ambiguous NP* is used to refer to the first NP after the ambiguous conjunction *en* (*and*). This NP can either be interpreted as part of the complex object NP *Marie en haar zusje* (*Mary and her sister*), producing an NP-coordination (as in example (1)) or as the subject/topic of a conjoined sentence, e.g. *haar zusje lachte* (*her sister laughed*), producing an S-coordination (as in example (2)). Syntax-first approaches such as the garden path model and construal theory have argued that readers prefer an NP-coordination analysis on the basis of syntax-based strategies, particularly minimal attachment (Frazier 1987a, b; Clifton, Frazier, Rapoport & Radó, 1996, as described in Frazier & Clifton, 1997; see also section 1.2.2).³ More specifically, an NP-coordination requires fewer syntactic nodes in the parse tree and is therefore considered more economical. This can be illustrated by means of the tree structures in Figures (1) to (3) (taken from Frazier, 1987b).

³ Construal theory distinguishes between primary relations and nonprimary relations (Frazier & Clifton, 1997). Primary relations are parsed in agreement with the garden path theory, which means that an immediate fully specified analysis is constructed. Nonprimary relations, on the other hand, are not analyzed fully immediately. Rather, they are “*associated* into the current thematic processing domain” (Frazier & Clifton, 1997, p.280, italics in the original). What this basically means is that in case of a nonprimary relation, the parser is allowed more freedom as to where to ultimately attach a particular phrase without necessarily needing to revise the structure it was building so far. This ultimate attachment decision may be influenced by non-structural information as well. As long as the phrase is attached within its original thematic processing domain, no revision of the current syntactic commitments is necessary. Because NP- and S-coordinations are considered primary relations and are therefore assumed to be analyzed according to the garden path model, the specific details of construal theory are not discussed here.

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Figure 1: Minimal attachment structure of *Piet kuste Marie ...* (taken from Frazier, 1987b, p. 534).

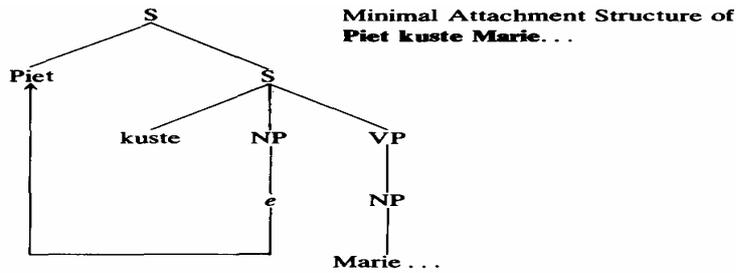


Figure 2: Minimal attachment structure of *Piet kuste Marie en haar zusje* (i.e. an NP-coordination; taken from Frazier, 1987b, p. 534).

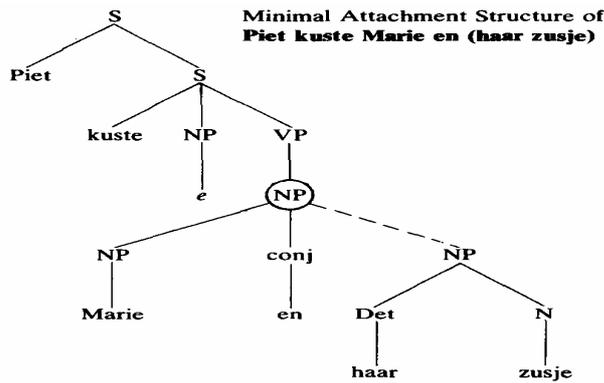
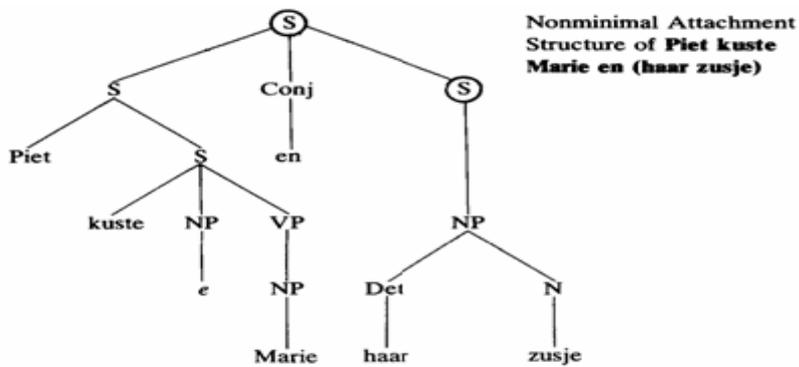


Figure 3: Nonminimal attachment structure of *Piet kuste Marie en haar zusje* (i.e. an S-coordination; taken from Frazier, 1987b, p. 535).



According to the minimal attachment strategy, *Marie* is preferred to be the object of the verb *kuste* (see Figure (1)). Upon encountering *en* the phrase marker in Figure (2) is constructed. Subsequently, upon encountering the ambiguous NP *haar zusje* there are two possibilities: this NP can be either analyzed as part of the complex object NP *Marie en haar zusje* (i.e. as an NP-coordination; see Figure (2)) or as the subject of the verb *lachte* (i.e. as an S-coordination; see Figure (3)). As the dotted line in figure (2) indicates, an NP-coordination analysis is consistent with the phrase marker that was constructed upon encountering *en*. The object of the sentence is only expanded from *Marie* to *Marie en haar zusje*, requiring one additional NP node (i.e. the circled one in Figure (2)). However, in order to analyze the sentence as an S-coordination, the structure that was build at *en* needs to be revised to the structure in Figure (3). This requires two additional S-nodes (i.e. the circled ones).

As an NP-coordination requires fewer nodes than an S-coordination, the garden path theory predicts that an NP-/S-coordination ambiguity is initially analyzed as an NP-coordination *under all circumstances*. As a consequence, an NP-coordination analysis always needs to be reanalyzed in an S-coordination upon encountering the disambiguating verb (*lachte* in example (2)). Evidence for this idea has been reported in self-paced reading studies (the processing of S-coordinations was impeded as compared to the processing of NP-coordinations) and a completion study (in 76% of the cases the sentence was completed as an NP-coordination instead of an S-coordination (Frazier & Clifton (1997), p. 287).

A parsing preference for an NP-coordination has been shown in other studies as well (see Hoeks (1999) for an overview). Two studies of specific interest were conducted by Hoeks, Vonk and Schriefers (2002) and Hoeks, Hendriks, Vonk, Brown & Hagoort (2006). Hoeks et al. (2002) argue that an NP-coordination is more economical than an S-coordination. However, this is not because of its syntactic simplicity, but because it has a simpler topic structure than an S-coordination: an NP-coordination has only one topic, whereas an S-coordination has two (see section 1.3.3 for a more elaborate explanation). However, the preferred structure in case of an NP-/S-coordination ambiguity is not believed to depend on the topic structure of the two possible structures in isolation, but rather on the topic structure of the discourse prior to the ambiguous sentence. If the preceding discourse has a one-topic structure, readers are

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expected to opt for an NP-coordination, as this does not alter the existing topic structure. However, for exactly the same reason, readers are predicted to opt for an S-coordination if the preceding discourse has a two-topic structure. Hoeks et al. (2002) report self-paced reading and eye movement results that support this principle of minimal topic structure. Various models of sentence processing maintain that the parser uses frequency information to decide upon the structure of a sentence (cf. constraint-based models; see section 1.2.3.2). For this reason, it is important to get an impression of the way in which *en* (*and*) is used in written Dutch. Hoeks et al. (2006) report the results of a corpus study, in which a set of one thousand occurrences of the connective *en* (*and*) was analyzed. The corpus was taken from one edition of a Dutch daily newspaper. In order to determine the frequency of occurrence of *en*, both coarse-grained and fine-grained measures were used. Whereas in the coarse-grained measures only the succession of syntactic categories was included (e.g. NP *en* NP, NP *en* VP, PP *en* PP), the fine-grained measures also included animacy, definiteness and syntactic function (e.g., how frequently NP-coordinations occurred as grammatical objects and how frequently S-coordinations contained grammatical subjects referring to the same and to different entities). The results of the coarse-grained measures indicated that NP *en* NP strings occurred considerably more often in an NP-coordination than in an S-coordination (i.e., 46% as compared to 10%). However, when the fine-grained measures were used, the percentages within the subset of *en* occurrences started to shift. More specifically, the difference between NP- and S-coordination occurrences was much smaller and even reversed, depending on how many additional constraints were considered.⁴ Thus, there would only be a strong preference for NP-coordination if a frequency-based parser were to use coarse-grained data. If a frequency-based parser uses the more fine-grained frequency data, this preference disappears or is even reversed.

⁴ 6% of the occurrences of *en* appeared in NP-coordinations that served as grammatical objects and 9% appeared in S-coordinations with two different subjects (e.g. *Pete kissed Mary and her sister laughed* instead of *Pete kissed Mary and he ran away*). Counting only those cases for which the grammatical object consisted of NP's that were both animate and definite amounted to only 1% of the total number of occurrences of *en*. Similarly, counting only those cases for which the grammatical subject of the conjoined sentence was both animate and definite also amounted to only 1% of the total number of occurrences of *en*.

It is still disputed whether frequency should be one of the central factors in a model of parsing, and if so, whether coarse- or fine-grained records should be used. This discussion is passed over here, but see for example Mitchell, Cuetos, Corley, and Brysbaert (1995) and Rayner & Clifton (2002, p. 294) for a discussion.

In an eye movement study, Hoeks et al. (2006) investigated the influence of animacy on the processing of S-coordinations as well. Consider the following example sentence:

- (3) Jasper sands the board and the carpenter scrapes the paint from the doors.

In this sentence, there is a conflict between the ambiguous NP *the carpenter* being animate and the thematic requirements of the verb *sands*. Because of this, the parser must at some point reject *the carpenter* as part of a complex object NP (*Jasper sands [the board and the carpenter]*) and analyze it as the subject of a conjoined sentence instead (*[Jasper sands the board] and [the carpenter...]*). The results showed that this thematic information was used rapidly and that the processing difficulty for S-coordinations was reduced greatly in case of a poor thematic fit between the ambiguous NP and the verb. However, Hoeks et al. still found some residual processing difficulty for S-coordinations as compared to NP-coordinations. For this reason, it was concluded that animacy facilitates the process of *reanalysis*, reducing the garden path effect, but *cannot* guide the initial analysis of the sentence (cf. e.g. Clifton Jr., Traxler, Mohammed, Williams, Morris & Rayner, 2003).

Summarizing, there are economy-based principles that predict a preference for an NP-coordination over an S-coordination. In particular, S-coordination was argued to require more nodes in the parse tree than NP-coordination. Moreover, according to Hoeks and his colleagues, an S-coordination is compatible with two topics, whereas an NP-coordination is compatible with only one. The topic structure of the preceding discourse context has been shown to modify this NP-coordination default: if the preceding discourse context has a two-topic structure, the ambiguous coordination is initially parsed as an S-coordination, because this interpretation preserves the existing topic structure. The factor animacy, on the other hand, was not found to affect

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the initial analysis of an NP-/S-coordination ambiguity, but only the process of reanalysis.

2.2.2 Some pitfalls in investigating the NP-/S-coordination ambiguity

There are some pitfalls in the use of NP-/S-coordination ambiguity as a tool in investigating the parsing process. These could lead to conclusions that may not be justified. In this section, these pitfalls are described through critically reviewing the experimental set-up of a number of previous studies.

In Frazier's study (1987b), the experimental sentences were presented to participants in three frames: the first frame included the sentence fragment preceding the ambiguous NP, the second frame included only the ambiguous NP and the third frame included all words following the ambiguous NP (see example (4) and (5), which are taken from Frazier (1987b)).

- (4) Ik zag de man en / de vrouw / samen. (NP-coordination)
I saw the man and / the woman / together.

- (5) Ik zag de man en / de vrouw / schreeuwde. (S-coordination)
I saw the man and / the woman / screamed.

As these examples indicate, the final frame of the experimental sentences was rather short (two words at most). In example (5), for instance, the final frame consists of only one word, i.e. the disambiguating verb. Reading difficulty was measured from these final frames.

The fact that the final frame of sentence (5) consists of the disambiguating verb only is problematic for the following reason (see also Hoeks, 1999; Hoeks et al. 2006). Besides the fact that an S-coordination has a more complex syntactic structure than an NP-coordination, semantic integration processes are likely to be more complex for this structure as well. More precisely, in case of an S-coordination, readers must integrate the two events that are described in the two different clauses. An NP-coordination, on the other hand, describes only one event and therefore requires less complex integration processes. Since these integration processes can be assumed to occur at the end of the sentence, processing the final parts of an S-coordination can be considered more laborious than processing the final parts of an

NP-coordination. Consequently, increased reading times for the final part of an S-coordination, such as in (5), could reflect either reanalysis or laborious integration processes. In particular, increased reading times in the final frame of an S-coordination can be explained in at least two different ways. One explanation is that readers could have initially analyzed the sentence as an NP-coordination, which then results in a reanalysis effect at the disambiguating verb. Another explanation, however, is that readers could just as well have immediately selected the correct S-coordination. Due to the relative complex integration of the two events described, reading times increase on the disambiguating verb as well.

A second problem with Frazier's materials is that the coherence relations (see e.g. Sanders, Spooren & Noordman, 1992; 1993) that were conveyed in the S-coordination sentences varied in nature. More specifically, in some cases the relationship that was expressed by the connective *and* was merely an additive one, but in other cases this relationship was ambiguous between an additive and a causal one. This is for example the case in the following S-coordination (taken from Frazier (1987b)):

- (6) Sylvia begon vandaag in een nieuwe roman en haar studieboek bleef liggen.
Sylvia started today in a new novel and her study book remained untouched.

In this sentence, the fact that the text book remained untouched can be interpreted as a *consequence* of the fact that Sylvia started reading a new novel. In other sentences in Frazier's experiment readers might be looking for a causal relationship in vain, cf. example 7.

- (7) Inge serveerde de erwtensoep en de Quiche Lorraine mislukte.
Inge served the pea-soup and the Quiche Lorraine went wrong.

Various studies have shown a processing advantage for causal relations (see Noordman & Vonk, 1998; Sanders & Noordman, 2000, for an overview). This result has been explained by arguing that readers prefer to relate two events in the most highly connected way, i.e. as being causally related instead of being related through an additive or temporal relation.

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However, causal relations are generally considered to be linguistically more complex than additive relations, because they convey more information (see Sanders, 2005, for an explanation of ideas along these lines). More specifically, they are taken to presuppose an additive relation (see e.g. Sanders, Spooren & Noordman, 1992; 1993). Therefore, one could also hypothesize that it would be more time-consuming to process an S-coordination that conveys a causal relation than one that just conveys an additive or temporal relation. Whatever the exact details of discourse processing, it is clear that one should only compare S-coordinations that unambiguously convey the same coherence relation. In Hoeks et al.'s (2002; 2006) study, the shortcomings of Frazier's experiment seemed resolved. S-coordinations were used in which at least three words appeared between the disambiguating verb and the final word, as in the following example sentence:

- (8) De mannequin omhelsde de ontwerper en de fotograaf opende lachend een fles champagne.
The model embraced the designer and the photographer opened smilingly a bottle of champagne.

As a result, it was possible to separate processes of disambiguation from those involving sentence-final integration. Furthermore, the events that the S-coordinations described were uniformly additively related, and causal/additive ambiguities were explicitly avoided.

In sum, if the NP-/S-coordination ambiguity is used as a tool to investigate the parsing process, several things need to be taken into account in order to exclude irrelevant interpretations of the data. First, the disambiguating verb should not coincide with the end of the sentence. Second, if S-coordinations are investigated, all sentences must convey the same coherence relation.

In the following section, some previous work on the possible effects of world knowledge on parsing is described. Subsequently, the set-up of the current study is explained in more detail.

2.3 The effects of domain knowledge on parsing

The experiments described in Chapter 1 mostly focused on the question how different sources of *linguistic* information affect parsing. However, readers also possess a large amount of *nonlinguistic* knowledge and

therefore it seems important to reach a closer understanding of how this kind of knowledge affects parsing as well.

One interesting study has been conducted by Hagoort, Hald, Bastiaansen and Petersson (2004), who investigated the effects of world knowledge on sentence interpretation. In EEG and fMRI experiments, sentences were investigated such as *The Dutch trains are yellow/white/sour*. The first sentence is true in all respects (Dutch trains are yellow). However, the sentence that contains *white* is correct from a linguistic point of view, but not with respect to one's world knowledge regarding Dutch trains. Finally, the sentence with *sour* contains a violation of semantic constraints (the feature of being sour does not apply to trains). The results supported the idea during sentence processing, the semantic interpretation of a sentence and the integration of world knowledge occur at the same time, raising questions about the distribution between semantics and world knowledge.

Versteeg, Sanders and Wijnen (2004) conducted a moving window self-paced reading experiment to investigate how readers' domain knowledge regarding the topic of a text affects the resolution of syntactic ambiguity. In order to do this, the processing of temporarily ambiguous subject relative and object relative clauses was compared (hereafter: *SR clauses* and *OR clauses* respectively).

Before Versteeg et al.'s (2004) results are described, some information regarding the processing of SR and OR clauses is presented first. Consider the following example sentences:

- (9) De leraar, die de kinderen prees, was erg aardig. (SR clause)

*The teacher, that the children praised_{SG}, was very kind.*⁵

(The teacher, who praised the students, was very kind.)

- (10) De leraar, die de kinderen prezen, was erg aardig. (OR clause)

The teacher, that the children praised_{PL}, was very kind.

(The teacher, whom the students praised, was very kind.)

The sentences (9) and (10) are temporarily ambiguous between an SR and an OR clause up to the disambiguating verb *prees/prezen*

⁵ The suffix *SG* indicates that the Dutch verb was singular, the suffix *PL* that it was plural.

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(*praised*_{SG/PL}).⁶ More specifically, up to the disambiguating verb, the relative pronoun (*die*) can be given the function of subject and object. Consider the following example sentence:

- (11) De leraar, die <gap 1> de kinderen <gap 2> prees/prezen...
*The teacher, that <gap 1> the children <gap 2> praised*_{SI/PL}...

According to government and binding theory (see e.g. Haegeman, 1994), the relative pronoun in an SR clause originates in subject position in the sentence and is then moved to the beginning of the relative clause. The moving of the relative pronoun to clause initial position leaves behind a so-called trace or gap at the original subject position, i.e. <gap 1> in example (11). The relative pronoun is called the *filler* for this gap. The second possibility to interpret the relative pronoun is by assigning it the function of object, producing an OR clause. In this case, the relative pronoun *die* originates from the object position in the sentence (i.e. at <gap 2> in example (11)) and is then moved to the beginning of the relative clause, leaving a trace or gap.

Earlier work has reported convincing evidence that shows that an SR structure is easier to process than an OR structure (see e.g. Frazier, 1987b; Gibson, 1998). In particular, increased reading times on the disambiguating word have been reported for OR clauses as compared to SR clauses. Frazier (1987b) maintains that the *active filler strategy* can explain this preference. According to this syntax-based strategy, the parser prefers to associate the 'filler' *die*, i.e. the dislocated element, with the first available position, which is the subject position (corresponding to *gap 1* in example (11)). However, several other studies have shown that non-syntactic factors, such as animacy, topicality and the semantic properties of the verb modulate the disambiguation process. These studies are not discussed here, but see for instance Mak, Vonk & Schriefers (2006; see also Mak, 2001; Mak, Vonk & Schriefers, 2002).⁷

⁶ One must note that, unlike in Dutch, the word order in English SR clauses is different from that in OR clauses. Due to this, the grammatical function of the noun phrases is already disambiguated at the word following the pronoun in English, whereas this is not the case in Dutch (see e.g. Frazier, 1987b).

⁷ Summarized briefly, Mak et al. (2006) provide evidence for the *Topichood Hypothesis*. According to this hypothesis, the subject of the relative clause is selected on the basis of its suitability as a topic, which subsumes both the animacy and the topicality of the antecedent. In particular, an animate entity is more likely to be the subject of a

Versteeg et al. (2004) investigated how readers' domain knowledge affects the processing of the SR-/OR-ambiguity. This was done by controlling for participants' domain knowledge with respect to the topic of the experimental texts (i.e., literary history). SR and OR clauses such as the following were investigated:

- (12) Slauerhoff, die de Forum-oprichters bewonderde, opende de eerste jaargang van dit tijdschrift. (SR clause)
Slauerhoff, who the founders of Forum admired_{SG}, opened the first volume of this journal.
- (13) Slauerhoff, die de Forum-oprichters bewonderden, opende de eerste jaargang van dit tijdschrift. (OR clause)
Slauerhoff, who the founders of Forum admired_{PL}, opened the first volume of this journal.

The critical sentences were embedded within explanatory texts which were five or six sentences in length. Both relevant NP's (*Slauerhoff* and *de Forum-oprichters* in example (12) and (13)) were always animate. In order to prevent an a priori bias towards either an SR or an OR clause, it was important that the relation conveyed was equally plausible in both directions. More precisely, for the examples (12) and (13) it was important that it was equally plausible that Slauerhoff admired the founders of the journal *Forum* and vice versa. This was verified by a university professor of literature.

Participants either had high or low knowledge of the topic of the text. The low-knowledge participants never participated in any courses on

relative clause than an inanimate one. Furthermore, the relative clause is a statement about an antecedent and therefore the antecedent noun phrase can be considered the topic of the relative clause. Because the topic of a sentence is most likely to be the subject, Mak et al. hypothesize that, other relevant factors being equal, the antecedent noun phrase will be chosen as the subject of the relative clause.

On the basis of self-paced reading and eye movement results, Mak et al. conclude that if the factors animacy and topicality are in accordance with each other, the parser immediately assigns the antecedent noun and the relative-clause-internal noun to the subject and object role upon encountering the relative-clause-internal noun. However, if the factors animacy and topicality counteract, the assignment of syntactic functions to the nouns is postponed until further relevant information is encountered. In this case, the eventual assignment of syntactic functions to the nouns can be based upon information such as the semantic content of the verb. For further details see Mak et al. (2006).

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literature, whereas the high-knowledge participants were enrolled in a three month university undergraduate course on the history of Dutch literature. In fact, the experimental items were based on their course materials. In order to make sure that experts really distinguished themselves from novices regarding the amount of relevant knowledge, they received a short extra training just before the start of the experiment.

Remember that the SR and OR readings of the experimental sentences were equally plausible, even to expert readers. The goal of the experiment was not to see whether domain knowledge assisted immediate ambiguity resolution. Rather, all participants were expected to opt for an SR parse and to be forced to reanalyze this structure if the disambiguating word demanded it. However, experts were expected to recover more easily from the OR parsing difficulty, because they needed to spend less cognitive resources on understanding the contents of the text. This line of reasoning is based on the idea that readers only have a limited amount of processing resources at their disposal, which is in concordance with, for instance, Gibson's *syntactic prediction locality theory* (1998). If a large amount of the available processing resources has to be spent on a certain (complex) aspect of sentence processing, there are not many resources left for other aspects. Thus, a reader type (expert-novice) by sentence type (SR-OR) interaction effect was expected in the reading times of the disambiguating word.

Versteeg et al.'s reading time results showed a main effect of sentence type: the disambiguating verb and the subsequent word were processed faster in an SR clause than in an OR clause. However, the expected interaction between prior knowledge and sentence type was not found. Facilitative effects of prior knowledge were only found off-line, in a verification task: experts verified statements that reflected the contents of the critical sentences better than novices.

Despite the fact that the expected on-line interaction between domain knowledge and sentence type was not found, it can be concluded that the effects of world knowledge on parsing require further investigation. First, because this issue has not received much attention in the literature as yet, and second, because it can be investigated more thoroughly than in Versteeg et al.'s study. Perhaps the expected on-line effects would have been found if more experimental items were used (Versteeg et al.'s study left no room to include more than four items per condition) or a

more accurate research method had been applied (e.g. the registration of eye movements). Furthermore, it may be wise to manipulate world knowledge in such a way that the amount and the type of knowledge that participants have can be controlled better. Finally, it seems important to shift focus from the question whether world knowledge can facilitate the process of reanalysis, as was investigated in the Versteeg et al. experiment, to the question whether world knowledge can immediately affect *initial* parsing decisions. After all, the idea that world knowledge facilitates reanalysis is something that proponents of syntax-first models will not object to. This result would therefore not be a strong indication for the notion of an interactive parser. The current study intends to realize all these objectives. The next section explains how this is done.

2.4 The effects of situational knowledge on parsing

In the current study, it is investigated how a specific type of episodic knowledge affects parsing. Episodic knowledge refers to people's knowledge about events and is normally acquired through experiencing these events. However, it is assumed here that, in some respect, such episodic knowledge can be obtained through reading a text as well. In this case, it consists of the highly-integrated mental representation that readers form of events described in a text that he is currently processing (i.e. a so-called *situation model*; see e.g. Schmalhofer & Glavanov, 1986; Fletcher, 1994; Kintsch, 1998; Zwaan & Radvansky, 1998; Kamalski, 2007; Mulder, 2008). This mental representation of the text results from the integration of the propositional representation of a text (i.e. the so-called *textbase*) with the reader's world knowledge. In the current study, this kind of knowledge is referred to as *situational knowledge*.

The advantage of manipulating world knowledge by means of discourse context is that all the relevant knowledge is provided to the participants through the text they are reading. As a consequence, the extent to which participants have relevant knowledge upon encountering the target sentence can be largely controlled for. In the current study, the NP-/S-coordination ambiguity is used as a tool to study the impact of situational knowledge on parsing. This ambiguity is chosen over the SR/OR clause ambiguity that Versteeg et al. (2004) used (see section 2.3), because it is hard to investigate the effects of world knowledge on the *initial* analysis of an SR/OR ambiguity. Consider the following example:

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- (14) *Jacob, die ...*
Jacob, who ...

The initial analysis of an SR/OR ambiguity is generally determined at the relative pronoun *die*, which refers to *Jacob* (see section 2.3; see Mak et al., 2006, for exceptions). However, in order to determine whether *Jacob* is more likely to be the subject or the object of the sentence on the basis of world knowledge (prior knowledge), readers must at least have processed the relative clause-internal noun or even the verb. Consider the following possible continuation of example (14):

- (15) *Jacob, die Michiel feliciteerde ...*
Jacob, who Michiel congratulated ...

In order to determine who was more likely to congratulate whom on the basis of prior knowledge, readers must have at least processed the verb *feliciteerde*. As the initial analysis of the sentence is assumed to be made at the relative pronoun *die*, the relevant world knowledge comes into play too late to influence the initial analysis of the sentence. It can only facilitate the evaluation of the initial analysis and its possible reanalysis. In contrast to the SR/OR ambiguity, all information necessary to analyze the ambiguous *NP and NP* string in an NP-/S-coordination ambiguity has already been processed upon its encountering. Therefore, the NP-/S-coordination ambiguity promises to be a better tool to investigate the influence of world knowledge (situational knowledge) on initial parsing decisions. Consider the following example text:

Example text (1)

- (1) Ellen had a party together with her boyfriend Ruben to celebrate their birthdays. (2) She had a good time. (3) She only found it irritating that Ruben and his neighbor Peter drank so much alcohol. (4) When they opened the umpteenth bottle of beer, she decided to say something about it. (5) Ellen said that she was annoyed by the attitude of Peter and Ruben (...)

Upon encountering the ambiguous NP *Ruben* in sentence (5) in example (1), readers have to decide how to attach it within the parse tree (the

sentence stops at *Ruben* in the example for the purpose of illustration). There are two possible ways to do this, viz. as the subject/topic of a conjoined sentence (an S-coordination) or as part of the complex object NP that started out with *the attitude of Peter and* (an NP-coordination):

- (16) Ellen said that she was annoyed by Peter and Ruben *and she walked away angry.* (NP-coordination)
- (17) Ellen said that she was annoyed by Peter and Ruben *tried to calm her down.* (S-coordination)

The main question of the current study is whether the decision to analyze the critical sentence in example (1) as either an NP- or an S-coordination is immediately affected by situational knowledge. If this is the case, then the phrase *Peter and Ruben* in example (1) can be expected to be analyzed as an NP-coordination. After all, on the basis of the context it is obvious that Ellen was fed up by the attitude of both Peter and Ruben. However, imagine that sentence (5) of example (1) was embedded in the following text:

Example text (2)

(1) Ellen had a party together with her boyfriend Ruben to celebrate their birthdays. (2) She had a good time. (3) She only found it irritating that their neighbor Peter drank so much alcohol. (4) When he opened the umpteenth bottle of beer, she decided to say something about it. (5) Ellen said that she was annoyed by the attitude of Peter and Ruben (...)

This text closely resembles example text (1), except that sentence (3) indicates that Ellen is irritated by Peter's behavior only, instead of by the behavior of both Peter and Ruben. On the basis of both syntax-based and topic structure-based parsing strategies (the text has one topic, viz *Ellen*⁸), readers can be expected to prefer an NP-coordination analysis of sentence (5) (see section 2.2.1). However, on the basis of readers' situational knowledge, an NP-coordination would be a highly implausible continuation of this sentence. After all, on the basis of the context it is obvious that Ellen is only annoyed by the attitude of Peter and not by the attitude of Ruben. Therefore, readers' situational

⁸ The topic structure of the current experimental items is further explained in section 2.4.3.

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knowledge strongly supports an S-coordination interpretation of the sentence.

In sum, the central question of the current study is the following:

*Does situational knowledge immediately affect on-line parsing decisions? More specifically: can situational knowledge influence or even overrule the parsing preference for an NP-coordination that is induced by syntactic economy and/or a one-topic discourse structure?*⁹

In the following section the hypotheses regarding this question are presented.

2.4.1 Hypotheses

The main hypothesis of the current study is that all different sources of information immediately affect parsing without any prioritization. Parsing is assumed to be a highly interactive process in which different sources of information are invoked at the same time. In the current study, this implies that there are three factors that possibly affect the initial analysis of the NP-/S-coordination ambiguity, viz a syntax-based parsing strategy (i.e. minimal attachment), the topic structure of the preceding discourse context and situational knowledge. Consider the following example sentence:

(18) John kissed Mary and her sister laughed. (S-coordination)

The minimal attachment strategy supports an initial NP-coordination interpretation of this sentence under all circumstances (i.e. John kissed [Mary and her sister]). In the current study, the critical sentences were always embedded within a one-topic discourse context. Therefore, this pragmatic factor predicts an NP-coordination preference as well: this

⁹ It is important to note that the experiments in the current study were not primarily designed to adjudicate between serial and parallel parsing models. In other words, the main aim of the current study was to investigate the effect of situational knowledge on the initial analysis of the sentence, but not, however, to investigate whether this was the only structure that was initially constructed or whether it was selected among several (partly) activated syntactic alternatives.

structure has one topic and therefore requires no adaptations of the ongoing topic structure.¹⁰

However, imagine that the preceding (one-topic) discourse context provided readers with the following information: (1) John is very much in love with Mary and plans on kissing her and (2) John very much dislikes her sister and therefore (the reader would infer) would absolutely never kiss her. On the basis of this situational knowledge, readers could immediately decide that an NP-coordination analysis of sentence (18) would be highly unlikely.

In sum, this situation resembles that of example text (2): both syntax-based and topic structure based strategies support an NP-coordination and conflict with the factor situational knowledge, which supports an S-coordination. In other words, three different economy principles are relevant. First, the syntax-based principle of selecting the structure that requires fewest nodes in the parse tree (i.e. minimal attachment). Second, the pragmatic principle of selecting the structure that requires no adaptations of the existing topic structure. Third, the situational knowledge-based principle of selecting the structure that best fits the existing situation model of the discourse, i.e. which requires fewest adaptations of the existing mental representation of the discourse.

The present study aims to investigate whether situational knowledge can immediately determine parsing decisions. Given that syntactic factors and topicality are kept constant, finding such an immediate effect implies that situational knowledge outweighs topicality and minimal attachment. In the following section, it is described how the initial analysis of an NP-/S-coordination ambiguity can be distinguished from its reanalysis.

2.4.2 Distinguishing initial analysis from reanalysis

The on-line studies on the NP-/S-coordination ambiguity that were described above mainly focused on reading time differences at the point

¹⁰ Previous work by Hoeks and his colleagues (2002) has shown that an NP-coordination analysis is preferred in a one-topic context. As all experimental items in the current study had a one-topic structure, it can provide insight in whether this NP-coordination preference can be modulated by situational knowledge. However, one must note that as the topic structure of the discourse context was not manipulated in the current study, it can only provide an incomplete picture of how situational knowledge and the topic structure of the preceding discourse context interact.

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of disambiguation. However, as was mentioned before, in order to determine whether a certain factor affects the *initial* analysis of the sentence, it is not sufficient to show effects of this factor on the processing of the disambiguating position. The reason for this is that readers could have already changed their initial analysis before the sentence was irreversibly disambiguated. The garden path model, for instance, assumes that the syntactic processor determines the initial analysis of the sentence on the basis of syntax-based parsing strategies alone. The thematic processor is assumed to evaluate the proposed structure with regard to semantic and pragmatic plausibility and, if necessary, propose an alternative structure. What is essential is that the thematic processor is believed to operate concurrently with the syntactic processor. This implies that, even though there is no top-down influence of the thematic processor on the *initial* analysis of the sentence, it can reject an inappropriate analysis *immediately* after it is proposed. This could very well happen before the ultimate point of disambiguation is reached.

Consider the following example sentences:

- (19) Ellen said that she was irritated by the attitude of Peter and Ruben at her party. (NP-coordination)
- (20) Ellen said that she was irritated by the attitude of Peter and Ruben tried to calm her down. (S-coordination)

Sentence (19) and (20) are both temporarily ambiguous between an NP- and an S-coordination. Sentence (19) is disambiguated to an NP-coordination at the word *at*; sentence (20) is disambiguated to an S-coordination at the verb *tried*. However, the initial decision as to how to analyze the sentence is believed to be made at the ambiguous NP *Ruben*. At this point readers must decide to interpret it as a part of the complex object NP *Peter and Ruben* (i.e. as an NP-coordination), or to start a new clause with *Ruben* as its subject/topic (i.e. as an S-coordination).¹¹

¹¹ Frazier (1987b; p.529-530) maintains that “one might assume that the attachment of *and* is accomplished only when the following word has been received”. In the current study this assumption is adopted. Therefore, the decision how to initially interpret the sentence is believed to be taken at the ambiguous NP (*Ruben* in sentence (19) and (20)).

Imagine that sentence (20) is initially (i.e. at the NP *Ruben*) analyzed as an NP-coordination, but that this analysis is immediately evaluated as being inappropriate. This may, for example, happen if the reader has prior knowledge of the situation that is being described in the sentence and therefore *knows* that Ellen was definitely *not* irritated by the attitude of Ruben. This knowledge makes an NP-coordination a very implausible analysis of the sentence and therefore, the initial NP-coordination analysis is reanalyzed to an S-coordination immediately after its proposal. According to the garden path model, this can very well happen before the disambiguating verb *tried* is encountered. Therefore, in order to demonstrate immediate effects of situational knowledge on the initial analysis of an NP-/S-coordination ambiguity, it is necessary to look into the ambiguous part of the sentence as well (for a similar suggestion see e.g. Mitchell, Corley & Garnham, 1992; Altmann, Garnham, & Dennis, 1992; MacDonald, 1993; 1994; Ni, Crain & Shankweiler, 1996). If an effect of situational knowledge can already be demonstrated at the onset of the ambiguity (i.e. at *Ruben* in the examples (19) and (20)), this would provide strong evidence for an immediate effect of this factor on the parsing process.

However, how can one determine whether readers have initially analyzed the ambiguous NP (*Ruben*) as part of an NP- or an S-coordination? In the current study, it is predicted that reading times at the ambiguous NP are longer if the sentence is initially analyzed as an S-coordination than if it is initially analyzed as an NP-coordination structure. A view that yields this prediction is Gernsbacher's Structure Building Framework (1990), which maintains that readers shift from building one substructure to initiating a new one when the incoming information is less related to the previous information. This is, for instance, the case if the topic, point of view or setting of a passage changes (Gernsbacher 1990, p. 25-26; p. 62 for references). In an NP-coordination, the ambiguous NP (*Ruben*) is part of a complex object NP, whereas in an S-coordination it is the subject/topic of the conjoined sentence. In other words, in case of an S-coordination analysis, readers need to initiate a new substructure upon encountering *Ruben*. As a consequence, reading times of the proper name *Ruben* will increase as compared to an analysis in which it is seen as being part of a complex object NP (i.e. in case of an NP-coordination).

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Another factor that can predict increased reading times for the ambiguous NP in case of an S-coordination is the topic structure of the preceding discourse context. Reconsider example text 2:

Example text (2)

(1) Ellen had a party together with her boyfriend Ruben to celebrate their birthdays. (2) She had a good time. (3) She only found it irritating that their neighbor Peter drank so much alcohol. (4) When he opened the umpteenth bottle of beer, she decided to say something about it. (5) Ellen said that she was annoyed by the attitude of Peter and Ruben (...)

In the present study, the notion *topic* will be loosely defined as the element that refers to the central entity about which information is provided by a sentence or text.¹² The part of the experimental items prior to the target sentence always showed a one-topic structure. More specifically, *Ellen* is considered to be the discourse topic in example (2). She is the first actor to be introduced and she is mentioned four times prior to the target sentence, three times of which in typical topic positions, i.e. at sentence initial subject position. Furthermore, she is always the first-mentioned person in the target sentence (sentence (5)). This constitutes a referential chain of the discourse topic.

As was mentioned in section 2.2.1, the principle of minimal topic structure predicts that participants *always* prefer an NP-coordination analysis of the target sentence if it is embedded in a one-topic context. The reason for this is that an NP-coordination has only one topic (*Ellen* in example (21)), whereas an S-coordination has two (*Ellen* and *Ruben* in example (22)). Therefore, an NP-coordination analysis does not require any adaptations of the existing topic structure.

¹² Although there are strong correlations between (grammatical) subjecthood and (discourse) topichood, it is important not to conflate the two. It is also important to note that there is still little consensus on what exactly counts as a topic. The current study leaves no room to further discuss this issue, but one is referred to Brown & Yule (1983), Givon (1983), Lambrecht (1994) and Pander Maat & Sanders (to appear) for a review of the notion discourse topic, and to Reinhart (1981) for a review of the notion of sentence topic.

- (21) Ellen said that she was fed up with the attitude of Peter and Ruben and she walked away angry. (NP-coordination)
- (22) Ellen said that she was fed up with the attitude of Peter and Ruben tried to calm her down. (S-coordination)

If situational knowledge modulates this topic structure-based NP-coordination preference, then participants would immediately select an S-coordination structure in an S-coordination supportive context, regardless of the topic structure of the preceding context. Nevertheless, the preferred structure is not necessarily the structure that is easiest to build (see also section 1.3.5 about reversed ambiguity effects). In particular, even if the S-coordination interpretation is preferred in an S-coordination supportive context, it still requires the existing one-topic structure to be altered to a two-topic structure, which has been argued to require processing resources (Hoeks et al., 2002). This is not the case in an NP-coordination supportive context, because in this case both situational knowledge and the topic structure of the preceding context support an NP-coordination interpretation.

In sum, even though previous studies on the NP-/S-coordination ambiguity have not reported this result, there is reason to predict increased reading times for the ambiguous NP in case of an S-coordination analysis as compared to an NP-coordination analysis. If situational knowledge can be shown to modulate the processing of the ambiguous NP, this would provide strong support for an interactive account of sentence processing.

2.5 Summary and preview

Summarizing, the current study aims to investigate the influence of situational knowledge on the on-line resolution of the NP-/S-coordination ambiguity. The main question is whether situational knowledge immediately affects whether readers initially analyze a phrase such as *Ellen was annoyed by Peter and Ruben...* as an NP- or as an S-coordination. More precisely, the question is whether situational knowledge can overrule the NP-coordination preference that is induced by syntactic economy and/or a one-topic discourse structure.

The current study aims to investigate the effects of situational knowledge as precisely as possible. This is done in the following ways. First, in order to make sure that situational knowledge is manipulated in

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the strongest possible way, its manipulation is tested extensively before investigating its on-line effects. Second, effects of situational knowledge are explored both in the ambiguous region and at its point of disambiguation. Third, in order to maximize the chance that effects of situational knowledge are detected, several moving window self-paced reading experiments are conducted (in Chapter 3 and 4). In addition to these experiments an eye movement study was also conducted (in Chapter 5). Finally, the influence of situational knowledge is not only investigated separately, but also in contrast to the influence of another factor, viz. verb number agreement. How this was done is explained in Chapter 4.

Chapter 3

The effect of situational knowledge on parsing ambiguous coordinations

3.1 Introduction

The aim of the experiments reported here is to investigate whether the parsing process is immediately affected by readers' situational knowledge, i.e. by the state of affairs described by the text and hence, by assumption, by readers' internal representation of this information. In particular, it is examined if the proper situational knowledge can modify parsing preferences in ambiguity resolution. If syntactic ambiguity resolution is an interactive process in which multiple sources of information are brought to bare immediately, this would indeed be the case. The NP-/S-coordination ambiguity is used as a research tool to investigate this issue. In the current chapter, three experiments are described, viz an off-line completion study, an off-line judgment study and an on-line moving window self-paced reading experiment. Before these three experiments are discussed, the manipulation of situational knowledge is explained in detail.

3.2 The manipulation of situational knowledge

Consider the following examples:

- (1) Bart said that he was annoyed by the unfounded opinion of Manon and Francien about this important issue. [NP-coordination]
- (2) Bart said that he was annoyed by the unfounded opinion of Manon and Francien said repeatedly that the discussion had gotten completely out of hand. [S-coordination]

Example sentences (1) and (2) are temporarily ambiguous between an S- and an NP-coordination up to and including the proper name *Francien*. As was described in the preceding chapter, an intrinsic preference for an NP-coordination has been generally observed (see section 2.2.1). This

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preference has been explained by two economy-based principles, viz the syntax-based minimal attachment strategy (Frazier, 1987) and a pragmatic topic structure principle (Hoeks, Vonk & Schriefers, 2002).

In the current study, it is investigated whether the appropriate situational knowledge can change preferences in ambiguity resolution. Situational knowledge is manipulated by means of discourse context. For example, imagine that the example sentences (1) and (2) are embedded in a discourse context stating that Bart has published a book that is criticized by both Manon and Francien. This information makes it plausible that Bart is annoyed by both Manon and Francien and is therefore supportive of an NP-coordination interpretation over an S-coordination analysis. However, a context that states that Bart's book is criticized by Manon, but is *appreciated* by Francien, makes an NP-coordination less and an S-coordination more plausible. After all, this knowledge makes it implausible that Bart is annoyed by Francien (i.e. that *Francien* is part of the object of the verb *annoyed*) and therefore biases towards interpreting the NP *Francien* as the subject/topic of the conjoined sentence, which produces an S-coordination.

The following two examples illustrate the above two scenarios, that provide either NP-coordination or S-coordination supportive situational knowledge. Example (1) has an NP-coordination supportive context (hereafter *NP-context*) and example (2) an S-coordination supportive context (hereafter *S-context*). The examples are freely translated from Dutch, except from the critical sentence, which is translated both freely and literally.

Example 1: NP-coordination supportive context

- (1) Jonge schrijver Bart Schut heeft in het tv-programma De Plantage fel uitgehaald naar recensente Manon Thijssen.
(Young writer Bart Schut has lashed out at reviewer Manon Thijssen in the TV program The Plantation.)
- (2) De schrijver vertelde dat hij erg boos is over Thijssens negatieve recensie van zijn debuut.
(The writer said that he is very angry over Thijssen's negative review of his debut.)
- (3) In de uitzending kreeg Schut ook al kritiek van uitgeefster Francien Koopmans.

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(In the broadcast the debutant was criticized by publisher Francien Koopmans as well.)

- (4) Ook dat kon hij niet begrijpen, zei hij tegen Koopmans.
(This he could not understand either, he pointed out to Koopmans.)
- (5) Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans vond eigenlijk dat de discussie te veel werd opgeblazen.
Schut said to be annoyed by the unfounded opinion of Thijssen and Koopmans found actually that the discussion too much was being blown up.
(Schut said that he was annoyed by the unfounded opinion of Thijssen and Koopmans actually found that the discussion had gotten completely out of hand.)
- (6) Volgende week zal ook De Volkskrant een recensie aan het debuut wijden.
(Next week 'De Volkskrant' will publish a review of the debut too.)

Example 2: S-coordination supportive context

- (1) Jonge schrijver Bart Schut heeft in het tv-programma De Plantage fel uitgehaald naar recensente Manon Thijssen.
(Young writer Bart Schut has lashed out at reviewer Manon Thijssen in the TV program The Plantation.)
- (2) De schrijver vertelde dat hij erg boos is over Thijssens negatieve recensie van zijn debuut.
(The writer said that he is very angry over Thijssen's negative review of his debut.)
- (3) In de uitzending kreeg Schut daarentegen wel erkenning van uitgeefster Francien Koopmans.
(In the broadcast Schut however did receive recognition from publisher Francien Koopmans.)
- (4) Dat kon hij wél waarderen, zei hij tegen Koopmans.
(This he could appreciate, he pointed out to Koopmans.)
- (5) Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans vond eigenlijk dat de discussie te veel werd opgeblazen.

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Schut said to be annoyed by the unfounded opinion of Thijssen and Koopmans found actually that the discussion too much was being blown up.

(Schut said that he was annoyed by the unfounded opinion of Thijssen and Koopmans actually found that the discussion had gotten completely out of hand.)

- (6) Volgende week zal ook De Volkskrant een recensie aan het debuut wijden.

(Next week De Volkskrant will publish a review of the debut too.)

The experimental items were designed to resemble short newspaper reports. The theme of the texts was always an argument or debate about a certain issue. The exact set-up of the texts was as follows. Three characters were introduced in the text. The character that was introduced first (here: Bart Schut) was the discourse topic. This character was in subject position throughout the text and hence repeatedly referred to. Sentence (1) described that the discourse topic and one of the other two characters disagree about a particular matter. In sentence (2) this disagreement was elaborated. In sentence (3) the third character was introduced. In this sentence the essential situational knowledge was manipulated: the third character either did (example (2), i.e. S-coordination supportive) or did not (example (1), i.e. NP-coordination supportive) support the first character. Sentence (4) described the response of the first character to the (non-) support of the third character, and hence underlined once more whether the third character was to be seen as supportive or non-supportive of the second character. Sentence (5) was the critical S-coordination sentence. This sentence always started with the first character and topic (Schut) expressing negative feelings towards the second character (Thijssen), such as the first character and topic criticizing or saying that he/she was annoyed by the second character. At this point, the third character was introduced (Koopmans). The NP *Koopmans* appeared in a structurally ambiguous position: it could be interpreted as being part of the direct object of the verb *annoyed* (i.e. as an NP-coordination) or as the subject of the subsequent verb *found* (i.e. as an S-coordination). The ultimate structure of the target sentence was an S-coordination in all cases.

As was described in section 2.4.2, the notion discourse topic is defined here as the element that refers to the central entity about which information is provided by a sentence or text (following Lambrecht, 1994; Hoeks, Vonk, & Schriefers, 2002). On the basis of this definition, *Bart Schut* can be identified as the discourse topic and hence, the discourse context prior to the target sentence had a one-topic structure, which is generally more compatible with an NP-coordination than an S-coordination. This was the case for all experimental items.

Two variants of the situational knowledge manipulation were used. The first involved texts consisting of one paragraph. The second involved basically the same texts, but now they were divided in two parts: the first part (three sentences) served as background information for the second part, which contained the actual message (three sentences, including the critical sentence). These different manipulations were used in order to test the effectiveness of different ways of providing participants with situational knowledge through the discourse context. An example of a two-paragraph text can be found in Appendix 1.

Predictions

Upon encountering the ambiguous NP *Koopmans* in the critical sentences in example (1) and (2), the sentence processor has two options, viz to analyze the sentence as an NP-coordination or as an S-coordination. Both syntax-based minimal attachment and topic structure-based parsing strategies predict that an NP-coordination analysis will be initially selected in all circumstances. Still, situational knowledge is expected to affect the initial analysis of the sentence. If situational knowledge is supportive of an S-coordination, the target sentence is expected to be initially analyzed as such, even though both minimal attachment and the topic structure-based parsing strategy indicate otherwise.

In sum, participants are expected to prefer an NP-coordination in an NP-context and an S-coordination in an S-context. In particular, situational knowledge is expected to overrule both syntax-based and topic structure-based parsing strategies. If this is indeed the case, this would entail that syntax- and topic structure based constraints are outweighed by situational knowledge. The rationale of this idea is further elaborated in Chapter 6. In the remaining part of this chapter, results of an off-line completion study, an off-line judgment study and an on-line moving window self-paced reading experiment are discussed.

3.3 Experiment 1: completion study

The first goal of the off-line completion study was to estimate language users' expectations regarding sentence structure, given the conceptual properties of the discourse. Furthermore, the experiment was conducted to test the materials, in particular the manipulation of situational knowledge, in preparation of the on-line study that is reported in section 3.5.

Text materials were designed to manipulate situational knowledge in the manner that was described in section 3.2. The dependent factor was the syntactic structure of the critical sentence as completed by the participants. The critical sentence was interrupted after the first proper name after the conjunction *en* (*and*), i.e. *Koopmans* in sentence (3), which was ambiguous between a part of the object of *annoyed* (NP-coordination) or the subject of a conjoined sentence (S-coordination):

- (3) Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans ...
Schut said to be annoyed by the unfounded opinion of Thijssen and Koopmans ...
(Schut said that he was annoyed by the unfounded opinion of Thijssen and Koopmans ...)

Situational knowledge was expected to affect the way participants completed the critical sentence. Specifically, participants were expected to complete the critical sentence more often as an NP-coordination in an NP-context and more often as an S-coordination in an S-context.

3.3.1 Method

Participants

One hundred and thirty students (of whom ninety-one were women) at the Faculty of Humanities of Utrecht University participated in the experiment for course credits. The mean age of the participants was 21 years (range: 18-44 years). All were native speakers of Dutch and naïve as to the purpose of the experiment.

Materials

Twenty-four experimental texts were constructed, each with an NP- and an S-context version and each with a one-paragraph and a two-

paragraph version. The structure of the texts was identical to that in example (1) and (2). The frequency was controlled of the occurrence of the surnames that were used.

Design

Two experimental lists were constructed, such that each of the two conditions was equally represented and no two versions from the same item appeared in the same list. To prevent any ordering effects, ten different orders of presentation for the texts were randomly selected. The selection of texts that appeared together in the same condition was determined at random and was the same for all lists. Each list consisted of twenty-four experimental texts, interspersed among twenty-four filler items in such a way that the list started with two fillers and that after this every experimental text alternated with a filler. The one- and two-paragraph texts were randomly assigned to the participants and each participant received only one of the text types.

The scenarios that were described in the fillers were of the same kind as those described in the experimental texts. Thirteen fillers contained an NP-coordination supportive context and eleven an S-coordination supportive context. The set-up of the fifth sentence resembled the set-up of the critical sentence of the experimental texts in that it described the interaction between the main characters of the text. Twelve filler items contained the connective *and*.¹ In ten other fillers the connective *but* was used, such as in the phrase *Brandsma criticized De Haard, but Rutte....* In one filler sentence the construction *and also* was used and in one other filler the construction *between NP and NP*.

Procedure

Participants were instructed both orally and in writing that they were about to read forty-eight texts, which would end at a particular point in

¹ The filler items that were used in Experiment 1 were in fact designed for the self-paced reading experiment (Experiment 3). In Experiment 3, the filler items that contained the connective *and* developed as NP-coordinations, because all critical items were S-coordinations. However, in the current experiment the filler items were already interrupted after the first NP after the conjunction *en* (*and*). As the sentences had not developed as an NP- or an S-coordination at this position yet, the set-up of the filler items that contained the connective *and* was identical to that of the critical items (cf. example (3)). Therefore, they may not have been very distracting. However, the current study left no room to create separate filler items for Experiment 1.

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the middle of a sentence. Their task was to complete the sentence from that point on in a way that would be grammatical and plausible given the contents of the text. It was emphasized that it was not important that the continuation be very funny or original. Participants had approximately one hour to complete the task.

3.3.2 Results and discussion

The data were submitted to a multilevel analysis. This analysis allows one to combine all random factors simultaneously in one full statistical analysis (see Goldstein, 1995; Snijders & Bosker, 1999; Quené & Van den Bergh, 2004; Mulder, 2008, for in-depth discussions). The reported means of S-coordination continuations were derived from the logit-scores, which are a non-linear transformation of proportions (Fienberg, 1980; Goldstein 1995). The model for the current data can be found in Appendix 2. Ungrammatical continuations and missing data, for instance from participants who were unable to finish in time, were excluded from analysis. For one-paragraph texts, this concerned 2% of the data, for the two-paragraph texts 0,5%.

The results for the one- and two-paragraph texts showed the same pattern. Therefore, only the results for the latter are shown in Table 1 (but see Appendix 3 for the results for two-paragraph texts). Results with a p-value of .05 or less were considered statistically significant.

Table 1: Mean proportion of S-coordination continuations (*S-continuations*) for one-paragraph texts as a function of situational knowledge (standard errors in parentheses).

NP-context	Proportion S-continuations	0,36*
	logit scores (se)	-0,55 (0,13)
	s ² subj_between (se)	0,68 (0,18)
S-context	Proportion S-continuations	0,86*
	logit scores (se)	1,85 (0,25)
	s ² subj_between (se)	3,33 (0,71)

Note: *s²subj-between* denotes the between-subjects variance. * marks a statistically significant difference between conditions.

The results show that, in both the one- and two-paragraph texts, the critical sentence was completed more often as an NP-coordination in a NP-context, viz in 64% of the cases. In an S-context however, participants completed the critical sentence more often as an S-coordination, viz in 86% of the cases ($\chi^2 \geq 2.64$; $df = 1$; $p \leq 0.05$, one-sided; $d \geq 1.70$).²

On the basis of the results it can be concluded that (1) the manipulation of situational knowledge had effectively impacted on readers' mental representation of the text, and that (2) situational knowledge affected expectations with respect to the structure of the critical (interrupted) sentence. More specifically, situational knowledge determined whether the critical sentence was completed as an S-coordination or as an NP-coordination. Therefore, it appears that the way participants eventually completed the critical sentence was not determined by syntax-based or topic structure-based strategies (which were both supportive of an NP-coordination). Put differently, these two strategies were outweighed by situational knowledge.

It is remarkable that there was an overall preference for an S-coordination completion of the critical sentence, even though situational knowledge appeared to significantly modulate it. This result is particularly striking, given the overall parsing preference for an NP-coordination that has been found in past completion studies (see e.g. Frazier & Clifton, 1997). The only plausible explanation that presents itself is that the manipulation of situational knowledge was stronger in the S-context than in the NP-context. Even though both minimal attachment and topic structure supported an NP-coordination continuation of the critical sentence, participants seem to have preferred to complete the target sentence as an S-coordination, unless the situation as described in the discourse context made an NP-coordination completion *substantially* more plausible. This idea is further discussed in section 4.3.2.

² The effect size (d) is an objective and standardized way to measure the magnitude of a treatment effect. Unlike significance tests, this index is independent of the sample size. The effect size is measured in accordance with Cohen (1988), who defined it as the difference between the means divided by the pooled standard deviation. An effect size from 0.2 represents a small effect, from 0.5 a medium effect and from 0.8 a large effect.

3.4 Experiment 2: judgment study

Experiment 1 tells us what readers consider as an adequate continuation of an ambiguous sentence fragment, on the basis of the situational knowledge that they received through the discourse. The present off-line judgment study was designed to test whether a certain continuation-type is judged to be easier, more plausible, and more natural in one context over another.

As in the completion study, the independent variable was situational knowledge. Participants' judgments of the perceived complexity, plausibility and naturalness of the critical sentence within its context were measured. Participants were expected to judge the critical sentence, which was *always* an S-coordination, to be easier, more plausible and more natural if it was embedded in an S-context than if it was embedded in an NP-context.

3.4.1 Method

Participants

The same students participated in the present experiment as in Experiment 1.

Materials

The same texts were used as in the completion study, only now they were presented as complete texts (cf. example (1) and (2)). Thus, participants judged twenty-four experimental items and twenty-four fillers. The target sentences were temporarily ambiguous between an NP- and an S-coordination, but the true structure of the sentence was an S-coordination in all cases. As in the completion study, one-paragraph texts were compared with two-paragraph texts.

The scenarios that were described in the fillers were of the same kind as those described in the experimental texts. Twelve fillers contained an NP-coordination supportive context. In these fillers the fifth sentence, which was the critical sentence in the experimental texts, was an NP-coordination, such as the following:

- (4) In deze uitzending bekritiseerde Van den Hoogenband de negatieve houding van Heitman en De Graaff ten opzichte van hem, een opmerking die De Graaff duidelijk irriteerde.

In this broadcast criticized van den Hoogenband the negative attitude of Heitman and De Graaf with respect to him, a remark that De Graaff clearly annoyed.

(In this broadcast van den Hoogenband criticized the negative attitude of Heitman and De Graaf towards him, a remark that clearly annoyed De Graaf.)

No S-coordination supportive contexts were used in combination with NP-coordinations, because this would make the NP-coordination sentences rather implausible. In ten fillers, the context was supportive of an S-coordination and the “critical” sentence contained the connective *but* (such as in the sentence *Brandsma criticized Brandsma, but De Haard emphasized that it was a more general trend*). The “critical” sentence of the two remaining fillers contained the connective *and*, but was neither an NP- nor an S-coordination. One of the scenarios contained an NP-coordination supportive context, the other an S-coordination supportive context.

Design

The design of the present experiment was identical to that of Experiment 1.

Procedure

After participants finished the completion study, they had a short break, after which they participated in the judgment study. They had approximately forty-five minutes to complete the task. Participants were led to believe (both orally and in writing) that they were about to judge the completions of other students that participated in the completion study the week before. The participants’ task was to judge the critical sentences (alleged completions) on the following scales (cf. Millis, Graesser & Haberlandt (1993); Wijnen & Kaan, 2006; Sadeh-Leicht (2007):

1. Easiness: how difficult is the critical sentence to process?
2. Plausibility: how plausible is the critical sentence within its context?

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3. Naturalness: how natural is the critical sentence, irrespective of the context in which it appears?

These three scales were used, because they reflect different aspects of sentence processing. The *easiness-scale* assessed participants' estimation of the general understandability of the target sentence, viz of its structure, meaning and appropriateness within the context all together. The *plausibility-scale* assessed participants' estimation of the plausibility of the target sentence within the discourse context and hence mainly focused on its meaning. Finally, the *naturalness-scale* assessed participants' estimation of the form of the sentence and thus mainly focused on its structural aspects. Situational knowledge was expected to affect all these aspects of processing. More specifically, the critical S-coordination sentence was expected to be considered easier, more plausible and more natural in an S-context as compared to an NP-context.

Participants indicated their assessments by markings on three separate 5-point scales, one for each variable. In order to encourage participants to carefully consider their assessments, not all scales extended in the same direction. The scale to judge the easiness of the critical sentence extended from a negative to a positive evaluation, those for plausibility and naturalness extended in the other direction.

3.4.2 Results and discussion

The data were submitted to a multilevel analysis. The model for the current data can be found in Appendix 4. Missing data, for instance from participants who were unable to finish in time, were excluded from the analysis. For one-paragraph texts this concerned 1% of the data, for two-paragraph texts, 2%. Because the results for the two-paragraph texts were identical to those for the one-paragraph texts in all relevant respects, only those of the one-paragraph texts are presented in Table 2 (but see Appendix 5 for the results for two-paragraph texts). The plausibility and naturalness scales were reversed in the analysis, so that higher scores indicate more positive judgments for all three scales in Table 2.

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Table 2: Mean judgments for one-paragraph texts on the easiness, plausibility and naturalness of the critical sentence as a function of situational knowledge (five-point scale; standard errors in parentheses).

<i>Easiness</i>		
NP-context	Judgments (se)	3,65 (0,08)*
	$s^2_{subj_between}$ (se)	0,33 (0,07)
	$s^2_{subj_within}$ (se)	0,58 (0,03)
S-context	Judgments (se)	3,73 (0,08)*
	$s^2_{subj_between}$ (se)	0,34 (0,07)
	$s^2_{subj_within}$ (se)	0,54 (0,03)
<i>Plausibility</i>		
NP-context	Judgments (se)	2,83 (0,08)*
	$s^2_{subj_between}$ (se)	0,27 (0,06)
	$s^2_{subj_within}$ (se)	0,91 (0,05)
S-context	Judgments (se)	3,10 (0,06)*
	$s^2_{subj_between}$ (se)	0,18 (0,05)
	$s^2_{subj_within}$ (se)	0,98 (0,05)
<i>Naturalness</i>		
NP-context	Judgments (se)	3,11 (0,08)*
	$s^2_{subj_between}$ (se)	0,32 (0,07)
	$s^2_{subj_within}$ (se)	0,86 (0,05)
S-context	Judgments (se)	3,23 (0,08)*
	$s^2_{subj_between}$ (se)	0,30 (0,07)
	$s^2_{subj_within}$ (se)	0,89 (0,05)

Note: $s^2_{subj_between}$ denotes the between-subjects variance, $s^2_{subj_within}$ the within-subjects variance. * marks a statistically significant difference between conditions.

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The results show that participants judged the critical S-coordination sentence to be easier, more plausible and more natural in the S-context than in the NP-context (*ease*: $\chi^2 \geq 3.58$; $df = 1$; $p \leq 0.048$; $d \geq 0.11$; *plausibility*: $\chi^2 \geq 14.83$; $df = 1$; $p \leq 0.001$; $d \geq 0.35$; *naturalness*: $\chi^2 \geq 6.80$; $df = 1$; $p < .001$; $d \geq 0.20$).³ On the basis of these results, it can be concluded that situational knowledge affects the after-reading representation of a sentence (i.e. the product of sentence processing).

It is important to note that the effects of situational knowledge in the present experiment were relatively small as compared to Experiment 1.⁴ In particular, even though it reflected results in the expected direction, the effect of situational knowledge on the perceived easiness of the critical sentence was rather small, as indicated by the effect size (d) of 0.11. These differences in effect size are most likely due to the fact that the effect of situational knowledge was measured differently in the two experiments. In particular, in Experiment 1 participants had to complete the critical sentences themselves, which provided a direct insight in their expectations regarding the structure of the unfolding sentence. In Experiment 2, on the other hand, participants had to compare their own expectations regarding the critical sentence with the actual sentence and convert this comparison in an assessment. This procedure is more indirect and therefore likely to produce more subtle results.

3.5 Experiment 3: self-paced reading experiment

The results of Experiment 1 and 2 showed that situational knowledge affects participants' expectations regarding the structure (and hence the

³ The observed score for a participant consists of two parts, viz the true score, which reflects the participant's actual score on a specific text, and the error score, which reflects errors of measurement. The total effect size is calculated on the basis of both the true variance and the error variance (i.e. the between-subjects and the within-subjects variance), whereas the true effect size is calculated on the basis of the true variance alone (i.e. the between-subjects variance). The total effect size is always smaller than the true effect size and therefore it seems appropriate to report the former. However, the part of the observed score that one is generally interested in is the participant's actual score, which is indicative for the constructs measured, and not the part of his score that was caused by errors of measurement. For this reason, the true effect size is reported here. However, one must note that, judging by the large within-subjects variance, measurement errors still make up for a considerable part of the observed scores (see Table 2).

⁴ An effect size from 0.2 represents a small effect, from 0.5 a medium effect and from 0.8 a large effect (Cohen, 1988).

meaning) of the critical sentence. This was demonstrated both if participants' task was to continue the critical sentences themselves (Experiment 1) and (more subtly) if they had to judge the complexity, plausibility and naturalness of the target sentence (Experiment 2).

In the present experiment, on-line reading processes were measured, using a moving window self-paced reading paradigm. Specifically, it was investigated if situational knowledge immediately affects on-line parsing decisions. If this is the case, the proper situational knowledge would alter the on-line parsing preference from an NP- to an S-coordination. An example of the critical sentence, including the way it was segmented, is presented in (5). There were two critical positions in the target sentence, which are marked with the suffixes C1 and C2.

- (5) Schut / zei / zich te storen aan / het ongegronde oordeel van / Thijssen / en / Koopmans_{C1} / vond_{C2} / eigenlijk / dat / de discussie / te veel / werd opgeblazen.

Schut / said / to be annoyed by / the unfounded opinion of / Thijssen / and / Koopmans_{C1} / found_{C2} / actually / that / the discussion / too much / was being blown up.

(Schut said that he was annoyed by the unfounded opinion of Thijssen and Koopmans actually found that the discussion had got completely out of hand.)

The specific expectations for this example sentence would be the following. In an NP-context it is very plausible that Schut is annoyed by the unfounded opinion of both Thijssen and Koopmans (see example (1) in section 3.2). Therefore, participants would initially analyze the ambiguous NP *Koopmans_{C1}* as part of the object NP *Thijssen en Koopmans* (*Thijssen and Koopmans*), i.e. an NP-coordination. However, in an S-context it is plausible that Schut is annoyed by the unfounded opinion of Thijssen but *not* by Koopmans (see example (2) in section 3.2). Therefore, participants would immediately analyze the ambiguous NP *Koopmans_{C1}* as subject/topic of a conjoined sentence (i.e. an S-coordination), which corresponds to the actual structure of the sentence.

Hence, the first position in the sentence where an effect of situational knowledge is expected to become visible is the first proper name after the conjunction *en* (*and*) (i.e. *Koopmans*). More precisely, reading times for this word are predicted to be longer if the sentence was initially

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analyzed as an S-coordination than if it was initially analyzed as an NP-coordination (see section 2.4.2 for an explanation of this reading pattern). The second position in the sentence where an effect of situational knowledge is expected is the disambiguating verb (*vond_{c2}* (*found*) in example (5)). At this position, the sentence is definitively disambiguated to an S-coordination. As participants are expected to initially analyze the critical sentence as an NP-coordination in the NP-context, reanalysis of the sentence is necessary in this condition upon encountering the disambiguating verb. This leads to increased reading times for this word in the NP-context as compared to the S-context.

Situational knowledge may have the same on-line effects for all readers. However, its effects may also interact with reader's working memory capacity for language. Working memory is generally considered to be a specialized memory system that temporarily allows small amounts of information to be simultaneously stored and processed during the performance of a task (Waters & Caplan, 2004; see p. 129 for references). It has been argued that readers with a low working memory capacity have fewer resources available for sentence processing than readers with a high working memory capacity (see e.g. Daneman & Carpenter, 1980; King & Just, 1991; Just & Carpenter, 1992; see also section 1.2.3.2). As a consequence, high-capacity readers might have enough resources to invoke different constraints simultaneously during sentence processing, whereas low-capacity readers might not, which would lead to relatively inefficient processing. If this is the case, the degree of modularity depends on the working memory capacity of the reader rather than on some structural separation between modules (Just & Carpenter, 1992). For the current study, this may entail that situational knowledge immediately impacts on ambiguity resolution for high-capacity participants, whereas this is not the case for low-capacity readers. To explore if any processing differences of this kind occur, working memory capacity was included as a second independent variable.

3.5.1 Method

Participants

Fifty-three students (of whom forty-five were women), mostly at the Faculty of Humanities of Utrecht University, participated in the experiment. The mean age of the participants was 23 years (range: 19-50 years). They were paid 7.50 euros for their participation. None of them

participated in Experiment 1 and 2 and all were naïve as to the purpose of the experiment.

Materials

The materials that were used were essentially the same as those in Experiment 1 and 2. On the basis of the results of these experiments, some minor changes were made in some of the texts to make the manipulation stronger. Hence, readers were presented with twenty-four experimental texts and twenty-four filler items (see Appendix 6 for all experimental texts; see section 4.3.1 for a detailed description of the filler items).⁵ Because the one- and two-paragraph texts had yielded the same results in both off-line experiments, it was decided to use only one-paragraph texts. The one-paragraph texts were chosen, because this would make the design of the present texts to a great extent comparable to that of related experiments in the literature.

Design

The experiment started with a practice session which comprised three filler texts. Then the first twelve experimental texts and nine fillers were presented to the participants in a random order. After a one-minute break, the remaining texts were presented. Two experimental lists were constructed, in which both conditions were equally represented and no two versions of the same item appeared in the same list. The texts that appeared in the first part of the experiment in the first list appeared in the second part of the experiment in the second list, and vice versa.

⁵ In their experiments, Hoeks et al. (2002) used unambiguous S-coordinations as control sentences. In an unambiguous S-coordination, a comma is placed before the conjunction *en* (*and*), as in the following sentence: *Schut said that he was annoyed by the unfounded opinion of Thijssen, and Koopmans actually found that the discussion had gotten completely out of hand.* Using an unambiguous S-coordination control structure may provide interesting additional information regarding the processing of the NP-/S-coordination ambiguity. However, in order to find an answer to the current question (i.e. does situational knowledge affect initial parsing decisions), it was considered sufficient to compare the processing of ambiguous NP- and S-coordinations. In particular, the initial parsing decision between an NP- and an S-coordination is expected to be made at the first NP after the conjunction *en* (*and*). Therefore, this is the first position where an effect of situational knowledge is expected to become visible. If situational knowledge indeed causes reading time differences at this position, this would provide strong evidence that this factor has an immediate impact on parsing.

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Procedure

Prior to the reading experiment, participants' working memory capacity was determined by measuring their Reading Span with the test developed by Daneman & Carpenter (1980). Participants were required to read increasingly longer sequences of sentences, remembering the final word of each sentence. At the end of each sequence people had to recall the final words of that sequence in the order in which they had been presented. The rationale behind this test is that after comprehending the sentences, high span readers would have more working memory resources left to remember the final words of the sentence. The scores on the Reading Span test were included as a covariate in the analyses of the reading times.

After completion of the Reading Span test (which took about ten minutes), participants were seated in front of a computer. They were instructed both orally and in writing that some short texts would be presented to them, which they had to read as they would normally do. For situational knowledge to be an independent factor, it was necessary that participants had properly processed the manipulated discourse information by the time they were reading the critical sentence. To increase the likelihood that they had actually done so, participants were instructed to pay specific attention to the (mutual) relationships between the characters in the texts.

Reading times were measured, using a moving window self-paced reading paradigm. This was done using the software program E-prime. The texts were presented to the participants phrase-by-phrase, because this was considered less unnatural than a word-by-word presentation. Moreover, effects may get washed out if a word-by-word presentation is used, because the participant may tend to read the texts "on automatic pilot" (Spivey-Knowlton & Sedivy, 1995; see also e.g. Altmann & Steedman, 1988; Hoeks, Vonk & Schriefers, 2002). However, to be able to measure the reading times of the critical segments as accurately as possible, all critical parts of the target sentence were presented word-by-word. The part of the critical sentence starting from the second proper name up to and including two words after the disambiguating verb always appeared on the same line, not starting at the beginning of the line or ending at its final position.

After each text, participants had to verify three statements. The first statement of an experimental text always questioned the manipulation of situational knowledge. This statement was always true to avoid any effects due to possible processing differences between giving an affirmative or a negative answer (the answer to the first question of the filler items was always false). For our example texts, this means that in an NP-context the statement would be 'Schut did not receive appreciation from Koopmans' and in an S-context 'Schut received appreciation from Koopmans'. The idea was that if a participant was not capable of correctly verifying this statement, one could not be sure that he had properly gathered the situational knowledge of the corresponding text. Therefore the reading time data of participants with incorrect answers were excluded from further analysis. The remaining two statements questioned more general aspects of the text. For the example text they were: 'Schut was angry about Thijssen's review' and 'Koopmans is a writer'.

3.5.2 Results

The reading times of the participants who gave correct answers to the critical statement were submitted to a multilevel analysis (see Appendix 4 for the exact model). The results for the ambiguous NP (*Koopmans_{C1}*), the disambiguating verb (*vond_{C2}* (*found*)) and the following adverb (*eigenlijk_{C2+1}* (*actually*)) are shown in Table 3.⁶ For the sake of convenience, the target sentence is repeated here:

- (6) Schut / zei / zich te storen aan / het ongegronde oordeel van / Thijssen / en / Koopmans_{C1} / vond_{C2} / eigenlijk_{C2+1} / dat / de discussie / te veel / werd opgeblazen.

Schut / said / to be annoyed by / the unfounded opinion of / Thijssen / and / Koopmans_{C1} / found_{C2} / actually_{C2+1} / that / the discussion / too much / was being blown up.

(Schut said that he was annoyed by the unfounded opinion of Thijssen and Koopmans actually found that the discussion had got completely out of hand.)

⁶ The subscript C2+1 indicates that the segment *actually* appeared one segment after the second critical position (i.e. *found_{C2}*).

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First, the on-line results showed the following picture. There was a main effect of situational knowledge on the processing of the adverb (*eigenlijk*_{C2+1} (*actually*)): reading times for this word were faster in the S-context than in the NP-context ($\chi^2 = 5.66$; $df = 1$; $p < .05$; $d \geq 0.2$). Second, the results for the verification task showed that participants correctly verified the critical statement in a large majority of cases and that there was no effect of situational knowledge on the number of correct answers: in the NP-context the proportion correctly verified statements was 89%, in the S-context this was 88%. Third, the only effect of reading span that was found was an interaction of this factor with situational knowledge in the verification task: in the NP-coordination supportive condition, the verification times for high-capacity participants with correct answers to the critical statement were around 120 milliseconds faster than for low-capacity participants with correct answers to the critical statement ($t = (119.76/56.97) = 2.102$; $df = 51$; $p = 0.018$ one-sided).

Interestingly, the reading times on *eigenlijk*_{C2+1} (*actually*) for participants with incorrect answers to the critical statement showed a pattern opposite of that of participants with correct answers ($\chi^2 = 4.67$; $df = 1$; $p < .05$; $d \geq 0.5$). As compared to the disambiguating verb, the adverb was processed *faster* in the NP-context than in the S-context. It is not difficult to explain this result. Recall that the critical statement questioned the situational knowledge manipulation. Therefore, if a participant wrongly verified this statement, he apparently misinterpreted the context and therefore did not acquire the intended situational knowledge.

Table 3: Mean reading times (msec) for participants with correct answers to the critical statement as a function of situational knowledge (standard errors in parentheses).

<i>Koopmans</i> _{SC1}		
NP-context	Reading times (se)	503 (16.00)
	s ² subj_within (se)	19548.12 (1161.79)
	s ² txt (se)	602.32 (223.02)
	s ² subj_between (se)	10379.82 (2344.48)

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<i>Koopmans_{C1}</i>		
S-context	Reading times (se)	505 (16.95)
	$s^2_{subj_within}$ (se)	18562.42 (1096.96)
	s^2_{txt} (se)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	12123.17 (2663.08)
<i>vond_{C2} (found)</i>		
NP-context	Reading times (se)	486 (12.07)
	$s^2_{subj_within}$ (se)	19548.12 (1161.79)
	s^2_{txt} (se)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	10379.82 (2344.48)
S-context	Reading times (se)	486 (11.90)
	$s^2_{subj_within}$ (se)	18562.42 (1096.96)
	s^2_{txt} (se)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	12123.17 (2663.08)
<i>eigenlijk_{C2+1} (actually)</i>		
NP-context	Reading times (se)	461 (13.55)*
	$s^2_{subj_within}$ (se)	19548.12 (1161.79)
	s^2_{txt} (se)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	10379.82 (2344.48)
S-context	Reading times (se)	439 (16.95)*
	$s^2_{subj_within}$ (se)	18562.42 (1096.96)
	s^2_{txt} (se)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	12123.17 (2663.08)

Note: $s^2_{subj_within}$ denotes the within-subjects variance, s^2_{txt} the between-texts variance, $s^2_{subj_between}$ the between-subjects variance. * marks a statistically significant difference between conditions.

Even more, this result could indicate that he obtained the *opposite* situational knowledge as compared to the participants with correct answers. On the basis of this reasoning, one could predict the following. If the context, for instance, indicated that Schut's debut *was* appreciated

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by Koopmans (i.e. supportive of an S-coordination), participants who indeed obtained this situational knowledge would immediately analyze the sentence as an S-coordination. However, participants with wrong answers appeared to have misinterpreted the context as being supportive of an NP-coordination (i.e. as stating that Schut's debut was appreciated by neither Thijssen, nor Koopmans) and therefore they would initially analyze the sentence as an NP-coordination. This could explain why the pattern of reading times on the adverb for participants with wrong answers was the opposite of the pattern for participants with correct answers.

However, one cannot unequivocally explain what caused participants to incorrectly verify the critical statement. For example, it could have been caused by the fact that these participants did not thoroughly process the critical context information or because they did not thoroughly process the entire text (i.e. including the target sentence). For this reason, the data for these participants are not further interpreted here (but see Appendix 7 for further details).

3.5.3 Discussion

The main goal of the self-paced reading experiment was to determine if situational knowledge affects on-line processing, particularly, if it can overrule a shown preference to analyze the phrase *N and N* as an NP-coordination by providing discourse cues in support of the alternative. Modular theories of parsing, like the garden path model, prescribe that this is not the case: the initial analysis of the sentence is a syntax-first matter and non-syntactic factors only come into play after this initial structural decision has been made. Interactive models of parsing, on the other hand, predict that the structural analysis of the sentence is an interactive process, in which non-syntactic factors are immediately brought to bear as well (cf. constraint-based or strong interactive models, see section 1.2.3.2 and 1.2.3.3).

The results of the self-paced reading experiment indeed suggest that situational knowledge affects on-line processing. In particular, it seems that the reader's representation of the state of affairs described by the text affects the parsing of subsequent sentences. However, that all different sources of information affect parsing at *some* stage is something that not many would object against. Therefore, the aim of the current experiment was to look more closely into the *exact* moment at which

situational knowledge has its impact on parsing, in particular, if this factor affects the *initial* analysis of a sentence.

Consider again the following example of the target sentence:

- (7) Schut / zei / zich te storen aan / het ongegronde oordeel van / Thijssen / en / Koopmans / vond / eigenlijk / dat / de discussie / te veel / werd opgeblazen.

Schut / said / to be annoyed by / the unfounded opinion of / Thijssen / and / Koopmans / found / actually / that / the discussion / too much / was being blown up.

(Schut said that he was very annoyed by the unfounded opinion of Thijssen and Koopmans said repeatedly that the discussion had got completely out of hand.)

The NP-/S-coordination ambiguity starts at the ambiguous phrase *and Koopmans*. In particular, participants had to decide whether they were to analyze this phrase as part of a conjoined NP (i.e. an NP-coordination) or as part of a conjoined clause (i.e. an S-coordination). This decision was expected to be made at the first proper name after the conjunction *en* (*and*), i.e. *Koopmans*_{C1}. Therefore, in order to provide evidence that situational knowledge affects the *initial* analysis of the sentence, it was important to demonstrate an effect of situational knowledge at this initial choice point. However, the reading time results showed no effects of situational knowledge at this position. Moreover, no effects of situational knowledge on the disambiguating verb (*vond*_{C2} (*found*)) were found either. An effect of situational knowledge was only found on the adverb that followed upon the disambiguating verb (i.e. *eigenlijk*_{C2+1} (*actually*)): reading times on the adverb were faster in the S-context than in the NP-context as compared to the disambiguating verb. This pattern of results can be reconciled with both parsing strategies.

On the one hand, the results seem to provide evidence for a syntax-first parsing strategy. More specifically, because no effects of situational knowledge were found on the onset of the ambiguity, but only after its disambiguation, one can conclude that situational knowledge did not affect the initial analysis of the sentence, but rather the process of reanalysis (see section 1.4). Specifically, situational knowledge supported the ultimate S-coordination analysis of the sentence in the S-context,

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leading to decreased reading times on the adverb in this context as compared to the NP-context.

On the other hand, the results can also be reconciled with an interactive account of parsing. First, the effect of situational knowledge on *eigenlijk*_{C2+1} (*actually*) may not have represented an effect on this segment, but rather an effect on *vond*_{C2} (*found*) that spilled over onto *eigenlijk*_{C2+1} (*actually*). As was mentioned before, such delayed effects often occur in a moving window self-paced reading paradigm (cf. Hoeks, Vonk & Schriefers (2002), experiment 2; Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort (2005), experiment 3). Under such a *spill-over* interpretation, one could argue that situational knowledge *did* immediately affect the initial analysis of the sentence. In particular, participants immediately selected an S-coordination in the S-context and an NP-coordination in the NP-context. As the target sentence turned out to be an S-coordination, reanalysis was necessary in the NP-context, leading to increased reading times in this condition as compared to the S-context.

However, this scenario can still not explain why no effect of situational knowledge was found on the ambiguous NP *Koopmans*_{C1}.⁷ An explanation could be that the effects of situational knowledge were too subtle to be reflected in the reading times. However, the design of the current experimental items could provide an explanation as well. Remember that the following pattern of reading times was expected to occur. First, reading times on the ambiguous NP (*Koopmans*_{C1}) were expected to be longer in an S-context than in an NP-context, because participants would immediately analyze the sentence as an S-coordination in the S-context and as a relatively easy NP-coordination in an NP-context. Second, reading times on the subsequent disambiguating verb were expected to show the *reversed* pattern: longer reading times in

⁷ Even though the ambiguous NP was not the focus of attention in the experiments of Hoeks, Vonk and Schriefers (2002), some processing differences for this NP were reported. In particular, the self-paced reading experiment showed that the ambiguous NP was processed faster in an unambiguous S-coordination sentence than in an ambiguous one. However, this effect was the same for the different topic structure contexts. Therefore, it cannot be caused by the independent variable, as was expected in the current experiment. Because the effect disappeared in the eye movement experiment, it was interpreted as not being related to the process of ambiguity resolution, but to more basic processes of reading or to task-related processing (see Hoeks et al., p. 116 for a discussion).

the NP-context than in the S-context, because reanalysis was only necessary in the former condition.

The design of the materials may not have been precise enough to enable a distinction between the processes of initial analysis and that of reanalysis. The reason for this is that no words appeared between the ambiguous NP, where the initial analysis was assumed to be determined, and the disambiguating verb, where reanalysis was assumed to take place. More specifically, if the expected effects of situational knowledge on both the ambiguous NP and the disambiguating verb in fact occurred, they may have disappeared in the reading times because they counteracted each other. This would have been the case if the effects on the ambiguous NP spilled over onto the disambiguating verb. In this case, the increase in reading times for the ambiguous NP in the S-context (the constitution of an S-coordination is more difficult than that of an NP-coordination) was neutralized by the decrease in reading times for the disambiguating verb in this condition (no reanalysis was necessary). The same kind of reasoning holds for the NP-context: reading times were expected to be shorter on the third proper name and longer at the disambiguating verb.

In sum, on the basis of this argumentation the following pattern of reading times would occur. The effect of situational knowledge on the ambiguous NP *Koopmans*_{C1} spills over onto the disambiguating verb *vond*_{C2} (*found*) and therefore no reading time differences are found on the ambiguous NP. Furthermore, the reading times on *found*_{C2} reflect the average of the reading times on the ambiguous NP (S > NP) and the verb itself (NP > S). Therefore, no differences in reading times between conditions are found on *vond*_{C2} (*found*) either, even though situational knowledge affected the processing of this word as well. Finally, the effect of situational knowledge on *vond*_{C2} (*found*) spilled over onto *eigenlijk*_{C2+1} (*actually*) as well, producing an decrease in reading times for this word in the S-condition as compared to the NP-condition (i.e. in the NP-condition reanalysis is necessary).

Another possible interpretation of the results that needs consideration is that situational knowledge *did* affect the initial analysis of the sentence, but that it was not constraining enough to overrule the syntax-based or topic structure based parsing preferences, which both supported an NP-coordination. This could be due to the fact that syntax-based and/or

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topic structure-based parsing strategies a priori overrule situational knowledge, but it can also be due to a weak manipulation of this factor (cf. Ferreira and Clifton (1986) versus Trueswell, Tanenhaus & Garnsey, (1994); see section 1.3.1). The latter possibility seems not very likely, however, because in general situational knowledge showed clear effects in the off-line experiments. However, that this was the case does not necessarily mean that situational knowledge is strong enough to immediately affect *on-line* processes as well.

It is important to note that the above argumentation can be applied to every possible result: one can always argue that immediate on-line effects of a certain factor were not found because the manipulation was not strong enough. For this reason, it cannot simply be accepted without investigating in more detail the exact weight of the different factors that influence the parsing process.

3.6 Conclusion

In sum, the self-paced reading results leave room for different interpretations. At first sight, they seem to provide evidence for a syntax-first model of parsing, in which situational knowledge is not brought to bear during the initial analysis of the sentence, but only during the later phase of reanalysis. However, the results can be reconciled with an interactive account of parsing as well, supporting the idea that situational knowledge does affect the initial analysis of the sentence. Especially the design of the experimental items made it difficult, if not impossible, to distinguish between effects of initial parsing operations and those of possible reanalysis. Thus, it is difficult to align the results with predictions of competing models. In order to gain a more reliable insight in the on-line effects of situational knowledge, some alterations in the design of the materials are necessary. This will be discussed in the next chapter.

Apart from adapting the materials, there are other ways to investigate the effects of situational knowledge in a more precise way. First, comparing the influence of several (opposing) constraints could provide a clearer insight in the course of the on-line interaction between different factors. Are multiple constraints equally relevant, or does one clearly overrule the other? Second, in order to gain the clearest understanding of how situational knowledge affects the resolution of the NP-/S-coordination ambiguity, it is important to not only investigate the

processing of temporarily ambiguous S-coordinations (as in the current experiments), but of temporarily ambiguous NP-coordinations as well. Third, the experimental method that was used in the current reading experiment was a moving window self-paced reading paradigm. This method turned out to be suitable for demonstrating effects of situational knowledge. However, other experimental methods might provide a more detailed insight in the exact time course of the parsing process. More specifically, very subtle effects may elude detection by a self-paced reading technique, whereas this is not the case for a more sensitive method, such as the registration of eye movements. In the remaining experiments of this study, these considerations are aimed to be met as well as possible.

No on-line effects of working memory capacity were found. The only effect that occurred was that in the NP-context, high-capacity participants with correct answers to the critical statement showed faster verification times than low-capacity participants. A possible explanation for this result is that in this condition situational knowledge did not support the correct interpretation of the critical sentence. This makes the processing of the sentence more complex. As a result, low-capacity readers may not have been able to build a solid mental representation of the sentence, making it more difficult to retrieve it and to verify the critical statement. On the basis of this result, one could argue that the impact of working memory capacity is possibly connected with the difficulty of comprehending a particular sentence. Just and Carpenter (1992) indeed report evidence in favor of the idea that differences between high and low capacity readers get larger and more consistent when the comprehension task gets more demanding. However, unlike the results reported here, their study showed some on-line results as well.

In the current experiments, Daneman and Carpenter's (1980) reading span task was used to control for effects of individual differences in verbal working memory capacity. The reason for using this task is that it has been applied in many related studies (see e.g. Caplan & Waters, 1999, for an overview) and therefore allows for a direct comparison between the current and previous results. However, over the past years, the Daneman and Carpenter task and the notion of verbal working memory capacity in general have been thoroughly debated. One important issue concerns the question what the Daneman and Carpenter

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task exactly measures, in particular, if it is an appropriate measure of the resources involved in language processing (see e.g. Waters & Caplan, 1996a, 2004; Hupet, Desmette, & Schelstraete, 1997; MacDonald & Christiansen, 2002). This issue relates to the more general issue of the composition of the verbal working memory system. Some have suggested a single verbal working-memory system that is used in all aspects of sentence processing (cf. Just & Carpenter, 1992; Just, Carpenter & Keller, 1996), whereas others have suggested that the verbal working memory system is further subdivided into different subsystems for (1) initial, unconscious, first-pass processing and (2) conscious, controlled processing (cf. Waters & Caplan, 1996a,b; 2004; see also Fedorenko, Gibson, & Rohde, 2006, for a discussion). If the verbal working memory system is indeed subdivided in this manner, it imposes strong restrictions on the applicability of the Daneman and Carpenter task. In particular, as the Daneman and Carpenter task requires the conscious retrieval of items held in memory, it is unrelated to the unconscious, initial processes that are investigated in the current study.

If one wants to investigate the possible relation between readers' verbal working memory capacity and the degree to which sentence processing is an interactive process, it is important to thoroughly examine these (and other related) issues. However, in the present study this factor was only brought in as a control measure and therefore, this issue is left for future research.

3.7 Summary

In this chapter, the influence of situational knowledge on the processing of temporarily ambiguous S-coordinations was investigated in three experiments. Situational knowledge was manipulated to either bias towards analyzing the sentence as an NP-coordination or as an S-coordination. The results of Experiment 1 showed that readers continue a sentence in the way that is most plausible according to their situational knowledge. Furthermore, Experiment 2 showed that readers find an S-coordination more easy, plausible and natural when their situational knowledge supports an S-coordination than when it supports an NP-coordination. Finally, Experiment 3 showed that processing an S-coordination is easier when the sentence is embedded in an S-context than when it is embedded in an NP-context. These results also indicate that the manipulation of situational knowledge was effective.

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However, it is important to investigate in more detail whether the parser is quite adaptive in the sense that its preferences are changed when the situational knowledge that is provided by the discourse varies in a relevant respect. Specifically, the current experiment cannot rule out the possibility that the initial analysis of a sentence is determined by syntax-based parsing preferences only, whereas other factors such as situational knowledge only come into play during processes of reanalysis. In the following chapters, this issue is investigated in more detail.

Chapter 4

The interaction of situational knowledge and subject-verb agreement in parsing ambiguous coordinations

4.1 Introduction

The results of Experiment 3 supported the idea that situational knowledge affects the on-line processing of the NP-/S-coordination ambiguity. However, a more specific interpretation of the self-paced reading results was hampered by two observations. First, the effect of situational knowledge did not appear until one segment after the point of disambiguation. Therefore, it was reconcilable with two conflicting hypotheses, viz (1) that situational knowledge affects the initial analysis of a sentence and (2) that situational knowledge does not affect the initial analysis of a sentence, but only comes into play during its evaluation and (if necessary) reanalysis. Second, no words appeared between the onset of the ambiguity and its disambiguation. Due to possible spill-over effects, this set-up made it difficult to distinguish initial and later effects of situational knowledge as well.

The purpose of the experiments discussed in this chapter was to obtain more specific information about when exactly during the processing of the NP-/S-coordination ambiguity situational knowledge comes into play. This was done by enlarging the ambiguous region of the target sentence. Furthermore, in addition to investigating if situational knowledge affects the initial analysis of a sentence, the aim was to explore how this factor interacts with other factors as well (see e.g. MacDonald, 1994; Spivey & Tanenhaus, 1998; see also section 1.3.5). Therefore, a second factor was brought into play that either supported an NP- or an S-coordination, viz subject-verb agreement. How this was done is explained in the following section. Subsequently, in section 4.3 and 4.4 two off-line completion studies are described, in which the target sentence was interrupted at different points in the target sentence. In section 4.5, results of an off-line judgment study are presented and

finally, in section 4.6, an on-line moving-window self-paced reading experiment is described.

4.2 Two factors under investigation: situational knowledge and subject-verb agreement

In the present experiments, two factors were manipulated to support either an NP- or an S-coordination. First, situational knowledge was manipulated in basically the same fashion as in the previous experiments.¹ However, because in the previous experiments all critical sentences were S-coordinations, the current experiments focused on the processing of NP-coordinations. Some alterations in the materials were made to be able to assess the effects of situational knowledge on the initial analysis of the sentence more accurately and to be able to investigate how situational knowledge interacts with a second factor. Consider the following example of a target sentence (the suffix *PL* indicates that the verb of the relative clause is plural):

- (1) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leken te zien in nog een biertje, en ze keek hen met boze ogen aan. (NP-coordination)

Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{PL} to see in another beer, and she looked them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

In this NP-coordination, the ambiguous region is enlarged by embedding a relative clause in it. More precisely, the NP-/S-coordination ambiguity begins at the NP *Ruben* and ends only at the verb *looked*. Therefore, the initial syntactic choice point and the point of disambiguation are clearly separated. Furthermore, the second factor to either support an NP- or an S-coordination was manipulated through the

¹ One difference was that in the present experiments more informal texts were constructed. This was done to facilitate the construction of appropriate scenarios. In order to do so, the characters were called by their first name instead of by their surname and the episodes were on private matters instead of professional or public matters.

verb of the relative clause (hereafter *RC verb*). In sentence (1), the number of the RC verb *leken* (*appeared_{PL}*) indicates that the content of the relative clause concerns both *Peter* and *Ruben* and therefore it supports analyzing the phrase *Peter en Ruben* (*Peter and Ruben*) as part of the complex object NP *de houding van Peter en Ruben* (*the attitude of Peter and Ruben*), producing an NP-coordination. Now, consider the following example sentence (the suffix *SG* indicates that the verb of the relative clause is plural):

- (2) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en ze keek hen met boze ogen aan. (NP-coordination)

Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG} to see in another beer, and she looked them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

This example sentence is identical to example sentence (1), except that the RC verb (*leek* (*appeared_{SG}*)) is singular instead of plural. As a consequence, the RC verb indicates that the content of the relative clause concerns only *Ruben* and therefore biases against analyzing the phrase *Peter en Ruben* (*Peter and Ruben*) as part of the complex object NP *de houding van Peter en Ruben* (*the attitude of Peter and Ruben*). After all, this analysis would ask for a relative clause the content of which concerned both *Peter* and *Ruben*. Instead, the number of the RC verb supports analyzing this *Ruben* as the subject/topic of a conjoined sentence, producing an S-coordination.²

In sum, depending on its number, the RC verb was either supportive of an NP- or an S-coordination. Also, the number of the RC verb either was or was not in accordance with the structure of the sentence so far, depending on how it was initially analyzed. This second factor will be called *subject-verb agreement* (hereafter *SV-agreement*).

² In case of an S-coordination, the ambiguous NP is always analyzed as the subject of the conjoined sentence. Depending on the definition of the notion sentence topic, the ambiguous NP can be considered as the second topic of the sentence as well (see Reinhart (1981) for a review of the notion of sentence topic).

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As was mentioned above, the verb *looked* is considered to be the true disambiguation point of the examples (1) and (2). However, in English it is difficult to imagine that it is still possible to analyze the sentence as an S-coordination upon encountering the first two words after the relative clause (i.e. *en ze (and she)*). Yet, in Dutch this is possible (albeit not very plausible). The reason for this is that the Dutch pronoun *ze* can have both a singular feminine and a plural antecedent. In the examples (1) and (2) the use of *ze (she)* to refer to a singular feminine entity was illustrated. In the following sentence, the pronoun *ze (them)* is used to refer to a plural antecedent, viz some number of beers:

- (3) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en *ze* achteloos achteroversloeg, lachte haar uit. (S-coordination)

Ellen said to be fed up with the attitude of Peter and Ruben, who no harm at all appeared_{SG} to see in another beer, and them carelessly tossed down, laughed at her.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who appeared to have no trouble with another beer, and who tossed them down carelessly, laughed at her.)

In sum, because *ze* refers ambiguously, the target sentence is still formally ambiguous between an NP- and an S-coordination at this position in the sentence. However, if a reader initially assigned an S-coordination structure to a sentence such as (2), he may strongly expect the first word after the relative clause to be a verb. Therefore, it is conceivable that a reader would already reject an S-coordination structure if this is not the case. In the present experiments (in particular Experiment 7), this issue is investigated from an exploratory point of view.

In the remainder of this section, the manipulation of situational knowledge and SV-agreement is explained in more detail. In doing this, the Dutch materials are presented with their free translations, except for the target sentence, which is also translated literally. Below, the abbreviation of the conditions is summarized.

The interaction of situational knowledge and SV-agreement

The designation of the conditions is abbreviated as follows:

1. The label for a certain condition is made up of the first letter(s) of the structure that is supported by situational knowledge and the structure that is supported by SV-agreement.
2. The letters appear in chronological order: situational knowledge is the factor that “kicks in” before the factor SV-agreement.

For example, the condition in which situational knowledge supports an NP-coordination and SV-agreement supports an S-coordination is abbreviated to NP_S-condition.

3. In order to indicate that situational knowledge, for example, supports an S-coordination the abbreviation S-context is used.
4. SV-agreement is manipulated by means of changing the number of the verb of the relative clause. This verb is referred to by RC verb. Furthermore, to indicate that this factor, for example, supports an NP-coordination, the label NP-verb is used. Whether the RC verb in the Dutch materials was singular or plural, is indicated in the English translation by adding the suffix SG or PL to the verb.

The first possible combination of the factors situational knowledge and SV-agreement is illustrated in example (1).

Example 1: NP-context, NP-verb: NP_NP_condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat Ruben en hun buurman Peter zoveel alcohol dronken.
(She only found it irritating that Ruben and their neighbor Peter drank so much alcohol.)
- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.

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(When they opened the umpteenth beer, she decided to say something about it.)

- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leken te zien in nog een biertje, en ze keek hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{PL} to see in another beer, and she looked them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

(After this collision, Ellen decided to just ignore them.)

First, situational knowledge is manipulated in sentence (3). This sentence states that Ellen was irritated by the (drinking) behavior of both Ruben and Peter. Upon encountering the ambiguous NP *Ruben* in the target sentence, readers have to decide how to attach it within the phrase tree. It can be either analyzed as the subject/topic of a conjoined sentence (an S-coordination) or as part of the complex object NP that started out with *de houding van Peter (the attitude of Peter and)*, i.e. an NP-coordination. If situational knowledge immediately affects this parsing decision, the NP *Ruben* would be analyzed as being part of the complex object NP. After all, it is plausible on the basis of the context (in particular sentence (3)) that Ellen was fed up by the attitude of both Peter and Ruben.

Subsequently, the factor SV-agreement is manipulated within the relative clause of the target sentence. Specifically, the number of the RC verb (*leken (appeared_{PL})*) indicates that the relative clause concerns both Peter and Ruben. Therefore, the relative clause supports the analysis of the phrase *Peter and Ruben* as part of the complex object NP *de houding van Peter en Ruben (the attitude of Peter and Ruben)*, which produces an NP-coordination as well.

In sum, situational knowledge and SV-agreement are in accordance with each other, because they are both supportive of an NP-coordination. Furthermore, since the target sentence evidently turns out to be an NP-coordination at the verb *looked*, both factors are supportive of the correct structure of the target sentence.

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The second possible combination of the factor situational knowledge and SV-agreement is illustrated in text (2).

Example 2: NP-context, S-verb: NP_S_condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat Ruben en hun buurman Peter zoveel alcohol dronken.
(She only found it irritating that Ruben and their neighbor Peter drank so much alcohol.)
- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.
(When they opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en ze keek hen met boze ogen aan.
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SC} to see in another beer, and she looked them with angry eyes at.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SC} not seem to see any harm in having another beer, and she looked at them with angry eyes.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

In this text, Ellen is annoyed by the behavior of both Peter and Ruben. Hence, if situational knowledge immediately affects parsing, readers would initially analyze the sentence as an NP-coordination. However, the number of the RC verb (*leek (appeared_{SC})*) indicates that the relative clause only concerns Ruben. Therefore, the factor SV-agreement biases against analyzing the ambiguous NP *Ruben* as part of the complex object NP *de houding van Peter en Ruben (the attitude of Peter and Ruben)*, i.e. an

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NP-coordination. Instead, it supports analyzing the ambiguous NP *Ruben* as the subject/topic of a conjoined sentence, resulting in an S-coordination. In sum, the factors situational knowledge and SV-agreement contradict each other.

The third possible combination of situational knowledge and SV-agreement is illustrated in text (3).

Example 3: S-context, NP-verb: S_NP_condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat hun buurman Peter zoveel alcohol dronk.
(She only found it irritating that their neighbor Peter drank so much alcohol.)
- (4) Toen hij het zoveelste biertje opentrok, besloot ze er wat van te zeggen.
(When he opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leken te zien in nog een biertje, en ze keek hen met boze ogen aan.
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{PL} to see in another beer, and she looked them with angry eyes at.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

Sentence (3) of this text indicates that Ellen is irritated by the behavior of Peter only. Therefore, as Ellen did not seem to be annoyed by Ruben's behavior as well, it is not plausible to analyze *Ruben* as being part of the

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object of the verb *balen van* (*fed up with*) (which would result in an NP-coordination). Rather, if situational knowledge affects initial parsing decisions, the ambiguous NP *Ruben* will be initially analyzed as the subject/topic of a conjoined sentence (which results in an S-coordination). However, the RC verb *leken* (*appeared_{PL}*), supports an NP-coordination analysis. More specifically, the relative clause indicates that even though Peter was the one that was drinking too much alcohol (according to sentence (3)), Ruben did not appear to see any harm in this behavior (according to the relative clause in sentence (5)), and this caused Ellen to be annoyed by Ruben as well. In sum, situational knowledge and SV-agreement conflict and only the latter factor supports the correct analysis of the sentence.

It is important to note that the factor SV-agreement more strongly affects sentence processing if it supports an NP-coordination than if it supports an S-coordination. The reason for this is that a singular RC verb supports an S-coordination, but does not exclude an NP-coordination as a possible structure of the sentence. A plural RC verb, on the other hand, does not just support an NP-coordination structure, it *commands* this structure and thus irrevocably excludes an S-coordination structure of the sentence. For example, a sentence such as the following is ungrammatical:

- (4) Ellen said she was fed up with the attitude of Peter and Ruben, who did_{PL} not seem to see any harm in having another beer, walked away angry.³

As a consequence, any interaction between situational knowledge and SV-agreement may differ in the NP_S-condition (example 2) from the S_NP-condition (example 3). The consequence of this difference for the predictions is discussed further in later sections of this chapter.

Finally, the following combination of factors is also possible:

Example 4: S-context, S-verb: S_S_condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)

³ An asterisk indicates a grammatically incorrect sentence.

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- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat hun buurman Peter zoveel alcohol dronk.
(She only found it irritating that their neighbor Peter drank so much alcohol.)
- (4) Toen hij het zoveelste biertje opentrok, besloot ze er wat van te zeggen.
(When he opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en ze keek hen met boze ogen aan.
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SC} to see in another beer, and she looked them with angry eyes at.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SC} not seem to see any harm in having another beer, and she looked at them with angry eyes.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

In this text, Ellen is annoyed by the behavior of Peter only, so situational knowledge is supportive of an S-coordination. The RC verb *leek* (*appeared_{SC}*) supports an S-coordination as well. Therefore, situational knowledge and SV-agreement are concordant. As the target sentence turns out to be an NP-coordination, neither of the two factors support the correct analysis of the sentence.

In sum, both situational knowledge and SV-agreement were manipulated to be supportive of either an NP- or an S-coordination. How this was done is summarized in Table 1. Combining the two factors yielded four conditions, as was illustrated above.

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Table 1: The manipulation of situational knowledge and SV-agreement, illustrated by means of the examples 1-4.

<i>Situational knowledge</i>	<i>Manipulation</i>
NP-context	Sentence (3): Ellen is annoyed by Peter and Ruben
S-context	Sentence (3): Ellen is annoyed by Peter
<i>SV-agreement</i>	<i>Manipulation</i>
NP-context	Sentence (5): Plural RC verb (<i>leken</i> (<i>appeared_{PL}</i>))
S-context	Sentence (5): Singular RC verb (<i>leek</i> (<i>appeared_{SG}</i>))

4.2.1 Summary of main questions

The purpose of the present experiments was to answer the following two questions:

- Does situational knowledge affect the initial analysis of a sentence?
- Does SV-agreement overrule the initial analysis of a sentence and cause it to be reanalyzed even before the true point of disambiguation is encountered?

Three positions in the target sentence were important for answering these questions. The first critical position was the ambiguous NP, where the initial analysis of the sentence was believed to be established. The second critical position was the RC verb, where the factor SV-agreement was manipulated to either support an NP- or an S-coordination and thus, to either be concordant or conflict with the initial analysis of the sentence. The third critical position of the target sentence was its true disambiguation point (the verb *looked* in the examples (1) to (4)).

Processing differences at these three positions were assumed to indicate how the sentence was currently being processed. Differences at the first two critical positions were assumed to indicate how the sentence was initially analyzed and hence if situational knowledge affected this process. Processing differences at the third critical position were assumed to indicate if the factor SV-agreement overruled this initial analysis and caused the sentence to be reanalyzed prior to its true point of disambiguation. What differences between the conditions were exactly expected to arise is further explained in the course of this chapter.

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There is reason to believe that the factor SV-agreement is a priori more likely to overrule the initial analysis of the sentence in one condition as compared to the other. A plural RC verb *commands* an NP-coordination analysis of the sentence and thus rules out an S-coordination analysis, whereas a singular RC verb only *supports* an S-coordination analysis, but does not rule out an NP-coordination analysis. The consequence of this difference is investigated from an exploratory angle.

In the following sections, four experiments are described that address the above questions. In section 4.3 and 4.4, two off-line completion studies are described, in which the target sentence was interrupted at two different positions. Subsequently, results of an off-line judgment study are described in section 4.5 and, finally, an on-line moving window self-paced reading experiment is described in section 4.6.

4.3 Experiment 4: completion study 1

Experiment 4 is a replication of Experiment 1 with different materials. Its purpose was twofold. First, it was set up to estimate language users' expectations regarding sentence structure, given the conceptual properties of the discourse. In other words, it was investigated whether the manipulation of situational knowledge had the intended effect. Second, and as a logical result of the first purpose, the aim was to test the materials for use in the on-line self-paced reading experiment.

As the current experiment aimed to investigate the impact of situational knowledge alone, the influence of the factor SV-agreement was not manipulated yet. Consequently, the target sentence was interrupted at a point where the relative clause was already unfolding, but its verb was not presented yet. Consider the following example sentence:

- (5) Ellen zei genoeg te hebben van de houding van Peter en Ruben, die helemaal geen kwaad ...
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm ...

The only two possible completions of this sentence are as an NP- or an S-coordination. If sentence (5) is embedded in an NP-context, stating that Ellen found both Peter and Ruben annoying, it is plausible that Ellen is fed up with the attitude of both of them. If situational knowledge affects readers' expectations regarding the unfolding of the sentence,

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participants will analyze the phrase *Peter en Ruben* (*Peter and Ruben*) as part of the complex object NP *de houding van Peter en Ruben* (*the attitude of Peter and Ruben*), resulting in an NP-coordination. On the other hand, if sentence (5) is embedded in an S-context, stating that Ellen found only Peter annoying, it is unlikely that Ellen is fed up by the attitude of Ruben as well. Therefore, if situational knowledge affects readers' expectations, participants will analyze the ambiguous NP *Ruben* as the subject/topic of a conjoined sentence, resulting in an S-coordination.

4.3.1 Method

Participants

Twenty-two students (of whom sixteen were women), mostly at the Faculty of Humanities of Utrecht University, participated in the experiment. The mean age of the participants was 21 years (range: 18-24 years). They were paid five euros for their participation. All were naïve as to the purpose of the experiment.

Materials

Thirty-two experimental items were constructed that were structurally identical to the examples 1-4 that were presented in the above. For each item, a version with an NP-context and a version with an S-context was constructed. The frequency and length of the three characters' names was controlled for.

Design

Four experimental lists were constructed, such that each condition was equally represented and no two conditions from the same item appeared in the same list. Each list consisted of thirty-two experimental texts. The texts were randomly presented.

Procedure

Participants were instructed that they were about to read thirty-two texts that would end at some point in the middle of the sentence. Their task was to complete the sentence from that point on in a way that would be grammatical and plausible given the contents of the text. Participants had an hour to finish the experiment, which was ample time for everyone. The sentence was interrupted at a point where the only two possible continuations were an S- and an NP-coordination. In the

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instruction, an example of both possible continuations was presented to the participants. Given the length and complexity of the experiment as a whole, it was decided not to use filler items.

4.3.2 Results and conclusions

The data were submitted to a multilevel analysis (see Appendix 2 for the exact model; see e.g. Snijders & Bosker, 1999; Quené & Van den Bergh, 2004; Goldstein, 1995; Mulder, 2008 for an in-depth discussion of this type of analysis). Twelve cases were left out of consideration, in which no continuation was filled in or an ungrammatical one (= 1,7% of the data). In the analysis, the mean proportion of S-continuations as a function of situational knowledge was estimated. The results are reported in Table 2.

The results showed an effect of situational knowledge ($\chi^2 = 48.12$; $df = 1$; $p < .001$; $d > .08$). The continuation of the target sentence as an NP-coordination appeared to be the preferred option overall (i.e. on average in 67% of all cases). This result is in accordance with previous observations (see e.g. Frazier & Clifton, 1997). However, the NP-coordination preference was modulated by situational knowledge: participants completed the target sentence more often as an S-coordination when the sentence was embedded in an S-context (i.e. on average in 62% of the cases) and more often as an NP-coordination when it was embedded in an NP-context (i.e. on average in 96% of the cases).

It is striking that the present results showed an overall preference for an NP-coordination completion of the critical sentence, as the results of Experiment 1 showed an overall preference for an S-coordination completion.

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Table 2: Mean proportion of S-coordination continuations (*S-continuations*) as a function of situational knowledge (standard errors in parentheses).

NP-context	Proportion S-continuations	0,04*
	logit scores (se)	-3,12 (0,48)
	s ² subj_between (se)	3,40 (1,51)
S-context	Proportion S-continuations	0,62*
	logit scores (se)	0,51 (0,39)
	s ² subj_between (se)	3,01 (0,99)

Note: The reported means of S-coordination continuations have been derived from the logit-scores, which are a non-linear transformation of proportions (Fienberg, 1980; Goldstein 1995). *s²subj_between* denotes the variance between subjects. * marks a statistically significant difference between conditions.

As was described in section 3.3.2, an explanation that presents itself is that the manipulation of situational knowledge was more successful in some cases than in others. In particular, the manipulation appeared stronger in the S-context than in the NP-context in Experiment 1, and the other way around in Experiment 4. This contrast seems to be related to the precise way in which the interrelations between the different actors in the individual scenarios were described. Some allegences and oppositions appeared more convincing than others.

All in all, the results of Experiment 1 and 4 provide evidence for the notion that expectations regarding sentence structure are affected by situational knowledge. In addition, the results go against the idea that readers have an overall preference to continue the target sentence as an NP-coordination.

4.4 Experiment 5: completion study 2

The purpose of Experiment 5 was to assess language users' expectations regarding sentence structure, given their situational knowledge and the factor SV-agreement. Situational knowledge was manipulated in the same manner as in the previous experiment. SV-agreement was manipulated as described in section 4.2, viz by manipulating the number of the RC verb. A plural RC verb biased towards (demanded) an NP-coordination completion of the target sentence, whereas a singular RC verb biased towards an S-coordination completion.

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In order to investigate the effect of both situational knowledge and SV-agreement, the target sentence was interrupted after the relative clause, as in example (6).

- (6) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek/leken te zien in nog een biertje, ...
Ellen said that she was fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG/PL} to see in another beer, ...

At this point, participants had to decide upon the most plausible continuation of the sentence. On the basis of the previous results, situational knowledge was expected to affect participants' completions of the target sentence. The hypotheses with respect to the interaction of situational knowledge and SV-agreement were the following. When situational knowledge and SV-agreement conflicted and SV-agreement *demand*ed an NP-coordination completion of the target sentence (i.e. in case of a plural RC verb), this factor was expected to overrule situational knowledge (see section 4.2). This expectation is based upon the assumption that completing the sentence in an ungrammatical way is less favorable than producing a sentence that does not cohere with the preceding discourse context, as would be the case if situational knowledge is overruled. However, when situational knowledge and SV-agreement conflicted and SV-agreement only *support*ed an S-coordination completion (i.e. in case of a singular RC verb), no a priori difference is assumed in the weight of both factors. In this condition, the interaction between both factors is investigated from an exploratory point of view.

4.4.1 Method

Participants

Forty-five students (of whom 33 were women), mostly at the Faculty of Humanities of Utrecht University, participated in the experiment. None of them had participated in Experiment 4. Their mean age was 21 one years (range 18-30 years). They were paid five euros for their participation. All were naïve as to the purpose of the experiment.

Materials

The same experimental items were used as in Experiment 4, only now four conditions were constructed for each item instead of two, since SV-

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agreement was manipulated as well. For the sake of convenience, the four different conditions are repeated here in Table 3. In this table, the manipulation of situational knowledge and SV-agreement is clarified on the basis of the examples 1-4 in section 4.2.

Table 3: The manipulation of situational knowledge and SV-agreement, illustrated by means of the examples 1-4.

<i>Situational knowledge</i>	<i>Manipulation</i>
NP-context	Sentence (3): Ellen is annoyed by Peter and Ruben
S-context	Sentence (3): Ellen is annoyed by Peter
<i>SV-agreement</i>	<i>Manipulation</i>
NP-context	Sentence (5): Plural RC verb (<i>leken</i> (<i>appeared_{PL}</i>))
S-context	Sentence (5): Singular RC verb (<i>leek</i> (<i>appeared_{SG}</i>))

Procedure and design

The procedure and design for the experiment were identical to Experiment 4. Given the length and complexity of the experiment as a whole, it was decided not to use filler items. One should note, however, that participants judged sentences in four conditions. For this reason, the experimental items can be considered to be fillers for one another.

4.4.2 Results and conclusions

The data were submitted to a multilevel analysis (see Appendix 8 for the exact model). One hundred and thirty-seven data points were left out of consideration (= 9,5% of all cases). In these cases no continuation was filled in or the continuation was ungrammatical or not meaningful and hence impossible to interpret.⁴ In the analysis, the mean proportion of S-

⁴ The reported results are based only on continuations that were grammatical and meaningful and that were either an NP-coordination or an S-coordination with two different subjects (i.e., *Ellen* and *Ruben* in example sentence (6)).

In a second analysis, a broader set of the data was used. Specifically, S-coordinations with one subject in both clauses (i.e. *Ellen* in example sentence (6)) were included and some ungrammatical continuations were included as well. Consider the sentence **Ellen said to be fed up with the attitude of Peter and Ruben, who saw_{PL} no harm in another beer, laughed at her*. The plural verb of the relative clause rules out an S-coordination

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continuations as a function of situational knowledge and SV-agreement was estimated. The results are reported in Table 4.

Table 4: Mean proportion of S-coordination continuations (*S-continuations*) as a function of situational knowledge and SV-agreement (standard errors in parentheses).

		SV-agreement	
		NP-bias	S-bias
NP-context	Proportion S-continuations	0,05	0,58
	logit scores (se)	-3,03 (0,53)	0,34 (0,26)
	s ² subj_between (se)	9,50 (2,66)	2,41 (0,63)
S-context	Proportion S-continuations	0,11	0,66
	logit scores (se)	-2,14 (0,30)	0,67 (0,29)
	s ² subj_between (se)	2,50 (0,85)	3,03 (0,77)

Note: The reported means of S-coordination continuations have been derived from the logit-scores, which are a non-linear transformation of proportions. *s²subj_between* denotes the variance between subjects.

First, the results showed a main effect of situational knowledge ($\chi^2 = 9.86$; $df = 1$; $p < .05$; $d > 0.2$). The target sentence was most often completed as an NP-coordination (i.e. on average in 65% of the cases), but this preference was suppressed by situational knowledge: the mean proportion of S-coordinations was higher in the S-context (i.e. in the S_NP-condition and the S_S-condition: 39%) than in the NP-context (i.e. in the NP_NP-condition and the NP_S-condition: 31%). Second, the

as a possible structure of the sentence. Still, the sentence is completed as an S-coordination, which makes the sentence ungrammatical. However, in the light of the current experiment it is important to think of possible explanations for ungrammatical continuations like this. If the sentence above was embedded in an S-coordination supportive context, the reason for the ungrammatical S-coordination continuation may have been that it was plausible on the basis of situational knowledge, ignoring the restrictive SV-agreement information. Thus, even though the continuation is ungrammatical, it may provide information about the weight of situational knowledge and SV-agreement in the structure building process that was under investigation.

The analysis using this broader set of data (excluding 7% of the data instead of 9,5%) yielded the same results. An analysis that also included continuations that were less meaningful, but in which a clear choice for one of both structures was made (i.e. excluding only 'real' ungrammatical continuations) produced the same results as well. Therefore, the most conservative analysis is presented here.

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results showed a main effect of SV-agreement ($\chi^2 = 55.50$; $df = 1$; $p < .001$; $d > 0.8$), as the target sentence was most often completed as an NP-coordination when the factor SV-agreement supported this structure (i.e. in the S_NP-condition and the NP_NP-condition: an average of 92%) and most often as an S-coordination when SV-agreement supported that structure (i.e. in the S_S-condition and the NP_S-condition: an average of 62%). Third, the effect sizes indicate that situational knowledge had a medium effect, whereas SV-agreement had a strong effect⁵. Fourth, no interaction effect was found between situational knowledge and SV-agreement ($\chi^2 = 2.50$; $df = 1$; $p = .11$).⁶

In conclusion, the results show that both situational knowledge and SV-agreement affect readers' idea of how a sentence should evolve. No interaction between both factors was found, which means that the effect of situational knowledge did not depend on whether SV-agreement biased towards an NP- or an S-coordination, and vice versa. However, the effect sizes did indicate that SV-agreement more strongly affected participants' completions than situational knowledge. It can be concluded from Table 5 that this was mainly caused by the fact that the factor SV-agreement *commanded* an NP-coordination in the S_NP-condition and the NP_NP-condition (i.e. in case of a plural RC verb), whereas it only *supported* an S-coordination in the other two conditions. In particular, the former two conditions showed a relatively high amount of NP-coordination completions (i.e. an average of 92%).

⁵ An effect size from 0.2 indicates a small effect, from 0.5 indicates a medium effect and from 0.8 indicates a large effect (Cohen, 1988).

⁶ One aspect of the results that deserves specific attention is that the between-subject variance is more than three times greater in the NP_NP-condition than in the S_S-condition. The variance in the S_NP- and NP_S-condition is the smallest and approximately identical. The great between-subject variance in the NP_NP-condition is difficult to explain. What it indicates is that participants act very heterogeneously in this condition, whereas they act much more homogeneously in the S_S-condition. In other words, some participants had many NP-completions in the NP_NP-condition, whereas others had many S-completions in this condition. This result could be due to characteristics of the participants. Maybe some participants were more inclined to complete the target sentence as an NP- or as an S-coordination in all cases, irrespective of the condition. However, the correlation between how participants completed the target sentence in the S_S-condition and the NP_NP-condition was only 0.26, which indicates that participants did not structurally complete the target sentence in the same way. In sum, what exactly caused the large between-subjects variance remains unclear.

4.5 Experiment 6: judgment study

The purpose of Experiment 6 was to investigate whether the factors situational knowledge and SV-agreement affect the perceived easiness, plausibility and naturalness of the target sentences. As explained in section 3.4.1, the *easiness* scale assessed participants' estimation regarding the general understandability of the target sentence, viz with respect to its structure, meaning and appropriateness within the context all together. Second, the *plausibility* scale assessed participants' estimation regarding the plausibility of the target sentence within its context and hence mainly focused on its meaning. Third, the *naturalness* scale assessed participants' estimation regarding the form of the sentence and thus mainly focused on its structural aspects.

On the basis of the results of the previous experiments, both situational knowledge and SV-agreement were expected to affect participants' perception of the target sentence, which was always an NP-coordination. The interaction between both factors was investigated from an exploratory angle.

4.5.1 Method

Participants

Forty-one students, mostly at the Faculty of Humanities of Utrecht University, participated in the experiment. None of them had participated in Experiment 4 or 5. Thirty-one were female and ten were male. Their mean age was 21 years (range: 18-27 years). They were paid five euros for their participation. All were naïve as to the purpose of the experiment.

Materials

The same items were used as in Experiment 4 and 5, except that they were presented as complete texts (cf. example (1)-(4)). Hence, the target sentence was an NP-coordination in all cases.

Procedure

Participants were led to believe (both orally and in writing) that they were about to judge the completions of other students that participated in the completion study a week before. The participants' task was to judge the critical sentences (alleged completions) on easiness, plausibility within the context and naturalness. They indicated their assessments by

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markings on three separate 5-point scales, one for each variable. In order to encourage participants to think thoroughly about their judgments, not all scales extended in the same direction. The scale to judge the easiness of the critical sentence extended from a negative to a positive evaluation, those for plausibility and naturalness extended in the other direction. Given the length and complexity of the experiment as a whole, it was decided not to use filler items. One should note, however, that participants judged sentences in four conditions. For this reason, the experimental items can be considered to be fillers for one another.

4.5.2 Results

The data were submitted to a multilevel analysis (see Appendix 9 for the exact model). For all scales, three cases in which participants failed to give an opinion were left out of consideration (< 0,5 % of all data). In Table 5, the mean judgments regarding the easiness, plausibility and naturalness of the critical sentence as a function of situational knowledge and SV-agreement are presented. It is important to note that the data with respect to the easiness of the target sentence were transformed so that all three scales pointed in the same direction: the higher judgment, the more positive participants' opinion on the regarding aspect of the sentence.

Table 5: Mean judgments regarding the easiness, plausibility and naturalness of the target sentence as a function of situational knowledge and SV-agreement (five-point scale, standard errors in parentheses).

		SV-agreement	
		NP-bias	S-bias
<i>Easiness</i>			
NP-context	Judgments (se)	3,98 (0,10)	3,72 (0,10)
S-context	Judgments (se)	3,79 (0,10)	3,55 (0,10)
	s ² subj_between (se)	0,417 (0,01)	
<i>Plausibility</i>			
NP-context	Judgments (se)	2,88 (0,10)	2,60 (0,10)
S-context	Judgments (se)	2,14 (0,10)	2,12 (0,10)
	s ² subj_between (se)	0,25 (0,06)	

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		SV-agreement	
		NP-bias	S-bias
<i>Naturalness</i>			
NP-context	Judgments (se)	2,73 (0,12)	1,77 (0,12)
S-context	Judgments (se)	2,34 (0,12)	1,60 (0,12)
s ² subj_between (se)		0,417 (0,1)	

Note: s²subj_between denotes the variance between subjects.

The results regarding the *easiness* of the target sentence showed the following picture. First, the results showed a main effect of situational knowledge ($\chi^2 = 23.40$; $df = 1$; $p < .001$; $d > 0.2$), as judgments were more positive in an NP-context (i.e. in the NP_NP-condition and the NP_S-condition) than in an S-context (i.e. in the S_NP-condition and the S_S-condition). Second, the results showed a main effect of SV-agreement ($\chi^2 = 44.42$; $df = 1$; $p < .001$; $d > 0.2$), as judgments were more positive when SV-agreement was supportive of an NP-coordination (i.e. in the S_NP-condition and the NP_NP-condition) than when it was supportive of an S-coordination (i.e. in the NP_S-condition and the S_S-condition). Third, the effect of both factors was approximately the same (i.e. small), as is indicated by the effect sizes. Fourth, no interaction was found between situational knowledge and SV-agreement ($\chi^2 = 0.04$; $df = 1$; $p = .84$).

The results regarding the *plausibility* of the target sentence showed an interaction between situational knowledge and SV-agreement ($\chi^2 = 5.05$; $df = 1$; $p < .05$; $d > 0.5$). More precisely, SV-agreement only affected participants' judgments when situational knowledge was supportive of the correct (NP-coordination) structure of the critical sentence (NP_NP versus NP_S: $\chi^2 = 12.23$; $df = 1$; $p < .001$). In this case, judgments were higher when SV-agreement supported an NP-coordination as well. However, when situational knowledge supported the wrong structure of the critical sentence, SV-agreement had no effect (S_NP versus S_S: $\chi^2 = 0.10$; $df = 1$; $p = .75$).

Finally, the results regarding the *naturalness* of the target sentence showed an interaction between situational knowledge and SV-agreement ($\chi^2 = 4.32$; $df = 1$; $p < .05$; $d > 0.2$). More precisely, situational knowledge more strongly affected participants' judgments when the factor SV-agreement supported the correct (NP-coordination) analysis of the critical sentence (i.e. in the NP_NP-condition and the S_NP-

condition) than when it did not (i.e. in the NP_S-condition and the S_S-condition). The same goes for the factor SV-agreement: it more strongly affected participants' judgments when situational knowledge supported the correct analysis of the critical sentence (i.e. in the NP_S-condition and the NP_NP-condition) than when it did not (i.e. in the S_NP-condition and the S_S-condition). However, this difference was much smaller.

One should note that the results regarding the naturalness of the target sentence also show a main effect of SV-agreement: judgments were much higher if this factor supported an NP-coordination than if it supported an S-coordination. However, this effect is somewhat difficult to interpret as it depends on the specific operationalization of the verb (*leek* versus *leken*). Furthermore, the interaction effect incorporates all the findings that are of interest.

4.5.3 Conclusions

The results of the judgment study give rise to the following conclusions. First, the results regarding the *easiness* of the critical sentence show that an NP-coordination is considered easier to process when (1) situational knowledge supports this structure and when (2) the factor SV-agreement supports this structure. The two factors appeared not to outweigh one another. This result can be explained by the fact that the perceived easiness of a sentence concerns the understandability of its structure, meaning and appropriateness within the context all together. Second, the results regarding the *plausibility* of the critical sentence indicated that situational knowledge outweighs SV-agreement. This conclusion follows from the observation that SV-agreement only had an additional positive effect on participants' judgments when situational knowledge supported the correct structure of the target sentence. This result can be explained by the fact that the perceived plausibility of a sentence mainly concerns the acceptability of its meaning within the context and this context was used to manipulate situational knowledge. Third, the results regarding the *naturalness* of the target sentence showed that both situational knowledge and SV-agreement affect judgments on this dimension. However, the additional value of both factors was bigger when the other factor supported the correct structure of the target sentence than when it supported the wrong structure. This dependency was stronger for the factor situational knowledge than for the factor SV-agreement. This can be explained by the fact that the naturalness of the target sentence was

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believed to depend for a larger extent on the structural properties of the sentence and these were largely determined by the SV-agreement. Overall, the results showed that the assessment of a sentence within its context is affected by both situational knowledge and SV-agreement. However, the weight of both factors appeared to depend on which feature of a sentence was assessed. Situational knowledge outweighs SV-agreement when the plausibility of the sentence within its context is concerned, whereas (albeit to a lesser extent) SV-agreement outweighs situational knowledge when the naturalness of the sentence is concerned. All in all, the manipulation of both situational knowledge and the factor SV-agreement proved to be successful.

4.6 Experiment 7: self-paced reading study

The results of Experiment 3 regarding the on-line effects of situational knowledge turned out to be reconcilable with both a syntax-first and an interactive account of parsing. Therefore, the first purpose of the present moving window self-paced reading experiment was to investigate the on-line effects of situational knowledge in a more reliable way. This was done by enlarging the ambiguous region of the target sentence. Doing this was considered to make it possible to distinguish effects of situational knowledge on the initial analysis of a sentence from effects of this factor during the evaluation and (possible) rejection of the initial analysis. The second purpose of the experiment was to investigate the on-line interaction between situational knowledge and SV-agreement. In particular, it was investigated if SV-agreement can cause the initial analysis of a sentence to be reanalyzed even before it is truly disambiguated.

The factors situational knowledge and SV-agreement were manipulated in the same manner as in the Experiments 4 to 6. Therefore, one is referred to section 4.2 for a detailed explanation of the manipulation and the experimental materials.

4.6.1 Hypotheses

In this section it is explained how reading time differences at four critical positions in the target sentence can provide information about the two main questions that were presented previously:

- *Does situational knowledge affect the initial analysis of a sentence?*

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- Does SV-agreement overrule the initial analysis of a sentence and cause it to be reanalyzed even before the true point of disambiguation is encountered?

Consider the following example of a target sentence, including the way it was segmented:

- (7) Ellen / zei / te balen van / de houding van / Peter / en / Ruben_{C1} /, die / totaal / geen kwaad / leek/leken_{C2} / te zien / in / nog een biertje, / en_{C3} / ze / keek_{C4} / hen / met boze ogen / aan.
Ellen / said / to be fed up with / the attitude of / Peter / and / Ruben_{C1} /, who / totally / no harm / appeared_{SG/PL/C2} / to see / in / another beer, / and_{C3} / she / looked_{C4} / them / with angry eyes / at.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who appeared_{SG/PL} to see no harm at all in another beer, and she looked at them with angry eyes.)

There were four critical positions in the target sentence, which are marked with the suffixes C1 to C4 in example (7). The suffixes SG and PL indicate that the RC verb was either singular (i.e. supportive of an S-coordination) or plural (i.e. supportive of an NP-coordination). In the following, it is explained how each of the four critical positions were assumed to contribute to an answer to the above questions.

Hypotheses for critical position 1: the ambiguous NP

The first critical position of the target sentence was the first proper name after the conjunction *and* (*Ruben_{C1}* in example (7)). At this position, readers were assumed to decide if the sentence should initially be analyzed as an NP- or an S-coordination. The outcome of this parsing decision was expected to be reflected in the reading times. In particular, reading times on *Ruben_{C1}* were expected to be longer if the sentence was initially analyzed as an S-coordination than if it was initially analyzed as an NP-coordination (see also section 2.4.2). This prediction results from the idea that it is more laborious to build an S-coordination than an NP-coordination. More specifically, an S-coordination requires the first (sub)clause to be wrapped up and the structure of a new (sub)clause to be started (with *Ruben_{C1}* as its subject/topic). An NP-coordination, on the other hand, only requires *Ruben_{C1}* to be embedded in the ongoing

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structure as part of the complex object NP *de houding van Peter en Ruben* (the attitude of Peter and Ruben).

Hypotheses for critical position 2: the RC verb

The second critical position of the target sentence was the RC verb (*leek/leken*_{C2} (*appeared*_{SG/PL}) in example (7)). At this position, the factor SV-agreement was manipulated to either support an NP- or an S-coordination. If the target sentence was initially analyzed as an NP-coordination, the function of object was assigned to the entire phrase *de houding van Peter en Ruben* (the attitude of Peter and Ruben). In this case, the relative clause was expected to be interpreted as if its content concerned both Peter and Ruben, requiring a plural RC verb. On the other hand, if the target sentence was initially analyzed as an S-coordination, the phrase *Peter en Ruben* (Peter and Ruben) did not constitute a whole, but *Ruben* was interpreted as the subject/topic of the conjoined sentence. In this case, the relative clause was expected to be interpreted as concerning only *Ruben*, requiring a singular RC verb. Hence, the number of the RC verb could either be consistent with or go against the initial analysis of the sentence. Therefore, similar to the first critical position, reading time differences at the RC verb were expected to reveal how the sentence was initially analyzed and, consequently, if this analysis was in accordance with situational knowledge.

The following predictions start from the assumption that (1) situational knowledge affected the initial analysis of the sentence and that (2) a plural RC verb was preferred in case of an initial NP-coordination analysis of the target sentence and that a singular RC verb was preferred in case of an initial S-coordination analysis. First, no reading time differences were expected in the S_S-condition and the NP_NP-condition, because in these conditions SV-agreement was concordant with situational knowledge. Second, reading times were expected to increase in the S_NP-condition and the NP_S-condition, because in these conditions situational knowledge and SV-agreement conflicted.

There is reason to believe that the inconsistency between situational knowledge and SV-agreement would have bigger consequences in the S_NP-condition than in the NP_S-condition. As was already described in section 4.2, a plural RC verb *demands* an NP-coordination, because embedding it within an S-coordination produces an ungrammatical sentence (see example sentence (3)). A singular RC verb, on the other

hand, *supports* an S-coordination, but does not exclude an NP-coordination as a possible structure of the sentence. On the basis of this, one could expect that a plural verb is more strongly preferred in the S_NP-condition than a singular verb in the NP_S-condition, leading to more processing difficulties (and thus stronger increased reading times) in the former condition as compared to the latter. Moreover, if participants complied with the commanding signal of the plural RC verb in the S_NP-condition and not with the supporting signal of the singular RC verb in the NP_S-condition, they would disambiguate their initial analysis in the former condition and not in the latter, causing the reading times to further increase in the former condition.

There is an additional ground for predicting larger processing problems in the S_NP-condition than in the NP_S-condition. In the NP_S-condition, the situational knowledge manipulation indicates that there is a set of annoying people that contains two entities, viz Peter and Ruben. Subsequently, the singular RC verb restricts this set by supporting an S-coordination structure, indicating that Ellen was annoyed by Peter only. In the S_NP-condition, on the other hand, the situation is reversed: the initial set of annoying people contains only one entity. Subsequently, the plural RC verb supports an enlargement of this set to both Peter and Ruben.

One could predict that it is easier to restrict a set (i.e. in the NP_S-condition: from two to one annoying person) than to expand one (i.e. in the S_NP-condition: from one annoying person to two). Evidence for this idea has for example been provided by Wijnen and Kaan (2006). Consider the following sentence (taken from Wijnen and Kaan's study):

- (8) Ten students marched by. Five were shouting insults.

One interpretation of the quantifier *five* is that it refers to a subset of the set of ten students that marched by. In other words, the *restrictor* of *five* is the set of *students that marched by*. However, *five* can also refer to a set of five other students that is not part of the set of *ten students that marched by*. For example, these five students could be standing next to the road shouting insults to the ten students that were marching by. In this case, the initial set of ten students is enlarged with five. Wijnen & Kaan argue that readers prefer the first interpretation of *five* (a suggestion that has also been made by Frazier (1999), as described by Wijnen and Kaan).

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Results from an on-line incremental acceptability judgment task provided evidence for this idea.

One should note that, even though it may be easier to restrict a set than to expand one, the latter situation does not necessarily produce an anomalous text. In the current experiment, a strange text could arise in the S_NP-condition if the context initially stated that Ellen was annoyed by the drinking behavior of only Peter and subsequently, in the critical sentence, that she was annoyed by the *drinking* behavior of Ruben as well. However, this was not the case. A closer look at example (3) shows that only sentence (3) was specifically on Ellen's annoyance about the *drinking behavior* of Peter. Sentence (5), on the other hand, was on Ellen being fed up with *the behavior* of both Peter and Ruben. This could, for example, mean that Ellen was annoyed by Peter because of his drinking behavior and by Ruben because he had turned a blind eye to it.

Hypotheses for critical position 3: the first word following the relative clause

The third critical position of the target sentence was the first word after the relative clause (en_{C3} (*and*)) (in all experimental items). If participants were analyzing the target sentence as an S-coordination by the end of the relative clause, they were assumed to strongly expect a verb to follow immediately after the relative clause (see section 4.2). This expectation was not borne out and this was assumed to at least hamper processing. Moreover, the expectation for a verb may have been so strong that its nonappearance was reason enough for participants to even reject their S-coordination analysis in favor of an NP-coordination analysis.

If SV-agreement overruled situational knowledge in all circumstances, reading times at en_{C3} (*and*) would be faster in the NP_NP-condition and the S_NP-condition than in the S_S-condition and the NP_S-condition. After all, in the former two conditions the plural RC verb caused the initial analysis (if necessary) to be reanalyzed to an NP-coordination. If situational knowledge determined the initial analysis of the sentence and SV-agreement only overruled this factor in case of a plural RC verb (because in this case the sentence was obliged to unfold as an NP-coordination), reading times would be slower in the S_S-condition than in the other three conditions. After all, participants had stuck to their initial NP-coordination analysis in the NP_S-condition. If situational knowledge determined the initial analysis of the sentence and SV-agreement never overruled this analysis, reading times would be faster

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in the NP_NP-condition and the NP_S-condition than in the S_S-condition and the S_NP-condition, because in the former two conditions situational knowledge supported the correct structure of the sentence.

Hypotheses for critical position 4: the verb after the relative clause

The fourth critical position of the target sentence was the verb after the relative clause (*keek_{C4} (looked)* in example (7)). It is at this position that the target sentence is strictly disambiguated to an NP-coordination (with the exception of the conditions that contained a plural RC verb; see section 4.2). Thus, if participants were analyzing the target sentence as an S-coordination by the end of the relative clause, there was in fact no need to reject this analysis before *keek_{C4} (looked)*. If participants indeed considered *keek_{C4} (looked)* as the ‘official’ disambiguating point of the target sentence instead of *enc₃ (and)*, the possible reading time differences that were described for *enc₃ (and)* can be expected to occur at *keek_{C4} (looked)*. However, the same pattern of reading times may still, more or less, be reflected at *enc₃ (and)*, because processing might still have been hampered by the fact that the first word after the target sentence was not, as expected in case of an S-coordination, a verb.

4.6.2 Summary

The outcomes regarding the four critical positions that were described above are summarized in Table 6. Even though the table does not present all logical possibilities, it does present all plausible outcomes.

Table 6: Plausible outcomes regarding the four critical positions of the target sentence. *Note: RT-results is an abbreviation for reading time results*

<i>Critical position</i>	<i>Possible RT-results</i>	<i>Conclusion</i>
<i>Ruben_{C1}</i>		
		(1)
<i>Goal: to reveal effects of situational knowledge on initial analysis of sentence</i>	NP-context < S-context	Situational knowledge determines initial analysis

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<i>Critical position</i>	<i>Possible RT-results</i>	<i>Conclusion</i>
	No differences	(2) Situational knowledge does not determine initial analysis: initial analysis always NP-coordination
<hr/>		
<i>leek/leken_{C2} (appeared_{SG/PL})</i>		
Goal: - to reveal effects of situational knowledge on initial analysis of sentence - whether SV-agreement more strongly affects processing when it supports an NP-coordination (i.e. in case of a plural RC verb) than when it supports an S-coordination (i.e. in case of a singular RC verb).	(NP_NP = S_S) < (NP_S = S_NP)	(3) a. Situational knowledge determines initial analysis b. Preference for plural RC verb in case of an NP-coordination and singular RC verb in case of an S-coordination c. Equally large processing problems in case of conflict between situational knowledge and SV-agreement
	(NP_NP = S_S) < NP_S < S_NP	(4) (3a) and (3b), but: Larger processing problems in case of a plural than in case of a singular RC verb

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<i>Critical position</i>	<i>Possible RT-results</i>	<i>Conclusion</i>
		(5)
	(NP_NP = S_NP) < (S_S = NP_S)	(3b), but: Situational knowledge does not determine initial analysis: initial analysis always NP-coordination
<hr/>		
<i>enc₃ (and)</i>		(6)
<i>Goal: to reveal if SV-agreement overrules initial analysis of sentence</i>	(NP_NP = S_NP = NP_S) < (S_S)	a. Situational knowledge determines initial analysis b. SV-agreement overrules initial analysis only in case of plural RC verb: reanalysis on RC verb c. S-coordination rejected as possible structure at <i>and₃</i>
		(7)
	(NP_NP = S_NP) < (S_S = NP_S)	(6c) and: - SV-agreement overrules initial analysis in all cases: reanalysis (if necessary) on RC verb
		(8)
	NP_NP < (S_NP=NP_S) < S_S	(6c) and: - Situational knowledge determines initial analysis

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<i>Critical position</i>	<i>Possible RT-results</i>	<i>Conclusion</i>
		- SV-agreement did not overrule initial analysis
		(9)
	NP_NP = S_NP = NP_S = S_S	a. Situational knowledge does not determine Initial analysis: always an NP-coordination
		b. SV-agreement did not overrule initial analysis
<hr/>		
<i>keek_{C4} (looked)</i>		(10)
<i>Goal: to reveal</i>	See possible outcomes 6-9	S-coordination not already rejected as possible structure at <i>and_{C3}</i>
<i>- If this position is ultimate disambiguation point</i>		
<i>- If SV-agreement overrules initial analysis of sentence</i>		

4.6.3 Method

Participants

Eighty-nine students, mostly at the Faculty of Humanities or the Faculty of Social and Behavioral Sciences of Utrecht University, participated in the experiment. Sixty-seven of them were female, twenty-two were male. The mean age of all participants was 22 years (range 18-50 years). They were paid 10 euros for their participation. None of the participants took part in any of the experiments 4 to 6 and all were naïve as to the purpose of the experiment.

Materials

Participants were presented with thirty-two experimental texts, similar to the ones presented in the experiments reported above, and nineteen filler items (see Appendix 10 for all experimental texts). Some minor

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adjustments were made in the texts, in order to improve the manipulation of situational knowledge or to make sure that the critical segments did not appear at the beginning or end of a line. The scenarios that were described in the fillers were of the same kind as those described in the experimental items. Seven fillers had an S-context, twelve an NP-context and none of them contained an NP-coordination. Eleven fillers contained an S-coordination with the singular form of the verb *lijken* (to appear). This was done to compensate for the fact that all target sentences with the singular verb *leek* (*appear_{SG}*) unfolded as an NP-coordination. Eight fillers contained sentences with the plural verb *leken* (*appear_{PL}*). In these sentences, other connectives were used instead of *en* (and), e.g. *omdat* (because), *want* (since) or *maar* (but). Similar to the experimental items, all “critical” sentences of the filler items described the interaction between the main characters of the text. Examples of a sentence with the connective *as* and *because* are presented in example (9) and (10) respectively:

- (9) Babs zei dat ze nu toch echt afscheid moest nemen van Martin, die nog wel een uur leek te willen kletsen, want Lars moest nog voor sluitingstijd een cadeautje kopen.
Babs said that she now really goodbye had to say to Martin, who for another hour appeared_{SG} to want to talk, since Lars had yet before closing time a gift to buy.
(Babs said that she now really had to say goodbye to Martin, who appeared_{SG} to want to talk for another hour, since Lars had to buy a gift before closing time.)
- (10) Cor zei stapeldol te worden, omdat Jaap en Maaïke elkaar het woord niet leken te gunnen, en hij schoot in de lach.
Cor said to be crazy going, because Jaap and Maaïke each other a few words not appeared_{PL} to spare, and he burst into laughter.
(Cor said that he was going crazy, because Jaap and Maaïke appeared_{PL} not to spare each other a few words, and he burst into laughter.)

Design

Four experimental lists were constructed, so that each condition was equally represented and no two experimental versions of any item

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appeared in the same list. Which texts appeared together in the same condition was randomly determined for each list.

Procedure

Participants were seated in front of a computer. They were instructed both orally and in writing that some short texts would be presented to them, which they had to read as they would normally do. Reading times were measured using a moving window self-paced reading design. This was done using the software program E-prime.

The experiment started with a practice session comprising three filler texts. The texts were presented constituent-by-constituent (see example (6)). However, to be able to measure the reading times of the critical segments of the target sentence as accurately as possible, these segments were presented word-by-word. The part of the target sentence starting from the ambiguous NP (*Ruben_{CI}*) up to and including two words after the disambiguating verb always appeared on the same line. Also, this part never appeared at the beginning or the end of a line.

After each text, participants had to answer two questions. The first always questioned the critical information of the text: who did the central figure in the text (Ellen in our example) find annoying? Participants had to choose from three possible answers: (1) Peter, (2) Ruben and (3) Ruben and Peter⁷. The second question focused on other aspects of the text. In this manner, it was made sure that participants read the whole text attentively.

In Experiment 3, the critical situational knowledge information was questioned as well. In this experiment, the basic idea was that if a participant was not capable of correctly verifying the statement, one could not be sure that he had properly gathered the situational knowledge of the corresponding text. Because only the factor situational knowledge was manipulated, the correct answer could be unambiguously determined. However, in the current experiment the correct answer could not always be unambiguously determined, because

⁷ If the alternative contained two characters (*Ruben and Peter*), the names were always presented in the order in which they appeared in the discourse context (in case of an NP-context). In the target sentence, the order of the names was reversed (see example (1) and (2)). This was done in order to avoid that participants used their memory for the surface representation of the text instead of their situation model to answer the question.

several factors were involved that sometimes supported different answers. First, in the examples above situational knowledge either supported the answer that Ellen was annoyed by Peter only, or by Ruben as well. Second, depending on its number, the RC verb was either in accordance with the situational knowledge-based answer or not. Finally, the target sentence always turned out to be an NP-coordination, stating that Ellen found both Peter and Ruben annoying. In sum, even though the opposing factors did not produce anomalous texts, they did cause a situation in which there were more correct answers to the critical question. For this reason, it was decided not to analyze the data of the verification task. The only purpose of this task was therefore to make sure that participants read the experimental items thoroughly.

4.6.4 Results

The results were submitted to a multilevel analysis (see Appendix 9 for the exact model). In two different conditions of two different texts two segments were left out of consideration, because an error occurred during their presentation to the participants.

Results for critical position 1: the ambiguous NP

For the sake of convenience, the target sentences are repeated here:

- (11) Ellen zei te balen van de houding van Peter en Ruben_{C1}, die totaal geen kwaad leek/leken_{C2} te zien in nog een biertje, en_{C3} ze keek_{C4} hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben_{C1}, who totally no harm appeared_{SG/PL/C2} to see in another beer, and_{C3} she looked_{C4} them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG/PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

Upon encountering the ambiguous NP (i.e. *Ruben_{C1}*), situational knowledge was the only manipulated factor. For this reason, the two S-context conditions on the one hand and the two NP-context conditions on the other were taken together in the analysis. The results for *Ruben_{C1}*

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and the subsequent segment (*die_{C1+1} (who)*) are presented in Table 7.⁸ The results showed that the ambiguous NP *Ruben_{C1}* was processed faster in an NP-context than in an S-context ($\chi^2 = 6.86$; $df = 1$; $p < .01$). This result spilled over onto (*die_{C1+1} (who)*) as well ($\chi^2 = 10.62$; $df = 1$; $p < .01$).

Table 7: Mean reading times (msec) for the first critical position (the ambiguous NP *Ruben_{C1}*) and the subsequent segment (*die_{C1+1} (who)*) as a function of situational knowledge (standard errors in parentheses).

<i>Ruben_{C1}</i>		
NP-context	Reading times (se)	442 (15.34)
S-context	Reading times (se)	465 (15.04)
	$s^2\text{txt}$ (se)	46480 (1380)
	$s^2\text{subj_between}$ (se)	13470 (2283)
<i>die_{C1+1} (who)</i>		
NP-context	Reading times (se)	393 (8.69)
S-context	Reading times (se)	412 (8.48)
	$s^2\text{txt}$ (se)	18380 (551)
	$s^2\text{subj_between}$ (se)	3704 (662)

Note: $s^2\text{txt}$ denotes the variance between texts, $s^2\text{subj_between}$ the variance between subjects.

Results for critical position 2: the RC verb

For the sake of convenience, the target sentences are repeated here:

- (12) Ellen zei te balen van de houding van Peter en *Ruben_{C1}*, die totaal geen kwaad leek/leken_{C2} te zien in nog een biertje, en_{C3} ze keek_{C4} hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben_{C1}, who totally no harm appeared_{SG/PL/C2} to see in another beer, and_{C3} she looked_{C4} them with angry eyes at.

⁸ The subscript $C1+1$ indicates that the segment *who* appeared one segment after the first critical position (i.e. *Ruben_{C1}*).

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(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG/PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

The results for the second critical position (the RC verb *leek/leken*_{C2} (*appeared*_{SG/PL})) and the subsequent segments are presented in Table 8.

Table 8: Mean reading times (msec) for the second critical position (the RC verb *leek/leken*_{C2} (*appeared*_{SG/PL})) and the subsequent three segments as a function of situational knowledge and SV-agreement (standard errors in parentheses).

		SV-agreement	
		NP-bias	S-bias
<i>leek/leken</i> _{C2} (<i>appeared</i> _{SG/PL})			
NP-context	Reading times (se)	386 (8.09)	373 (8.23)
S-context	Reading times (se)	395 (8.04)	380 (7.93)
	s ² txt (se)	14430 (428)	
	s ² subj_between (se)	3609 (623)	
<i>te zien</i> _{C2+1} (<i>to see</i>)			
NP-context	Reading times (se)	393 (13.42)	416 (13.68)
S-context	Reading times (se)	489 (13.30)	392 (13.10)
	s ² txt (se)	47750 (1418)	
	s ² subj_between (se)	8676 (1572)	
<i>in</i> _{C2+2} (<i>in</i>)			
NP-context	Reading times (se)	385 (7.45)	405 (7.59)
S-context	Reading times (se)	422 (7.39)	394 (7.28)
	s ² txt (se)	13990 (415)	
	s ² subj_between (se)	2782 (496)	

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		SV-agreement	
		NP-bias	S-bias
<i>nog een biertje</i> _{C2+3} (<i>another beer</i>)			
NP-context	Reading times (se)	464 (17.64)	491 (18.04)
S-context	Reading times (se)	496 (17.47)	461 (17.15)
	<i>s</i> ² txt (se)	96590 (2867)	
	<i>s</i> ² subj_between (se)	12870 (2476)	

Note: *S_NP* is an abbreviation for the condition in which situational knowledge supported an S-coordination and SV-agreement supported an NP-coordination, et cetera. *s*²txt denotes the variance between texts, *s*²subj_between the variance between subjects.

The results for *leek/leken*_{C2} (*appeared*_{SG/PL}) showed a main effect of SV-agreement: the verb was processed faster when it was singular than when it was plural. However, this effect could be due to the fact that the plural verb contained more letters and syllables than the singular verb. The results for the subsequent segments show a clear picture. The results for *to see*_{C2+1} showed an interaction between situational knowledge and SV-agreement ($\chi_2 = 43.59$; *df* = 1; *p* < .001). When SV-agreement was counteracted by situational knowledge (i.e. in the *S_NP*-condition and the *NP_S*-condition), reading times were longer than when both factors were concordant (i.e. in the *NP_NP*-condition and the *S_S*-condition; *NP_NP/S_S* versus *NP_S*-condition: $\chi_2 = 4.21$; *df* = 1; *p* < .05). However, there was a larger increase in reading times when the RC verb was plural (i.e. in the *S_NP*-condition) than when the RC verb was singular (i.e. in the *NP_S*-condition; $\chi_2 = 31.15$; *df* = 1; *p* < .001). The difference between the two conditions in which situational knowledge and SV-agreement were in accordance with one another and the conditions in which this was not the case was also found at the following words (*in*_{C2+2} (*in*): $\chi_2 = 23.89$; *df* = 1; *p* < .001; *nog een biertje*_{C2+2} (*another beer*): $\chi_2 = 5.81$; *df* = 1; *p* < .05).

Results for critical position 3 and 4: the disambiguating region

For the sake of convenience, the target sentences are repeated here:

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- (13) Ellen zei te balen van de houding van Peter en Ruben_{C1}, die totaal geen kwaad leek/leken_{C2} te zien in nog een biertje, en_{C3} ze keek_{C4} hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben_{C1}, who totally no harm appeared_{SG/PL/C2} to see in another beer, and_{C3} she looked_{C4} them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG/PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

The results for the disambiguating region of the target sentence are shown in Table 9.

Table 9: Mean reading times (msec) for the disambiguating region (en_{C3} (*and*) and subsequent segments) as a function of situational knowledge and SV-agreement (standard errors in parentheses).

		SV-agreement	
		NP-bias	S-bias
<i>en_{C3} (and)</i>			
NP-context	Reading times (se)	433 (12.31)	474 (12.59)
S-context	Reading times (se)	461 (12.19)	471 (11.97)
	s ² txt (se)	46560 (1382)	
	s ² subj_between (se)	6324 (1213)	
<i>ze_{C3+1} (she)</i>			
NP-context	Reading times (se)	363 (10.99)	388 (11.22)
S-context	Reading times (se)	383 (10.90)	401 (10.73)
	s ² txt (se)	32230 (957)	
	s ² subj_between (se)	5796 (1052)	
<i>keek_{C4} (looked)</i>			
NP-context	Reading times (se)	353 (12.90)	398 (13.19)
S-context	Reading times (se)	369 (12.77)	428 (12.54)
	s ² txt (se)	51200 (1520)	
	s ² subj_between (se)	6938 (1331)	

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		SV-agreement	
		NP-bias	S-bias
<i>hen_{C4+1} (them)</i>			
NP-context	Reading times (se)	374 (11.27)	396 (11.55)
S-context	Reading times (se)	401 (11.16)	426 (10.94)
	<i>s</i> ² txt (se)	42460 (1260)	
	<i>s</i> ² subj_between (se)	4790 (959)	
<i>met boze ogen_{C4+2} (with angry eyes)</i>			
NP-context	Reading times (se)	438 (14.66)	487 (14.99)
S-context	Reading times (se)	426 (14.52)	474 (14.27)
	<i>s</i> ² txt (se)	63930 (1898)	
	<i>s</i> ² subj_between (se)	9294 (1756)	

Note: *S_NP* is an abbreviation for the condition in which situational knowledge supported an S-coordination and SV-agreement supported an NP-coordination, et cetera. *s*²txt denotes the variance between texts, *s*²subj_between the variance between subjects.

The results for the third critical position *en_{C3} (and)* showed a main effect of SV-agreement ($\chi^2 = 8.33$; $df = 1$; $p < .01$); it was processed faster when SV-agreement supported an NP-coordination (i.e. in the *S_NP*-condition and the *NP_NP*-condition) than when it supported an S-coordination (i.e. in the *S_NP*-condition and the *S_S*-condition. This result continued on the segments *ze_{C3+1} (she)*, *keek_{C4} (looked)* and *hen_{C4+1} (them)* ($\chi^2 \geq 7.46$; $df = 1$; $p \leq .01$). However, the results for these three segments showed a main effect of situational knowledge as well ($\chi^2 \geq 5.06$; $df = 1$; $p \leq .05$). All three segments were processed faster when situational knowledge supported an NP-coordination (i.e. in the *NP_NP*-condition and the *NP_S*-condition) than when it supported an S-coordination (i.e. in the *S_NP*-condition and the *S_S*-condition). Finally, the results for *met boze ogen_{C4+2} (with angry eyes)* only showed a main effect of SV-agreement ($\chi^2 = 21.50$; $df = 1$; $p < .001$). No interaction effects between situational knowledge and SV-agreement were found.

4.6.5 Conclusion and discussion

The expectations regarding the first critical position (the ambiguous NP *Rubenc₁*) were that participants would initially analyze the phrase *Ruben* as the subject/topic of a conjoined sentence (i.e. an S-coordination) in an S-context and as part of the complex object NP *de houding van Peter en Ruben* (*the attitude of Peter and Ruben*; i.e. an NP-coordination) in an NP-context. The former analysis was considered to be more complicated and consequently more time-consuming than the latter. The increased reading times for *Rubenc₁* in the S-context conditions as compared to the NP-context conditions indeed suggest that participants were building a different, more difficult structure in the former conditions than in the latter. Therefore, the results support the notion that situational knowledge affects the initial analysis of a sentence.

On the basis of Traxler, Foss, Seely, Kaup & Morris (2000), one could think of an alternative explanation for the results, viz. that they were caused by so-called situational model priming. According to this theory, participants may have always initially analyzed the target sentence as an NP-coordination. The reading time differences on *Rubenc₁* can be explained by the fact that making the phrase *Peter en Ruben* (*Peter and Ruben*) part of a complex object NP was easier in an NP-context than in an S-context, because *Peter* and *Ruben* already appeared close to each other in the former context and not in the latter (compare sentence (3) of the examples in section 4.2). A solution would be to mention *Peter* and *Ruben* close to each other in the context preceding the critical sentence in both conditions. This is further explained in Chapter 6.

Still, situational model priming is an unlikely explanation for the results, because the results for the second critical region (*leek/leken_{C2}* (*appeared_{SG/PL}*)) and subsequent segments) also provided evidence that situational knowledge affected the initial analysis of the sentence. The expected effect of situational knowledge was not found on *leek/leken_{C2}* (*appeared_{SG/PL}*), but on the subsequent segment instead (*te zien_{C2+1}* (*to see*)). Such delayed effects are called spill-over effects and occur frequently in a moving window self-paced reading design (cf. Hoeks, Vonk & Schriefers (2002), experiment 2; Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort (2005), experiment 3)). In particular, the results on *to see_{C2+1}* confirmed the hypotheses in all respects. Reading times were faster when SV-agreement was in accordance with situational knowledge than when it was not. Moreover, the results showed a larger

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increase in reading times in the S_NP-condition than the NP_S-condition. This result supports the idea that processing was hampered to a larger extent in the former condition, because the plural RC verb in this condition was not only unexpected, as the singular RC verb in the NP_S-condition, but it also excluded an S-coordination analysis of the sentence (i.e. the initial situational knowledge-based analysis of the sentence). However, as was already noted in section 4.6.1, the possibility cannot be ruled out that this reading time difference was caused by the fact that it is easier to restrict a set of annoying people from two to one (i.e. in the NP_S-condition) than to expand this set from one to two (i.e. in the S_NP-condition; Wijnen and Kaan, 2006; see section 4.6.1).

Whatever the exact explanation for this result may be, the overall results in the second critical region of the target sentence provided further evidence for the idea that situational knowledge affected the initial analysis of the sentence. Therefore, it seems safe to conclude that the results for *Ruben_{C1}* were not caused by situation model priming. After all, if this had been the case, than the initial analysis would always have been an NP-coordination. Consequently, under the situation model explanation, the results should have reflected some processing advantage for the conditions in which SV-agreement supported this structure (i.e. in both the NP_NP-condition and the S-NP-condition). This was evidently not the case.

As was already described in section 4.2, it was difficult to predict where exactly participants would rule out an S-coordination as a possible structure of the critical sentence. The critical sentence was irrevocably disambiguated to an NP-coordination at the verb after the relative clause (i.e. *keek_{C4}* (*looked*)). However, the expectation that a verb would follow immediately after the relative clause in case of an S-coordination may have been so strong that this structure was already rejected if this expectation was not borne out (the first word after the relative clause was always *en_{C3}* (*and*)). In any case, even if the nonappearance of the verb did not cause a reanalysis, it was still expected to impede processing. Therefore, whichever of these possibilities is true, the reading time differences at *en_{C3}* (*and*) were expected to at least provide an insight in whether SV-agreement overruled the initial analysis of the sentence.

The interaction of situational knowledge and SV-agreement

The results for en_{C3} (*and*) showed faster reading times if SV-agreement supported an NP-coordination than if it supported an S-coordination. This result provides evidence for the idea that SV-agreement always overruled the initial analysis of the sentence, as determined by situational knowledge (as the previous results indicated that situational knowledge determined the initial analysis of the sentence). Moreover, the results support the idea that the reading time differences between the NP_S-condition and the S_NP-condition on *leek/leken*_{C2} (*appeared*_{SG/PL}) were not caused by the fact that the plural RC verb required an NP-coordination whereas the singular RC verb only supported an S-coordination. After all, the number of the RC verb appeared to have been a strong enough signal in both conditions to reanalyze the initial analysis of the sentence if necessary. Therefore, the results at en_{C3} (*and*) further support the idea that the differences at *leek/leken*_{C2} (*appeared*_{SG/PL}) between the NP_S-condition and the S_NP-condition were caused by the fact that restricting a set is easier than expanding one.

The effect of SV-agreement sustained during the three segments that followed upon en_{C3} (*and*) (i.e. ze_{C3+1} (*she*) to hen_{C4+1} (*them*)). However, a main effect of situational knowledge was found on these segments as well, as reading times were faster if situational knowledge supported an NP-coordination than if it supported an S-coordination. An explanation of this result could be the following. The results for en_{C3} (*and*) indicated that processing was hampered if SV-agreement supported an S-coordination as compared to if it supported an NP-coordination. Possibly, the encountering of en_{C3} (*and*) even caused an S-coordination structure to be rejected and reanalyzed to an NP-coordination. As the segments that followed upon en_{C3} (*and*) showed faster reading times if situational knowledge supported an NP-coordination, it can be concluded that this factor was deployed again to facilitate the reanalysis of the critical sentence in an NP-coordination. Finally, the effect of SV-agreement appeared to have the longest-lasting effect on processing, as the results on met_{C4+2} (*with*) showed faster reading times if SV-agreement supported an NP-coordination than if it supported an S-coordination.

Hence, the results of the present self-paced reading experiment provide clear evidence for the notion of an interactive parser that is immediately affected by situational knowledge. Support for this idea was already found at the first critical position of the target sentence, i.e. at the ambiguous NP *Ruben*_{C1}, and subsequently at the second critical position

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of the target sentence (i.e. *leek/leken*_{C2} (*appeared*_{SG/PL})). The results for these positions showed that the sentence was initially analyzed in accordance with situational knowledge.

The results for the disambiguating region of the target sentence supported the idea that SV-agreement overruled the initial analysis of the sentence, as determined by situational knowledge. This appeared not only to be the case when SV-agreement demanded a certain structure (i.e. an NP-coordination in case of a plural RC verb), but also when it only supported a certain structure (i.e. an S-coordination in case of a singular RC verb). Furthermore, the results for the first segment after the relative clause (*en*_{C3} (*and*)) supported the idea that the processing of an S-coordination was at least impeded if no verb followed directly upon the relative clause. If an S-coordination analysis was even rejected at this point, the results for the subsequent segments provide evidence for the idea that situational knowledge was deployed again to support reanalysis. Reading times on these segments were faster when situational knowledge supported an NP-coordination than when it supported an S-coordination.

4.7 General discussion

The experiments 4 to 6 provided evidence for the idea that both readers' expectations regarding sentence structure and their perception of a sentence after reading are affected by situational knowledge and SV-agreement. The results of Experiment 4 showed an overall preference to complete an interrupted NP-/S-coordination ambiguity as an NP-coordination, but this preference was modulated by situational knowledge: the sentence was preferably completed as an NP-coordination in an NP-context and as an S-coordination in an S-context. Subsequently, the results of Experiment 5 showed that this NP-coordination default is not only affected by situational knowledge, but by the factor SV-agreement as well. Moreover, the factor SV-agreement proved to affect readers' expectations more strongly than situational knowledge. This result can be explained by the fact that in one condition the factor SV-agreement did not only *support* a certain completion of the target sentence, but it even *demanded* it because it was the only completion that would produce a grammatical sentence. Finally, the results of Experiment 6 showed that both situational knowledge and SV-agreement affect readers' perception of a sentence after reading.

The interaction of situational knowledge and SV-agreement

Furthermore, the weight of each factor proved to depend on which feature of the target sentence was being questioned. In particular, situational knowledge and SV-agreement were shown to affect the general understandability (easiness) of the target sentence to the same extent. However, situational knowledge outweighed SV-agreement when the plausibility of the target sentence was concerned, whereas the results with respect to the naturalness of the sentence were (to a lesser extent) reversed.

The results of the on-line self-paced reading experiment (Experiment 7) provided support for the idea that parsing is an interactive process in which nonsyntactic sources of information are brought to bear immediately. In particular, situational knowledge appeared to affect the initial analysis of the sentence. Also, SV-agreement subsequently appeared to overrule the initial analysis of the sentence, as determined by situational knowledge. When reanalysis turned out to be necessary, situational knowledge was deployed again to facilitate this process.

In the next chapter, results are reported of an eye movement experiment. The purpose of this experiment was to measure the effects of situational knowledge and SV-agreement in an even more accurate way. The eye movement experiment partly replicated and partly elaborated on Experiment 7.

Chapter 5

A closer look at parsing ambiguous coordinations: an eye movement study

5.1 Introduction

In the previous chapter, results from a moving window self-paced reading experiment were described that support the hypothesis that situational knowledge immediately affects the initial analysis of a sentence. Even though the experiment seemed to measure the different stages of processing quite accurately and even though the evidence appeared rather solid, a more precise method could provide an even more detailed insight in the course of processing. An example of such a method is the registration of eye movements. This method can be considered a more ecological valid one than self-paced reading (see section 5.2). Furthermore, it may provide highly specific information about the different temporal aspects of the reading process.

In this chapter, an eye movement experiment is described. The aim of this experiment was to replicate and further elaborate on the results of Experiment 7. Before it is described in detail, some basic characteristics of the registration of eye movements are discussed (section 5.2). In doing this, the elaborate overview by Rayner (1998) is used extensively.

5.2 Eye movements and on-line processing

When readers read a text, their eyes jump from one position in the text to another. These jumps are called saccades. Their average size is about 7-9 letter spaces with a maximum of 15. In between the saccades, the eyes remain relatively still during so called fixations. The average fixation duration is about 200-250 ms and the perceptual span extends 3-4 letters to the left of the fixation and 14-15 letters to the right. However, readers are not capable of really identifying words further away than 7-8 letter spaces to the right of the fixation point.

The visual field can be divided into three regions: a foveal, paravofeal and peripheral region. Acuity is good in the fovea, not as good in the parafovea and even poorer in the periphery. Readers make sure that the

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part of the text that they want to see clearly and process is projected into the foveal region. Characteristics of the stimulus in parafoveal or peripheral vision influence whether readers make a saccade to identify it.

When readers 'jump' through a text, not all words are fixated. The decision to fixate a region of text is a complex process that is affected by different factors. Content words are fixated 85% of the time, whereas function words are fixated only 35% of the time. One reason for this is that function words tend to be shorter than content words and a clear relationship has been shown between the length of a word and the probability of fixating it: the longer a word, the more likely that it is fixated (Rayner & McConkie, 1976, as described in Rayner 1998).

The registration of eye movements has been used to investigate the on-line reading process for many years now (see Rayner, 1998, for an extensive overview). This method can provide a close understanding of the strategies that readers adopt while they read a text and has advantages over moving window self-paced reading methods (hereafter: *SPR-design*).

First, the registration of eye movements has a higher ecological validity than the SPR-method, because the natural reading process is reflected more closely. If eye movements are registered, the text can be presented to the participants as a whole, whereas the central idea of an SPR-design is that the materials are presented incrementally bit-by-bit. Furthermore, because participants' eye movements can be registered directly, they do not have to press a button to proceed through the text, as in case of an SPR-paradigm.

Second, the registration of eye movements provides more specific information about the different temporal aspects of the reading process than the SPR-method. The SPR-design that was used in the previous experiments 3 and 7, allowed readers to read only one piece of text at a time and left them no possibility to look back in the text. Readers could not look forward in the text either. Because of this, the SPR-method only yielded information about the time readers spent reading an isolated piece of text until they proceeded. In addition, the SPR-procedure more or less forces participants to read every piece of text. Furthermore, the fact that readers have to press a button to continue reading the next piece of text often leads to spill-over effects (i.e. delayed effects), because

readers tend to press the button before having fully processed a piece of text.

However, in real life readers are able to reread previous parts of text or to look forward in the text. The registration of eye movements also yields information about these aspects of reading, for instance about how often readers tend to look back in the text, so-called regressions, and the duration of these regressions. Therefore, a distinction can be made between the first reading of a word and later rereadings. Furthermore, readers can skip words more easily than in a SPR-design, something that frequently happens in real-life reading.

In order to gain information about the several aspects of the reading process, eye movement data are used to provide different measures of processing time (see e.g. Rayner, 1998; Cozijn, Vonk & Noordman, 2003 for an overview). Which measure should be used in part depends on the research question at hand. A general rule is that, in order to gain a good understanding of the different (temporal) aspects of the reading process, it is important to combine the results of different measures.

Summarizing, the use of eye movements enables participants to use their natural reading strategies. This provides a quite true-to-life rendering of the reading process. Furthermore, this method provides specific information about the different temporal aspects of the reading process.

5.3 Experiment 8

The purpose of the current eye movement experiment was threefold. The first goal was to further elaborate the findings of Experiment 7, i.e. to find additional evidence in favor of the idea that situational knowledge immediately affects parsing. The second goal was to investigate the on-line processing of not only NP-coordinations, as in Experiment 7, but of S-coordinations as well. The third goal was to resolve an issue concerning the manipulation of situational knowledge in Experiment 7 (see section 4.6.5). How this was done is explained in the next section.

5.3.1 Operationalization

In order to not complicate the design of the eye movement experiment too much, Experiment 7 was replicated only partially. By way of comparison, the design of Experiment 7 is repeated in Table 1 and the design of Experiment 8 is shown in Table 2.

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Table 1: Design Experiment 7

Situational Knowledge	SV-agreement	Structure target sentence
S-context	NP-bias	NP-coordination
NP-context	NP-bias	NP-coordination
S-context	S-bias	NP-coordination
NP-context	S-bias	NP-coordination

Table 2: Design Experiment 8

Situational knowledge	SV-agreement	Structure target sentence
S-context	S-bias	S-coordination
NP-context	S-bias	S-coordination
S-context	S-bias	NP-coordination
NP-context	S-bias	NP-coordination

As can be deduced from Table (1) and (2), the current experiment differs from Experiment 7 in that the factor SV-agreement was not manipulated: the number of the verb of the relative clause (hereafter: *RC verb*) was singular in all conditions and hence always biased towards an S-coordination. The current experiment is an extension of Experiment 7 in the sense that the processing of S-coordinations is investigated as well.

Apart from these differences, the materials of the present experiment closely resembled those of Experiment 7. In fact, the present materials consisted of a subset of the materials that were used in Experiment 7. However, one further difference between both experiments was the following. In all experiments, the critical sentence contained two NP's (i.e. *Peter* and *Ruben* in all examples) that could either be analyzed as both being part of a complex object NP (NP-coordination) or as being the subject/topic of the conjoined sentence (S-coordination). In Experiment 7, both these NP's were mentioned in the sentence in which situational knowledge was manipulated (sentence (3)) if this factor supported an NP-coordination (*Ze vond het alleen vervelend dat Ruben en hun buurman Peter zoveel alcohol dronken* (She only found it irritating that Ruben and their neighbor Peter drank so much alcohol), but not if it supported an S-coordination (*Ze vond het alleen vervelend dat hun buurman Peter zoveel alcohol dronk* (She only found it irritating that their neighbor Peter drank so much alcohol); see the examples in section 4.2). In the present materials, it was made sure that both critical NP's always appeared together in the

critical situational-knowledge sentence (*Ze vond het alleen vervelend dat Ruben en zijn buurman Peter zoveel alcohol dronken* (She only found it irritating that Ruben and his neighbor Peter drank so much alcohol) in the NP-context versus *Ze vond het alleen vervelend dat Rubens buurman, Peter, zoveel alcohol dronk* (She only found it irritating that Ruben's neighbor, Peter, drank so much alcohol) in the S-context). This was done in order to further optimize the situational knowledge manipulation, more specifically, to further ensure that the situational-knowledge sentences only differed with respect to the interpersonal relations between the characters and not with respect to other aspects, such as which of the characters were mentioned in this sentence and which were not.

In the following, the manipulation of all independent variables is illustrated with example texts. In doing this, the Dutch materials are presented with their free translations, except for the target sentence, which is also translated literally. The designation of the conditions will be abbreviated from now on. For example, the term *NP_S_NP-condition* refers to the condition in which situational knowledge supports an NP-coordination, the factor SV-agreement supports an S-coordination (i.e. always) and the target sentence turns out to be an NP-coordination. The abbreviation is made up of the first letters of the structure that was supported by the regarding factor (NP- or S-coordination) and the eventual structure of the target sentence. The characters appear in chronological order: situational knowledge is the factor that is manipulated first, the factor SV-agreement is manipulated next and finally the critical sentence is disambiguated.

Example 1: NP-context, S-verb, NP-coordination: NP_S_NP-condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat Ruben en zijn buurman Peter zoveel alcohol dronken.
(She only found it irritating that Ruben and his neighbor Peter drank so much alcohol.)

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- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.
(When they opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en ze keek hen met boze ogen aan.
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG} to see in another beer, and she looked them with angry eyes at.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, and she looked at them with angry eyes.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

Sentence (3) of example (1) states that Ellen finds both Ruben and Peter annoying. Therefore it supports the immediate analysis of the target sentence (sentence (5)), which is temporarily structurally ambiguous between an S- and an NP-coordination, as an NP-coordination. After all, on the basis of the information in sentence (3), it is highly plausible that Ellen is fed up by the attitude of both Peter and Ruben, leading to an NP-coordination.

The factor SV-agreement was manipulated again by altering the number of the RC verb. In this example, the singular RC verb (*leek (appeared_{SG})*) indicates that its content concerns only Ruben, supporting an S-coordination analysis of the target sentence. The target sentence eventually (i.e. at *keek (looked)*) turns out to be an NP-coordination, so only situational knowledge supports the correct analysis of the critical sentence.

Example 2: NP-context, S-verb, S-coordination: NP_S_S-condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.

- (She had a very good time.)
- (3) Ze vond het alleen vervelend dat Ruben en zijn buurman Peter zoveel alcohol dronken.
(She only found it irritating that Ruben and his neighbor Peter drank so much alcohol.)
- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.
(When they opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, deed alsof hij haar niet hoorde..
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG} to see in another beer, pretended as if he her not heard.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, pretended not to hear her.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

In this example text, situational knowledge biases towards an NP-coordination, whereas SV-agreement biases towards an S-coordination. However, in this case the target sentence turns out to be an S-coordination, so only the factor SV-agreement supports the correct analysis of the target sentence.

Example 3: S-context, S-verb, NP-coordination: S_S_NP-condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.
(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)
- (2) Ze had het erg naar haar zin.
(She had a very good time.)
- (3) Ze vond het alleen vervelend dat Rubens buurman, Peter, zoveel alcohol dronk.

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(She only found it irritating that Ruben's neighbor, Peter, drank so much alcohol.)

- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.

(When they opened the umpteenth beer, she decided to say something about it.)

- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, en ze keek hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SC} to see in another beer, and she looked them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SC} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

(After this collision, Ellen decided to just ignore them.)

Sentence (3) of this experimental text states that Ellen is annoyed by the behavior of Peter only. Based on this information, it is highly plausible that readers immediately choose to analyze the target sentence as an S-coordination. After all, for the reader, there is no reason to assume that Ellen is fed up with the attitude of Ruben as well, as in case of an NP-coordination analysis, making it more sound to analyze *Ruben* as a new topic of the sentence, as in case of an S-coordination.

Besides situational knowledge, the factor SV-agreement biases towards an S-coordination as well, but the target sentence turns out to be an NP-coordination. Therefore, neither situational knowledge, nor SV-agreement supports the correct structure of the target sentence.

Example 4: S-context, S-verb, S-coordination: S_S_S-condition

- (1) Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen.

(Ellen had a party together with her boyfriend Ruben on the occasion of their birthdays.)

- (2) Ze had het erg naar haar zin.

(She had a very good time.)

- (3) Ze vond het alleen vervelend dat Rubens buurman, Peter, zoveel alcohol dronk.
(She only found it irritating that Ruben's neighbor, Peter, drank so much alcohol.)
- (4) Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen.
(When they opened the umpteenth beer, she decided to say something about it.)
- (5) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, deed alsof hij haar niet hoorde.
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG} to see in another beer, pretended as if he her not heard.
(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, pretended not to hear her.)
- (6) Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.
(After this collision, Ellen decided to just ignore them.)

In this example, both situational knowledge and SV-agreement support the correct structure of the target sentence, i.e. an S-coordination.

5.3.2 Method

Participants

Forty-one students, mostly at the Faculty of Humanities or the Faculty of Social and Behavioral Sciences of Utrecht University, participated in the experiment. Thirty-eight of them were female, three of them were male and the mean age of all participants was 22 years (range from 18 to 41 years). They were paid 6 euros for their participation. None of the participants took part in any of the experiments 4 up to and including 7 and all were naïve as to the purpose of the experiment. For technical reasons concerning the registration of the eye movements, all participants had normal uncorrected vision or wore contact lenses.

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Materials

Participants were presented with twenty-two experimental texts, resembling the ones presented in the above, and twenty-five filler items (see Appendix 11 for all experimental texts). The experimental items were selected from the set of experimental materials that was used in Experiment 7. The filler texts closely resembled the experimental texts. One difference was that all fillers contained the plural version of the RC verb (*leken* (*appear_{PL}*)), because all experimental items contained the singular form of this verb. Three of the filler texts were NP-coordinations, so that there were also some NP-coordination sentences that contained the plural form of the verb *appear* besides the experimental NP-coordinations that contained the singular form of the verb. There were no S-coordinations with the plural form of the verb *appear*, as this would produce an ungrammatical sentence. The other twenty-two filler items contained constructions with other connectives, like *omdat* (*because*) and *maar* (*but*) (see section 4.6.3 for examples). Fourteen of the filler items contained a context that was supportive of an NP-coordination and eleven contained a context that was supportive of an S-coordination.

Design

Research has shown that the power of an experiment increases with the number of texts that is used (see e.g. Mulder, 2008). More specifically, if the independent variable has a small effect on the dependent variable, this effect is unlikely to be established in the experiment if only 5 or 6 texts per condition are used. Therefore, in order to reach a significant experimental power, subjects need to read as many texts as possible. Hence, a within-subjects design was used in which participants read 11 experimental texts in two of the four conditions only. All possible combinations of conditions were used, i.e. six in total. The selection of texts that appeared together in the same condition was randomly determined for each list. These lists were counterbalanced as well.

The experiment started with a practice session comprised of three filler items. After this, the materials were presented in four blocks of ten or twelve texts, with the same number of filler items as experimental items. Which of the experimental items appeared together in a block was determined randomly. Three lists were constructed, with different

random orders of items for each block. The materials were presented semi-randomly: every experimental item was alternated with a filler item and each block started with a filler item, but which experimental or filler text appeared at what time was determined randomly. The fillers were distributed in such a way that there was a proportional distribution of texts with NP- S-contexts.

Two of the possible combinations of conditions yielded a set of experimental items containing only texts with NP-contexts (namely if the NP_S_NP-condition and the NP_S_S-condition were combined) or only texts with S-contexts (namely if the S_S_NP-condition and the S_S_S-condition were combined). In order to improve the distracting effect of the fillers, the context of three fillers was changed from being supportive of an NP-coordination to being supportive of an S-coordination in the former case and the other way around in the latter case.

One line of text on the screen corresponded to sixty-one characters at the most. The materials were presented using a black non-proportional font on a white background. The critical regions never appeared at the end or beginning of a line, so that the fixation durations at these regions could not be influenced by the time it took participants to move their eyes from the end of a line to the beginning of the next line. Another reason to avoid critical regions at the end or beginning of a line is that the first fixation on a line tends to be longer than the other fixations, and the last tends to be shorter (Heller, 1982; Rayner, 1977 and Rayner 1978b, all as described in Rayner 1998).

Apparatus

The SMI EyeLink System was used, which consists of two computers and a headset. The EyeLink system samples the positions of both eyes at 250 Hz using IR video based tracking technology. It has an eye position tracking range of 30 degrees horizontally and 20 degrees vertically and a gaze position accuracy of 0.5 to 1.0 degrees. Viewing distance was approximately 70 cm. The experiment was run using the experimentation software FEP (Veenker, 2006).

Procedure

Participants were tested individually in a session of approximately thirty minutes. Before participating in the experiment, participants' dominant

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eye was determined.¹ Even though both eyes were tracked, only the eye movements of this eye were recorded.

Subsequently, participants were instructed that some short texts would be presented to them, which they had to read at their normal speed. They were asked to keep their head as still as possible and to avoid blinking as much as possible during the actual reading of the texts.

After the instruction, the head set was fitted and a calibration routine was practiced, consisting of nine points, by means of which screen positions could be determined. This routine was repeated at the beginning of each of the other three blocks. If the calibration was deemed satisfactory, the experiment proceeded. If not, the head set was adjusted until the calibration was deemed good enough.

All texts were presented to the participants in their entirety. The presentation of each text was preceded by an asterisk, indicating the exact starting point of the first character of the text.

After each text, participants had to verify a statement concerning the text, by pressing either a button labeled *correct* or *incorrect*. The purpose of this task was to stimulate participants to read the texts thoroughly. Various aspects of the texts were questioned.

5.3.3 Hypotheses

For purposes of analysis, all target sentences were divided into regions of one or more words, as in example (1) in case of an NP-coordination and in example (2) in case of an S-coordination²:

(1) NP-coordination:

Ellen / zei / te balen van / de houding van / Peter / *en Ruben*_{C1} /
die totaal / geen / kwaad / *leek*_{C2} / te zien / in nog een / biertje, /
*en zec*₃ / *keek hen*_{C4} / met boze ogen / aan.

¹ Participants' dominant eye was determined by asking them to place a finger in front of their head, parallel to a vertical line that was drawn on a piece of paper. Then they were asked to close their eyes one at the time and tell if the vertical line changed position at any time. The eye that was kept closed during the position change of the vertical line was dominant.

² The subscript *C1* indicates that the segment *and Ruben* was the first critical position of the target sentence. The subscript *C1+1* for instance indicates that the regarding segment is the first segment after the first critical region, et cetera.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} /, who totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / and she_{C3} / looked them_{c4} / with angry eyes / at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

(2) S-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} / die totaal / geen / kwaad / leek_{c2} / te zien / in nog een / biertje, / deed_{c3} / alsof_{c4} / hij / haar / niet hoorde.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} / who totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / pretended_{c3} / as if_{c4} / he / her / not heard.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG} not seem to see any harm in having another beer, pretended not to hear her)

The regions of analysis were approximately the same as in Experiment 7, although not entirely. Some really short words, like *and*, were added to the next word, as in the case of *en Ruben* (*and Ruben*). This was done because these small words were expected to be skipped in the majority of cases. No words were put together that were critical with respect to different predictions.

Obviously, the main hypothesis was that situational knowledge would immediately affect the initial analysis of the NP-/S-coordination ambiguity. More specifically, the following hypotheses were formulated.

Hypotheses for critical position 1: the ambiguous NP

The first location in the sentence where the effect of situational knowledge was expected to become clear was at *en Ruben_{C1}* (*and Ruben*). *Ruben* is the first word where participants could anticipate the structure of the target sentence: is it plausible to take Peter and Ruben together, or not? In the S-context participants were expected to initially analyze the target sentence as an S-coordination. Therefore, arriving at *Ruben*, they would have to wrap up the first (sub)clause of the sentence and start the structure of a new one (with *Ruben* as its topic). In the NP-context, readers were expected to initially analyze the target sentence as an NP-

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coordination. In this case, *Ruben* is embedded in the structure as part of a complex object NP (*Ellen zei te balen van de houding van [Peter en Ruben]* (*Ellen said that she was fed up with the attitude of [Peter and Ruben]*)).

Assuming that these processes of wrapping up a (sub)structure and initiating a new one taxes the processing system, this is expected to result in longer reading times when situational knowledge supported an S-coordination (the S_S_S-condition and S_S_NP-condition) than when it supported an NP-coordination (the NP_S_S-condition and NP_S_NP-condition).

Hypotheses for critical position 2: the RC verb

The second critical region is the RC verb (*leek_{C2} (appeared_{SC})*). Because the number of the RC verb was singular in all conditions, the factor SV-agreement always strongly biased towards an S-coordination. As a consequence, participants were expected to encounter problems processing the RC verb when situational knowledge supported an NP-coordination, leading to increased fixation durations in an NP-context (the NP_S_S-condition and NP_S_NP-condition) as compared to an S-context (the S_S_S-condition and S_S_NP-condition).³

Hypotheses for critical position 3 and 4: the first two regions after the relative clause

After the relative clause, the ultimate structure of the target sentence became clear to the reader; it either developed into an S-coordination or into an NP-coordination. Therefore, the third critical position of the target sentence was the first segment after the relative clause (*en ze_{C3} (and she)* in case of an NP-coordination and *deed_{C3} (pretended)* in case of an S-coordination).

Because the critical sentences developed differently after the relative clause, not all conditions were comparable anymore. Therefore, for the final section of the target sentence (i.e. the section after the relative clause), hypotheses were only formulated with respect to the differences

³ It is important to note that a singular RC verb does not permanently rule out an NP-coordination structure of the target sentence. However, the results of Experiment 7 indicated that reading times for a singular RC verb increased in an NP-context as compared to an S-context. This result supports the idea that a singular RC verb is at least unexpected if the context supported an NP-coordination analysis and that this hampers processing.

between the two conditions in which the target sentence developed into an S-coordination on the one hand, and the two conditions in which the target sentence developed into an NP-coordination on the other hand.

By the time participants had processed the RC verb, there were two factors involved (i.e. situational knowledge and SV-agreement) that were either in accordance with each other (i.e. in the S_S_S-condition and the S_S_NP-condition) or not (i.e. in the NP_S_S-condition or in the NP_S_NP-condition). The results of Experiment 7 supported the idea that SV-agreement overruled the initial analysis of the critical sentence, as determined by situational knowledge. Therefore, as the factor SV-agreement supported an S-coordination analysis in all conditions, the target sentence was expected to be analyzed as an S-coordination in all conditions by the time the first word after the relative clause was encountered. This analysis would lead to a strong expectation for a verb to follow immediately after the relative clause. One must note however, that the continuation of the target sentence with *and she*, as was the case when the target sentence turned out to be an NP-coordination, does not permanently rule out an S-coordination analysis of the target sentence yet (see also section 4.2). This structure was only permanently ruled out at the following verb (*keek (looked)*). Still, when the strong expectation for a verb was not borne out, this was assumed to at least hamper processing. Alternatively, the expectation for a verb may have been so strong that its nonappearance was reason enough for participants to even reject their S-coordination analysis in favor of an NP-coordination analysis.

Consequently, no differences in fixation durations were expected between the NP_S_S-condition and the S_S_S-condition on the one hand and the NP_S_NP-condition and the S_S_NP-condition on the other hand. If participants considered *keek hen_{C4} (looked them)* as the true disambiguating point of the target sentence instead of *en ze_{C3} (and she)*, the possible differences in fixation duration that were described for *en ze_{C3} (and she)* were expected to occur at *keek hen_{C4} (looked them)*.

5.3.4 Results

The registration of eye movements provides different measures of processing time. Before looking into the results of these measures, an important issue must be considered, viz. how to treat regions of text with a fixation duration of 0 msec.

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The course of action in these cases depends to a great extent on whether the skipped regions are randomly distributed across conditions. An even distribution across conditions would provide evidence for the idea that skipped regions are not meaningful. In this case, whether a region is skipped or not would be determined by chance. Hence, one could argue that the only interesting observations concern the fixation length of a word *if* it was fixated and that skipped regions must therefore be ignored. In other words, a fixation duration of 0 ms is interpreted as no fixation (no observation) and therefore not of interest.

On the other hand, if the proportion of skipped regions is unevenly distributed across conditions, this may indicate that whether a region is skipped or not depends on the experimental manipulation. It appears that readers had the opportunity to fixate a word, but for reasons related to the manipulation decided not to. This would provide evidence for the idea that skipped regions must be considered meaningful observations and must therefore be included in the statistical analyses. More specifically, omitting these cases leaves one with data that are disproportionately distributed among the conditions as well. As a consequence, the results cannot be interpreted unequivocally any more.

The current data

A first look at the data made clear that the cases with a fixation duration of 0 ms were not distributed evenly across the different conditions. Not considering the skipped cases is therefore no option, because the uneven distribution of the remaining data across conditions indicates a selective loss of data and this would make the remaining data hard to interpret (see e.g. Shadish, Cook & Campbell, 2002). On the other hand, including the skipped cases in the analyses as cases with a fixation duration of 0 ms might not be the best solution either, for instance because it causes a large increase of variance in the data.

An alternative approach is to calculate the proportion of cases in which readers fixate a region. This approach was followed in the current study. The underlying idea is that there is a causal relation between the probability of fixation and the difficulty of a particular piece of text: the more difficult readers find a sentence to process, the more often they fixate its words.

Because the immediate influence of situational knowledge was under investigation, the main focus was on the proportion of first-pass

fixations. One must note that whether participants encounter processing problems in a particular region or not, shows up in a different way in the first-pass fixation duration than in the proportion of first-pass fixations. In case of the first-pass fixation duration, the conclusion that a region was difficult to process is, generally speaking, based on longer average fixation durations for this region. In case of the proportion of first-pass fixations, however, the conclusion that a particular region was difficult to process because it was frequently fixated, can be drawn less easily. The reason is that the reader's conclusion that this region was difficult was drawn *after* it was fixated.

There are several reasons for readers to "decide" to fixate a particular region of text. First, they may already conclude that their expectations regarding a particular region are not confirmed via paravofeal processing from the word(s) prior to this region. Readers could for instance focus on the segment prior to the RC verb and already infer that its number is not as they expected. This could be the case if situational knowledge supported an NP-coordination and readers notice via paravofeal processing that the RC verb is singular. The fact that readers' expectation for the following region seems to be disconfirmed can make them decide to fixate it.

Second, if readers expect a piece of text to be difficult, they may be more likely to fixate it. For example, if the target sentence is an S-coordination, more laborious processes have to take place at the ambiguous NP than in case of an NP-coordination, for instance because an S-coordination requires a change of topic. Consequently, the likelihood that the ambiguous NP is fixated is higher if readers expect the sentence to be an S-coordination than if they expect it to be an NP-coordination. On the other hand, if readers strongly expect a subsequent piece of text to be relatively easy to process, they could decide to skip it. For example, if readers expect the target sentence to be an NP-coordination, they expect the RC verb to be plural. On the basis of this strong expectation, they could 'decide' to skip the verb of the relative clause, since they already think to know for sure that it will be plural, and focus more on the processing of the rest of the relative clause.

In sum, readers are more likely to fixate a region if (1) they already know through paravofeal processing that it will be difficult to process (2) they expect its processing to be difficult. The probability of first-pass fixation can therefore be considered an appropriate measure to detect the earliest

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decisions in sentence processing. After all, the decision to fixate a certain region of text has to be made even before it is actually encountered.

Encountering problems during the processing of a region of text is something that could influence the proportion of regressions that are made from this region or preceding ones as well. Therefore, this measure was used as well. In order to investigate whether a region triggered regressions, the first-pass reading time for a particular region was subtracted from the total-pass reading time. An outcome larger than zero indicated that regressions out of the region concerned were made. The pattern of the proportion of regressions was expected to resemble that of the proportion of first-pass fixations.

It should be noted that there are some other circumstances that can cause a region to be skipped. First, there can be a return sweep. This means that when readers have finished reading a line of a text and they want to go to the beginning of the next, they do this through later regions of the second line. As a consequence, even though the first region of the second line is fixated, the first-pass fixation duration of this region is 0 msec. Second, readers may skip more regions of text as they proceed.

In the current experiment, no distinction was made between these different causes for regions to be skipped. The reason is that only the skipped regions that were caused by the fact that readers expect processing to be easy were expected to be unevenly distributed among conditions.

In the next section the results are presented with respect to the proportion of first-pass fixations in a specific region and the proportion of cases in which a particular region triggered regressions. It must be noted that the proportion of fixations was based only on the question whether a particular region was fixated or not. How many times it was fixated, was not taken into consideration. The results were submitted to a multilevel analysis (see Appendix 9 for the exact model).

Statements

No differences between conditions were found in the amount of statements that were verified correctly. Therefore, there was no need to leave the data out of consideration from participants who gave wrong answers.

Results and discussion for critical position 1: the ambiguous NP

For the sake of convenience, the two different target sentences are repeated here:

(3) NP-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} /
die totaal / geen / kwaad / leek_{C2} / te zien / in nog een / biertje, /
en ze_{C3} / keek hen_{C4} / met boze ogen / aan.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} /, who
totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / and she_{C3} /
looked them_{C4} / with angry eyes / at.

(Ellen said that she was fed up with the attitude of Peter and Ruben,
who did_{SG} not seem to see any harm in having another beer, and she
looked at them with angry eyes.)

(4) S-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} /
die totaal / geen / kwaad / leek_{C2} / te zien / in nog een / biertje, /
deed_{C3} / alsof_{C4} / hij / haar / niet hoorde.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} / who
totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / pretended_{C3} /
as if_{C4} / he / her / not heard.

(Ellen said that she was fed up with the attitude of Peter and Ruben,
who did_{SG} not seem to see any harm in having another beer,
pretended not to hear her)

Upon encountering the ambiguous NP (i.e. *Ruben* in the segment *en Ruben_{C1}* (*and Ruben*)), situational knowledge was the only manipulated factor. Therefore, the two NP-context conditions on the one hand and the two S-context conditions on the other were taken together in the analysis. The first-pass and regression results are presented in Table 3. The results have been derived from the logit-scores, which are a non-linear transformation of proportions (Fienberg, 1980; Goldstein 1995). The logit-scores can be found in Appendix 12.

The results for *en Ruben_{C1}* (*and Ruben*) showed that the proportion of first-pass fixations was larger when situational knowledge was supportive of an S-coordination than when it was supportive of an NP-coordination (0,95 versus 0,89; $\chi^2 = 6.50$; $df = 1$; $p < 0.01$ one-sided). The

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regression results for *en Ruben_{C1} (and Ruben)* showed the same pattern: *en Ruben_{C1} (and Ruben)* triggered more regressions in an S-context than in an NP-context (0,19 versus 0,12; $\chi^2 = 6.59$; $df = 1$; $p = 0.01$). These results support the idea that the initial parsing decision for an NP- or an S-coordination is immediately affected by situational knowledge. As expected, building an S-coordination structure seemed to require more processing effort than building an NP-coordination structure.

Table 3: Mean proportion of first-pass fixations and regressions for the first critical region (*en Ruben_{C1} (and Ruben)*) and the preceding region (*Peter_{C1-1}*) as a function of situational knowledge.

<i>Peter_{C1-1}</i>		
NP-context	First-pass fixations	0,75
S-context	First-pass fixations	0,66
NP-context	Regressions	0,07
S-context	Regressions	0,07
<i>en Ruben_{C1} (and Ruben)</i>		
NP-context	First-pass fixations	0,89
S-context	First-pass fixations	0,95
NP-context	Regressions	0,12
S-context	Regressions	0,19

Furthermore, an effect of situational knowledge was found on the region prior to the first critical region, i.e. *Peter_{C1-1}*: the proportion of first-pass fixations was larger in case of an NP-context than in case of an S-context (0,75 versus 0,66; $\chi^2 = 9.67$; $df = 1$; $p < 0.01$). This effect is reversed to the effect that was found on *en Ruben_{C1} (and Ruben)* and difficult to explain. Possibly, readers are more likely to fixate the topic of the new clause in case of S-coordination, because this is the starting point for the remainder of the sentence, whereas they are more likely to fixate the first part of the complex object NP in case of NP-coordination.

Results and discussion for critical position 2: the RC verb

For the sake of convenience, the two different target sentences are repeated again:

(5) NP-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} /
die totaal / geen / kwaad / leek_{C2} / te zien / in nog een / biertje, /
en ze_{C3} / keek hen_{C4} / met boze ogen / aan.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} /, who
totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / and she_{C3} /
looked them_{C4} / with angry eyes / at.

(Ellen said that she was fed up with the attitude of Peter and Ruben,
who appeared_{SG} to see no harm at all in another beer, and she
looked at them with angry eyes.)

(6) S-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} /
die totaal / geen / kwaad / leek_{C2} / te zien / in nog een / biertje, /
deed_{C3} / alsof_{C4} / hij / haar / niet hoorde.

Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} / who
totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / pretended_{C3} /
as if_{C4} / he / her / not heard.

(Ellen said that she was fed up with the attitude of Peter and Ruben,
who did_{SG} not seem to see any harm in having another beer,
pretended not to hear her)

No differences were found in the proportion of first-pass fixations, nor in the proportion of regressions on *leek_{C2} (appeared_{SG})* ($\chi^2 = 0.21$; $df = 1$; $p = 0.65$; $\chi^2 = 0.52$; $df = 1$; $p > 0.05$ respectively). However, two regions prior to *leek_{C2} (appeared_{SG})*, i.e. at *geen_{C2-2} (no)*, the proportion of first-pass fixations and regressions was larger when situational knowledge supported an NP-coordination than when it supported an S-coordination (0,59 versus 0,51; $\chi^2 = 7.12$; $df = 1$; $p < 0.01$ / $\chi^2 = 8.90$; $df = 1$; $p < 0.01$ respectively; see Table 4).

These results resemble the expected effect for *leek_{C2} (appeared_{SG})*, i.e. that readers would encounter processing problems when the factor SV-agreement was not consistent with situational knowledge, i.e. in the NP-context conditions.

Could it be that upon encountering *geen_{C2-2} (no)*, participants had already paravofeally processed *leek_{C2} (appeared_{SG})*? If this were the case, participants should have decided already at *die helemaal_{C1+1} (who*

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completely) if the number of *leek*_{C2} (*appeared*_{SG}) matched their initial analysis or not. If this turned out not to be the case, they subsequently spent more first-pass fixations on *geen*_{C2-2} (*no*). Subsequently, after having fixated *geen*_{C2-2} (*no*), participants looked back in the text more often when the number of *leek*_{C2} (*appeared*_{SG}) did not correspond to their initial analysis.

Table 4: Mean proportion of first-pass fixations and regressions for the second critical position (*leek*_{C2} (*appeared*_{SG})) and two segments prior to it (*geen*_{C2-2} (*no*)) as a function of situational knowledge.

<i>geen</i> _{C2-2} (<i>no</i>)		
NP-context	First-pass fixations	0,59
S-context	First-pass fixations	0,51
NP-context	Regressions	0,16
S-context	Regressions	0,10
<i>leek</i> _{C2} (<i>appeared</i> _{SG})		
NP-context	First-pass fixations	0,47
S-context	First-pass fixations	0,49
NP-context	Regressions	0,13
S-context	Regressions	0,11

This scenario is unlikely for several reasons. First, as was already mentioned in section 5.2, readers' perceptual span extends 14-15 letters to the right. However, readers are not capable of really identifying words further away than 7-8 letter spaces to the right of the fixation. Therefore, the distance between region 3 and 6 was too big to really identify any words. One could argue that participants did not need to identify the exact contents of the RC verb, as long as they could detect if it was singular or plural. However, as the number of a Dutch verb becomes clear from its final letters, the distance between region 3 and 6 always exceeded the amount of 15 letters.

A better explanation for the results on *geen*_{C2-2} (*no*) is the following. As was described before, building an NP-coordination is initially easier than building an S-coordination. One could imagine that in case of an S-coordination, the processing of the relative clause becomes relatively

easy, after the first (sub)clause has been wrapped up and a new one has been started, because it causes a relatively small memory load (cf. the so-called rebound-effect described by Hoeks, Vonk & Schriefers, 2002). After all, the relative clause only has to be embedded in the conjoined sentence. By contrast, in case of an NP-coordination, the relative clause has to be embedded in a long, but still unfinished structure. After all, no wrapping up has taken place in this structure yet. This may very well cause the processing of the relative clause to be relatively difficult in case of an NP-coordination analysis, causing a larger proportion of first-pass fixations and regressions when situational knowledge supported an NP-coordination than when it supported an S-coordination.

However, how should one explain the absence of an effect of situational knowledge on the proportion of fixations on *leek*_{C2} (*appeared*_{SG}), an effect that was clearly present in the reading time data of Experiment 7? The data for *leek*_{C2} (*appeared*_{SG}) show that it was skipped 52% of the time. A possible explanation for this may be that *leek*_{C2} (*appeared*_{SG}) is rather short. Alternatively, participants may have felt in the majority of the cases that fixating this region was not necessary for a good understanding of the sentence. Perhaps their high expectations with respect to the number of the RC verb led them to skip it and focus more on the remainder of the relative clause.

Results and discussion for critical position 3 and 4: the first two regions after the relative clause

For the sake of convenience, the two different target sentences are repeated again:

(7) NP-coordination:

Ellen / zei / te balen van / de houding van / Peter / en Ruben_{C1} /
die totaal / geen / kwaad / *leek*_{C2} / te zien / in nog een / biertje, /
*en ze*_{C3} / *keek hen*_{C4} / met boze ogen / aan.

*Ellen / said / to be fed up with / the attitude of / Peter / and Ruben_{C1} /, who
totally / no / harm / appeared_{SG/C2} / to see / in another / beer, / and she_{C3} /
looked them_{C4} / with angry eyes / at.*

(Ellen said that she was fed up with the attitude of Peter and Ruben, who appeared_{SG} to see no harm at all in another beer, and she looked at them with angry eyes.)

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(8) S-coordination:

Ellen / zei / te balen van / de houding van / Peter / *en Ruben*_{C1} /
die totaal / geen / kwaad / *leek*_{C2} / te zien / in nog een / biertje /
*deed*_{C3} / *alsof*_{C4} / hij / haar / niet hoorde.

*Ellen / said / to be fed up with / the attitude of / Peter / and Ruben*_{C1} / *who*
*totally / no / harm / appeared*_{SG/C2} / *to see / in another / beer, / pretended*_{C3} /
*as if*_{C4} / *he / her / not heard.*

(Ellen said that she was fed up with the attitude of Peter and Ruben,
who did_{SG} not seem to see any harm in having another beer,
pretended not to hear her)

After the relative clause, the critical sentence developed into either an NP- or an S-coordination. In the S-coordination conditions, the sentence was definitively disambiguated at the first region after the relative clause (i.e. at *deed*_{C3} (*pretended*)). In the NP-coordination conditions, an S-coordination analysis became highly implausible at the first region after the relative clause (i.e. *en ze*_{C3} (*and she*)), but was only definitively ruled out at the subsequent region (i.e. *keek hen*_{C4} (*looked them*)).

The results for the first two regions after the relative clause are presented in Table 5.

Table 5: Mean proportion of first-pass fixations and regressions for the third and fourth critical position (*en ze*_{C3} (*and she*)/*deed*_{C3} (*pretended*) and *keek hen*_{C4} (*looked them*)/*alsof*_{C4} (*as if*) respectively) as a function of situational knowledge and sentence type.

		Sentence type	
		NP-coordination	S-coordination
<i>and she</i> _{C3} / <i>pretended</i> _{C3}			
NP-context	First-pass fixations	0,44	0,49
S-context	First-pass fixations	0,42	0,55
NP-context	Regressions	0,13	0,07
S-context	Regressions	0,07	0,09

		Sentence type	
		NP-coordination	S-coordination
<i>looked them_{C4}/as if_{C4}</i>			
NP-context	First-pass fixations	0,92	0,58
S-context	First-pass fixations	0,94	0,63
NP-context	Regressions	0,20	0,14
S-context	Regressions	0,18	0,09

The first-pass results for the first region after the relative clause (i.e. *en zec₃ (and she)/ deed_{C3} (pretended)*) showed no main effect of situational knowledge ($\chi^2 = .39$; $df = 1$; $p \geq 0.5$). The results did show a main effect of sentence type ($\chi^2 = 9.19$; $df = 1$; $p \leq .01$). There was a larger proportion of first-pass fixations when the sentence developed as an S-coordination than when it developed as an NP-coordination (i.e. a mean of 0,52 versus 0,43). However, this effect is hard to interpret, because the NP- and the S-coordination sentences obviously contained different words. What is of more interest is whether there was an interaction between situational knowledge and sentence type. This was not the case ($\chi^2 = 1.74$; $df = 1$; $p \geq .05$). Hence, the difference in the proportion of fixations between the NP- and the S-coordination sentences was not caused by any differences in situational knowledge. The results for the second region after the relative clause (i.e. *keek hen_{C4} (looked them)/ alsof_{C4} (as if)*) showed the same results (main effect of situational knowledge: $\chi^2 = .614$; $df = 1$; $p \geq .05$; main effect of sentence type: $\chi^2 = 57.86$; $df = 1$; $p \leq .001$; interaction effect between situational knowledge and sentence type: $\chi^2 = .02$; $df = 1$; $p \geq .05$, respectively).

The results for the first region after the relative clause regarding the proportion of regressions showed no significant effects ($\chi^2 \leq 2.60$; $df = 1$; $p \geq .05$). The results for the second region after the relative clause showed a main effect of sentence type ($\chi^2 = 7.72$; $df = 1$; $p \leq .01$). There was a larger proportion of regressions when the sentence developed as an NP-coordination than when it developed as an S-coordination (i.e. a mean of 0,19 versus 0,12). No effect of situational knowledge was found, nor an interaction effect between situational knowledge and sentence type ($\chi^2 \leq 2.72$; $df = 1$; $p \geq .05$).

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In sum, no effect of situational knowledge was found on the proportion of first-pass fixations and regressions for the first two segments after the relative clause. This result and the larger proportion of regressions in case of an NP-coordination as compared to an S-coordination on the second segment after the relative clause support the idea that the factor SV-agreement outweighed the influence of situational knowledge. More specifically, the results for the first two critical regions of the target sentence indicated that situational knowledge immediately affected the initial analysis of the target sentence. However, the factor SV-agreement, which biased towards an S-coordination analysis in all cases, appears to have triggered this initial analysis to be rejected (if necessary) in favor of an S-coordination. This leads to the situation in which the target sentence was being analyzed as an S-coordination by the end of the relative clause in all conditions. This explanation is in accordance with the results of Experiment 7.

5.3.5 General conclusion

The results regarding the first-pass fixations and regressions largely confirm the results of Experiment 7. Situational knowledge was found to have an immediate impact on the initial analysis of the target sentence. The first position in the target sentence where this effect was found was the region containing the ambiguous NP *Ruben*. At this position participants had to choose between an NP- and an S-coordination analysis. Initially analyzing the target sentence as an S-coordination was found to be a more elaborate process than analyzing it as an NP-coordination: there was a larger proportion of both first-pass fixations and regressions on *and Ruben_{C1}* when situational knowledge supported an S-coordination than when it supported an NP-coordination. The first-pass results also spilled over onto the next region (*die helemaal_{C1+1}* (*who completely*)).

Analyzing the proportions of fixations provided even stronger support for the hypotheses that situational knowledge *immediately* affected the initial analysis of the sentence than the analysis of the fixation durations may have. After all, the inference that more laborious processes would have to take place in one condition (i.e. in the S-context) than the other (i.e. in the NP-context), already had to be drawn by participants prior to actually fixating the regarding region. In contrast, how long a region has

to be fixated in order to process it properly is something that is a function of the actual processing.

The alternative explanation for the results of Experiment 7, viz. that they would be caused by situation model priming, was ruled out in the current experiment, because the manipulation of situational knowledge was changed such that the names *Peter* and *Ruben* appeared close to each other in both the NP- and the S-context. Therefore, the current results provide further evidence that situational knowledge immediately affects the parsing process.

Evidence that situational knowledge immediately affects parsing was found in the relative clause as well. It seemed that processing the relative clause was relatively easy when situational knowledge supported an S-coordination. This can be explained from the assumption that participants had already wrapped up the first (sub)clause of the sentence and started a new one when they chose to analyze it as an S-coordination. As a consequence, upon encountering the relative clause, they had to integrate it with a relatively small part of the preceding sentence. In case of an NP-coordination analysis, on the other hand, no wrapping up had taken place yet. As a consequence, participants had to integrate the relative clause with the entire preceding sentence, which cost a relative large amount of processing resources.

The results after the relative clause supported the idea that the factor SV-agreement outweighs the influence of situational knowledge. The singular form of the RC verb appears to have triggered the reanalysis of the initial analysis of the critical sentence (if necessary). This result confirms the results of Experiment 7 as well.

Even though the statistical analyses showed significant results, the effect size of the results regarding the proportion of fixations was rather small. This means that the distribution of the fixations among the different conditions strongly overlapped. More specifically, the proportion of fixations was also influenced by other factors than the ones that were manipulated in the current study.

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Summary and conclusions

6.1 Introduction

The aim of the current study was to investigate whether non-syntactic factors immediately affect parsing. Syntactic ambiguity was used as a window on the parsing process. In particular, the NP-/S-coordination ambiguity was investigated. The non-syntactic factor under investigation was situational knowledge, i.e. readers' knowledge about the state of affairs described in the text.

The question whether non-syntactic factors have an immediate impact on parsing has been investigated many times before. However, the current study investigated an important aspect of world knowledge, which was hardly investigated before: the influence of situational knowledge. Furthermore, the effects of situational knowledge were registered as early as from the onset of the ambiguity, instead of only at the point of disambiguation, and it was not only investigated *whether* non-syntactic factors immediately affect parsing, but it was also aimed to gain more insight into *how* different factors interact during this process. In the following, all three issues are briefly discussed again (see also Chapter 1).

Firstly, previous research has mainly focused on the effects of lexical semantics and referential context on parsing, whereas the effects of the wider discourse context have received very little attention (see Chapter 1). Outstanding research that did investigate discourse effects on sentence processing was conducted by Van Berkum, Hagoort & Brown (1999), Van Berkum, Zwitterlood, Hagoort and Brown (2003) and Altmann, Van Nice, Garnham and Henstra (1998; see also section 1.3.3 and 1.3.4). In the experiments of Van Berkum and his colleagues, an attribute of one of the characters as mentioned in the discourse context was contradicted in the target sentence. If, for example, a certain character was described as being slow at first, it was described as being quick in the target sentence. The results showed that readers relate the developing sentence very rapidly to the wider discourse very rapidly. Altmann et al. investigated whether embedding directive questions in

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the discourse context could modulate the low attachment-preference that is subscribed to late closure. The results showed that usually this was indeed the case.

Even though these experiments showed rapid effects of discourse context on sentence processing, they differ from the current study in several respects. First, both Van Berkum et al. and Altmann et al. directed readers' attention by explicitly contradicting information from the critical sentence with information from the preceding discourse context or by embedding questions in the context that specifically directed readers' attention. In the current study, the relevant knowledge was provided to readers in a more subtle and perhaps more natural way. The manipulation of situational knowledge approximates to the situation you would expect to see in normal texts, and is therefore highly ecologically valid. Second, Van Berkum et al. manipulated one aspect of the discourse context, whereas the situational knowledge manipulation that was used in this thesis concerned knowledge about the interpersonal relationships that are described throughout the entire text. Readers must have formed a good situation model representation of the entire discourse in order to gain the proper situational knowledge.

In fact, situational knowledge can be considered a factor that goes beyond discourse. It can be considered a specific type of episodic knowledge, which refers to people's knowledge about events. This knowledge is usually acquired through taking part in these events, witnessing these events in real life or through media or by hearing or reading about them. In the present study, it was obtained through reading a short text. Hence, situational knowledge can be considered a type of world knowledge rather than a mere discourse factor.

A study by Hagoort, Hald, Bastiaansen and Petersson (2004) also investigated the effects of world knowledge on sentence interpretation. They looked at sentences such as *The Dutch trains are yellow/white/sour*. The sentence with *yellow* is true in all respects (Dutch trains are yellow). However, the sentence that contains *white* is correct from a linguistic point of view, but not with respect to one's world knowledge regarding Dutch trains. Finally, the sentence with *sour* contains a violation of semantic constraints (the feature of being *sour* does not apply to trains). Results from an EEG and fMRI experiment showed that while reading a sentence, the semantic interpretation of a sentence and the integration of

world knowledge occur at the same time instead of being two separate processes.

The current study complements this knowledge in two ways. First, by showing that not only (semantic) world knowledge that is already available to readers has an immediate impact on sentence processing, but that this process is also immediately affected by world knowledge that was not available prior to reading a text, but that is acquired through the reading of a text. Second, by showing that this type of knowledge immediately affects the parsing process. Whereas Altmann et al. did investigate the parsing process, Van Berkum et al. and Hagoort et al. investigated more general processes of sentence interpretation. Secondly, previous research often focused solely on the effects of a non-syntactic factor on the point of disambiguation. Reading time results for this position in the sentence have often been interpreted in favor of an interactive account of parsing. However, in general results for the disambiguating point in a sentence cannot exclude the possibility of a syntax-first account of parsing: readers could have selected one possible analysis on the basis of syntax-based strategies at the onset of the ambiguity and subsequently revised it on the basis of other (non-syntactic) information prior to the point of disambiguation. In order to gain more decisive results, effects of situational knowledge were already investigated from the onset of the ambiguity. The NP-/S-coordination ambiguity is very suitable for doing this, because of the differences in processing load between both structures that are expected at this position of the sentence.

Thirdly, previous research often only investigated whether non-syntactic factors immediately affect parsing, whereas the current study aimed to gain a further insight in how different factors interact during this process as well. In order to do this, the influence of situational knowledge was not only investigated in isolation, but also in contrast to the influence of a second factor to either support an NP- or an S-coordination, viz subject-verb agreement.

Before the experimental results are summarized, the manipulation of situational knowledge and subject-verb agreement is briefly summarized once more gone over again (section 6.2). On the basis of the summary of the results in section 6.3, some general conclusions are drawn in section 6.4. Finally, some issues regarding the generalization of the results are discussed in section 6.5.

6.2 Operationalization

The main factor under investigation was situational knowledge, which referred to the prior knowledge regarding the state of affairs described by a text. This knowledge was provided to readers by means of discourse context. Consider the following example of a critical sentence, in which the NP *Ruben* is ambiguous between being part of the complex object NP *the attitude of Peter and Ruben* (i.e. an NP-coordination) and being the subject/topic of the conjoined sentence (i.e. an S-coordination):

- (1) Ellen zei te balen van de houding van Peter en Ruben luisterde aandachtig naar haar woorden. (S-coordination)
Ellen said to be fed up with the attitude of Peter and Ruben listened to her words attentively.

If situational knowledge was supportive of an NP-coordination, it was plausible on the basis of the preceding discourse context that Ellen was annoyed by the attitude of both Peter and Ruben. When readers would immediately take this information into account in determining the initial analysis of the sentence, this would produce an NP-coordination. On the other hand, when situational knowledge was supportive of an S-coordination, it was plausible on the basis of the preceding discourse context that Ellen was annoyed by the attitude of Peter, but not of Ruben. Immediately taking into account this knowledge would produce an S-coordination analysis of the sentence (see e.g. section 4.2 for further details).

In addition to investigating the effects of situational knowledge in isolation, this factor was contrasted with a second one to either support an NP- or an S-coordination as well, viz subject-verb agreement (hereafter *SV-agreement*). Consider the following example:

- (2) Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek/leken te zien in nog een biertje, en ze keek hen met boze ogen aan. (NP-coordination)
Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SC/PL} to see in another beer, and she looked them with angry eyes at.

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(Ellen said that she was fed up with the attitude of Peter and Ruben, who did_{SG/PL} not seem to see any harm in having another beer, and she looked at them with angry eyes.)

In this NP-coordination, the ambiguous region is enlarged by embedding a relative clause in it. The factor SV-agreement was manipulated through the verb of this relative clause. A plural verb (*appeared_{PL}*) indicated that the content of the relative clause concerned both *Peter* and *Ruben*, which biases towards analyzing the phrase *Peter and Ruben* as part of the complex object NP *the attitude of Peter and Ruben* (i.e. an NP-coordination). In contrast, a singular verb (*appeared_{SG}*) indicated that the content of the relative clause concerned only the second proper noun *Ruben* and therefore biased against an NP-coordination analysis.

6.3 Summary of the experimental results

Before the on-line effects of situational knowledge and SV-agreement were investigated, the off-line effects of these factors were investigated. In the following sections, the results of the completion and judgment studies are summarized. Subsequently, the on-line effects of situational knowledge and SV-agreement are described (section 6.3.3).

6.3.1 Readers' expectations regarding sentence structure

Several completion studies were conducted (Experiment 1 (Chapter 3) and 4 and 5 (Chapter 4)) in order to assess readers' expectations regarding sentence structure. The critical sentence was ambiguous between an NP- and an S-coordination and was interrupted after the ambiguous NP when only situational knowledge was manipulated (i.e. *Ruben* in example (2)), or after the relative clause when both situational knowledge and SV-agreement were manipulated (i.e. after *beer*, in example (2)).

The results indicated that situational knowledge affects readers' expectations regarding sentence structure: the critical sentence was continued more often as an S-coordination in an S-coordination supportive context (hereafter: *S-context*) and more often as an NP-coordination in an NP-coordination supportive context (hereafter: *NP-context*). Furthermore, the factor SV-agreement was found to affect readers' expectations regarding sentence structure as well: the critical

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sentence was more often continued as an NP-coordination when SV-agreement supported this structure and more often as an S-coordination when SV-agreement supported that structure.

Interestingly, SV-agreement appeared to have a stronger effect on the sentence continuations than situational knowledge. This finding can be explained by the fact that situational knowledge only *supported* an NP- or an S-coordination, whereas an NP-coordination was *obligatory* when SV-agreement supported this structure (i.e. in case of a plural relative verb; see section 4.2). In addition, the fact that SV-agreement was manipulated closer to the interruption point of the critical sentence than situational knowledge (i.e. a couple of words versus two sentences prior to the interruption point) may also have played a role.

6.3.2 Readers' perception of sentence structure

Readers' judgments of the perceived complexity, plausibility and naturalness of S-coordinations (Experiment 2 (Chapter 3)) and NP-coordinations (Experiment 6 (Chapter 4)) were investigated as well. The *easiness-scale* assessed participants' estimation of the general understandability of the target sentence, the *plausibility-scale* assessed participants' estimation of the plausibility of the critical sentence within the discourse context (i.e. it mainly focused on its meaning), whereas the *naturalness-scale* assessed participants' estimation of the structure of the sentence (i.e. it mainly focused on its structural properties).

In Experiment 2, only the effects of situational knowledge were investigated. The results indicated that situational knowledge affects readers' perception of a sentence after reading: judgments were higher on all scales when situational knowledge was supportive of the correct structure of the target sentence.

In Experiment 6, the effects of both situational knowledge and SV-agreement were investigated. The perceived easiness of the critical sentence was expected to be affected by both situational knowledge and SV-agreement. Its perceived plausibility was expected to be most strongly affected by situational knowledge, because this factor mainly focused on the meaning of the sentence. Finally, the perceived naturalness of the critical sentence was expected to be most strongly affected by SV-agreement, because this factor reflected a structural property of the critical sentence.

The results indeed showed the expected interaction between situational knowledge and SV-agreement. This finding confirms the idea that the perception of different aspects of a sentence (i.e. its meaning and its structure) are differently affected by both factors and that the different scales indeed reflected different aspects of processing.

6.3.3 The on-line effects of situational knowledge and SV-agreement

The main purpose of the current study was to investigate the on-line effects of situational knowledge, both in isolation and as opposed to the effects of SV-agreement. Both S-coordinations (Experiment 3 and 8) and NP-coordinations (Experiment 7 and 8) were investigated, using either a moving window self-paced reading paradigm (Experiment 3 and 7) or the registration of eye movements (Experiment 8).

In Experiment 3, the influence of situational knowledge on the processing of S-coordinations was investigated. The results showed a facilitating effect of situational knowledge, but this effect appeared two words after the onset of the ambiguity. As a consequence, the results could be reconciled with both a syntax-first and an interactive account of parsing.

In order to attain clearer results, some alterations in the design of the materials were made. In particular, the materials were redesigned in such a way that effects of situational knowledge during the initial analysis of the sentence could be distinguished better from effects of this factor during later stages of analysis (i.e. reanalysis). This was done in Experiment 7 and 8.

In order to investigate the on-line effects of situational knowledge and its interaction with other factors more precisely, the influence of this factor was also opposed to the influence of a second factor, viz SV-agreement. This was only done in Experiment 7; in Experiment 8 SV-agreement supported an S-coordination in all cases.

In Table 1, the results of Experiment 7 and 8 are presented schematically. This is done by means of the following examples of an NP- and an S-coordination:

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(3) Example from Experiment 7:

Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek/leken te zien in nog een biertje, en ze keek hen met boze ogen aan.

Ellen said to be fed up with the attitude of Peter and Ruben_{C1}, who totally no harm appeared_{SG/PL} to see in another beer, and she looked them with angry eyes at.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who appeared_{SG/PL} to see no harm at all in another beer, and she looked at them with angry eyes.)

(4) Example from Experiment 8:

Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, deed alsof hij haar niet hoorde. (S-coordination)

Ellen said to be fed up with the attitude of Peter and Ruben, who totally no harm appeared_{SG} to see in another beer, pretended not to hear her.

(Ellen said that she was fed up with the attitude of Peter and Ruben, who appeared_{SG} to see no harm at all in another beer, pretended not to hear her.)

Table 1 Summary of the results of Experiment 7 and 8.

Note: The phrase FP-fixations is an abbreviation of first-pass fixations.

<i>Position</i>	<i>Results</i>	<i>Conclusion</i>
<i>(en) Ruben_{C1}</i> <i>((and)</i> <i>Ruben_{C1})</i>	Faster reading times / fewer FP-fixations* and regressions when situational knowledge supported an NP- than when it supported an S-coordination.	Situational knowledge determines initial analysis: building an NP-coordination is easier than building an S-coordination.
<i>geen_{C2-2}</i> <i>(no_{C2-2})</i>	Fewer FP-fixations and regressions in S-context than NP-context.	Situational knowledge determined initial analysis: relative clause has to be embedded in the entire preceding sentence in case of an NP-coordination, whereas it has

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<i>Position</i>	<i>Results</i>	<i>Conclusion</i>
		to be attached into the conjoined sentence in case of an S-coordination.
<i>te zien</i> _{C2+1} (<i>to see</i> _{C2+1})	Faster reading times when SV-agreement was in accordance with situational knowledge. When SV-agreement and situational knowledge were not in accordance with each other: longer reading times in case of a plural RC verb than a singular RC verb.	Situational knowledge determined initial analysis. SV-agreement had a stronger effect when it <i>demand</i> ed one of the possible structures of the critical sentence (i.e. an NP-coordination in case of a plural RC verb) than when it only <i>support</i> ed one of both possible structures (i.e. an S-coordination in case of a singular RC verb).
<i>en</i> _{C3} . <i>hen</i> _{C4+1} (<i>and</i> _{C3-} <i>them</i> _{C4+1})	Faster reading times when SV-agreement supported the true structure of the target sentence. (In Experiment 7, SV-agreement either supported an S- or an NP-coordination).	SV-agreement overruled the initial analysis of the sentence, as determined by situational knowledge.
<i>en ze</i> _{C3} . <i>keek</i> <i>hen</i> _{C3+1} (<i>and she</i> _{C3-} <i>looked</i> <i>them</i> _{C3+1}) / <i>deed</i> _{C3 -} <i>alsof</i> _{C3+1} (<i>pretended</i> _{C3-as} <i>if</i> _{C3+1})	No differences in the proportion of FP-fixations and regressions between the conditions in which the critical sentence developed as an NP-coordination and idem for the conditions in which the critical sentence developed as an S-coordination. (In Experiment 8, SV-agreement always supported an S-coordination).	SV-agreement overruled the initial analysis of the sentence, as determined by situational knowledge.

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<i>Position</i>	<i>Results</i>	<i>Conclusion</i>
<i>ze</i> _{C3+1} - <i>hen</i> _{C4+1} (<i>she</i> _{C3+1} - <i>them</i> _{C4+1})	Faster reading times when situational knowledge supported the correct structure of the target sentence.	Situational knowledge facilitates reanalysis (if necessary)

6.4 General conclusions

6.4.1 The on-line effects of situational knowledge and SV-agreement

The main conclusion that can be drawn from the present on-line results is that situational knowledge has an immediate impact on the initial analysis of a sentence. This implies that the parsing process is immediately affected by a non-syntactic factor that is often even considered extra-linguistic. It should be stressed that this effect of world knowledge does not concern long-existing world knowledge, but rather world knowledge that has been acquired by processing the immediate preceding discourse context. This contributes to a picture of parsing as a highly interactive process that dynamically integrates various sources of information provided by the text.

The fact that the expected differences in the proportion of first-pass fixations were found at the onset of the ambiguity as well, provides even stronger evidence for the immediate impact of situational knowledge. This can be explained by the fact that building an S-coordination is assumed to be more elaborate than building an NP-coordination. As a consequence, participants were expected to fixate the first word of the ambiguity more often if they initially analyzed it as an S-coordination. Since the “decision” to fixate a word or not has to be made *prior* to actually fixating it, the first-pass results reflect an even earlier effect of situational knowledge, thereby providing even stronger support for the immediate effects of this factor than the reading time results did.

The results for the part of the critical sentence after the relative clause supported the idea that the factor SV-agreement overruled the initial analysis of a sentence as determined by situational knowledge. The results indicated that this was both the case when SV-agreement only *supported* a certain analysis of the critical sentence (i.e. an S-coordination in case of a singular relative verb) and when it *demand*ed a certain analysis (i.e. an NP-coordination in case of a plural relative verb). In both

conditions, the morpho-syntactic information of the verb appeared strong enough to make participants reanalyze their initial parse. If this analysis still turned out to be incorrect later on, situational knowledge was deployed again to facilitate the process of reanalysis, as indicated by the results from the second segment after the relative clause on.

6.4.2 When do different factors interact during parsing?

In Chapter 1, an overview of some of the most prominent theories of sentence processing was presented (see Table 2 below). In this section it is described where exactly on a scale between strict modularity and strong interaction the present results fit in.

Table 2 The most prominent theories of sentence processing and their claims

<i>Theory</i>	<i>Claim</i>
Syntax-first approach (for instance the garden path model Frazier, 1987a)	Sentence processing consists of minimally two stages, organized into two different processing modules: a syntactic processor and a thematic processor. The syntactic processor initially constructs one possible structure on the basis of syntax-based parsing strategies, without any top-down influence of non-syntactic factors. In the next stage, the thematic processor evaluates the proposed structure with regard to semantic and pragmatic plausibility and, if necessary, proposes an alternative structure.
Referential theory (see, for instance, Crain & Steedman, 1985)	Referential theory allows for a closer interaction between syntactic and semantic/referential modules than the garden path model (i.e. on a word-by word basis). The theory gives a special status to referential/discourse factors and claims that several possible structures are offered in parallel for evaluation instead of only one (syntax proposes and discourse disposes).

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<i>Theory</i>	<i>Claim</i>
Constraint-based models (see, among many others, MacDonald, 1994; Spivey-Knowlton & Sedivy, 1995; Spivey & Tanenhaus, 1998)	The basic features of constraint-based models are that (1) the most likely alternative syntactic analyses of a sentence are activated in parallel, (2) multiple sources of information provide evidence for these alternatives and (3) the alternatives compete until the most supported one remains.
Strong interactive models (see, for instance, Grodner, Gibson and Watson (2005))	Non-syntactic factors co-determine (guide) the initial analysis of a sentence, instead of only help to evaluate alternatives that are proposed on the basis of syntax-based parsing strategies.

The results of the current study do certainly not support a syntax-first approach, since clear evidence was found to show that situational knowledge immediately affects parsing. Also, the data do not speak in favor of the referential theory, because this theory focuses on the effects of the referential context and not on effects of factors such as situational knowledge. What about the constraint-based and the strong interactive approach to parsing?

A basic assumption of constraint-based models is that multiple possible analyses compete for activation in parallel and that all available sources of information provide evidence for these alternatives until one remains (see section 1.2.3.2). According to one constraint-based model, i.e. the competition-integration model, competition between alternatives is short-lived if one possible analysis is strongly favored by all constraints and long(er)-lived if different possible analyses receive approximately equal support, because in this case it takes longer for one analysis to reach the threshold necessary to get selected (see e.g. Spivey & Tanenhaus, 1998; McRae, Spivey-Knowlton and Tanenhaus, 1998).

The results for the ambiguous NP (*Ruben*) showed an increase in reading times and in the proportion of first pass fixations and regressions if situational knowledge supported an S-coordination as compared to an

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NP-coordination. As explained before, this result is believed to be caused by the fact that situational knowledge determined the initial analysis of the critical sentence and that an S-coordination is more difficult to build than an NP-coordination. This result can be explained by a constraint-based model as well.

However, an additional explanation for the results may be the following. If both the NP- and the S-coordination analyses competed for activation and situational knowledge was supportive of an S-coordination, competition would have been relatively severe, because both minimal attachment and the topic structure principle were always supportive of the alternative NP-coordination analysis. If, on the other hand, situational knowledge supported an NP-coordination as well, competition between an NP- and an S-coordination analysis would have been rather short-lived, because all available sources of information biased towards the same structure. This would lead to shorter reading times and fewer fixations in this condition as compared to the former one. As this is exactly what the results showed, the results fit into a constraint-based model of parsing very well indeed.

A strong interactive approach of parsing can account for the results for the ambiguous NP as well. According to this approach, the most suitable analysis of the sentence is constructed immediately on the basis of all relevant constraints, including situational knowledge. In other words, upon encountering the ambiguous NP, the NP- and S-coordination alternatives were not activated simultaneously and evaluated in parallel, as argued by the constraint-based approach, but rather, only the most suitable initial analysis was immediately activated. Hence, according to the results, an S-coordination was immediately constructed if situational knowledge supported this structure and an NP-coordination if situational knowledge supported that structure. This, as expected, led to increased reading times of the ambiguous NP in the former condition.

An example of a serial, interactive model that allows for non-syntactic factors to affect the initial parse of a sentence is the so-called *variable-choice reanalysis model* (or *probabilistic serial model*; see e.g. Lewis, 2000; see section 1.2.4). This model predicts that in case of a syntactic ambiguity, the analysis is pursued that is supported most by information sources prior to the ambiguity: the stronger the support for a particular analysis, the more likely it is that it will be adopted. If two alternative analyses receive equal support, the model predicts that each of them is adopted

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approximately half of the time. In this case, another possibility would be that both alternatives remain activated until there is enough evidence to pursue just one of them.

Even though the results of this thesis strongly favor an interactive model of parsing, a syntax-first account of parsing may possibly, however unlikely, account for the present results. In particular, one may argue that if (1) the activation of both the NP- and the S-coordination analysis, (2) the competition between these two alternatives and (3) the selection of the most suitable analysis, could take place in such a short time span, then perhaps the (modular) process of (1) selecting one analysis on the basis of syntax-based strategies, (2) evaluating it on the basis of all other available sources of information, including situational knowledge, and (3) (if necessary) adopting an alternative analysis, could take place in this short time span as well. This could account for the fact that reading times of the ambiguous NP increased if situational knowledge supported an S-coordination as well. In fact, in this condition, the initial NP-coordination analysis was immediately rejected in favor of an S-coordination. According to this idea of very fast reanalysis, which is generally supported among proponents of modularity, a syntax-first model could account for the current results.

However, one can come up with good reasons to consider an interactive interpretation of the results more appropriate than a modular one. First, even though possible, it seems implausible that readers choose an initial analysis of a sentence to reject this analysis immediately afterwards (i.e. during the processing of the same word). It seems more likely that the initial analysis is evaluated and if necessary revised during the word(s) to follow. Second, if one supports the idea that different models of parsing can account for certain results, the most economical model should be adopted. Put differently, a model that predicts (1) an initial analysis on the basis of syntax-based strategies and (2) a reanalysis on the basis of all other relevant constraints can be considered less economical than a model that predicts that all relevant constraints immediately affect the initial analysis of the sentence. Hence, for the current results the most economical model would be one in which non-syntactic factors immediately affect the initial analysis of a sentence and, even more, a model in which all available sources of information guide the initial construction of the initial analysis rather than help to evaluate different possible structures.

In the current study, like in many other experiments, the course of processing was inferred by comparing the processing of the two alternatives of a syntactic ambiguity. This comparison has produced some interesting results. However, additional research is needed in order to obtain results that provide stronger evidence for either a constraint-based or a strong interactive model of parsing. One example of how this can be accomplished may be to compare the processing of temporarily ambiguous S-coordinations with their unambiguous counterparts (the comma after *Peter* makes the following S-coordination unambiguous: *Ellen said that she was annoyed by Peter, and Ruben listened attentively to her words*; see Hoeks, Vonk & Schriefers, 2002). In particular, increased reading times of the first NP after the conjunction *and* for the ambiguous as compared to the unambiguous S-coordination might signify that in the former case, multiple alternative analyses were competing for activation. On the other hand, no reading time differences of the ambiguous NP between the ambiguous and the unambiguous S-coordination might signify that the S-coordination analysis was immediately constructed.

Whatever the exact course of processing may have been (one analysis being selected among several competing alternatives versus one initial analysis being immediately constructed), it is argued that the results provide clear evidence that situational knowledge overruled the syntax-based minimal attachment strategy and the pragmatic topic structure principle. In particular, the results have shown that the initial analysis of the critical sentence was concordant with situational knowledge, as indicated by the results in the relative clause. In the following section, a proposal as to how several constraints interact and how the dominance of situational knowledge over minimal attachment and the topic structure principle should be conceived is brought forward.

6.4.3 How do different factors interact during parsing?

Previous research has shown that readers have an intrinsic preference for an NP- over an S-coordination (see section 2.2). This preference can be explained by two economy-based principles, viz a syntax-based and a pragmatic one. First, according to the minimal attachment strategy, an NP-coordination is preferred over an S-coordination under all circumstances, because it requires more nodes in the parse tree than an NP-coordination. Second, according to a pragmatic topic structure

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principle, an NP-coordination analysis is preferred as well. The reason for this is that an NP-coordination is compatible with only one topic, whereas an S-coordination is compatible with two, which makes an NP-coordination analysis a more economical choice. However, the topic structure of the preceding discourse context has been shown to modulate this NP-coordination preference: if the preceding discourse context has a two-topic structure, an NP-/S-coordination ambiguity is initially analyzed as an S-coordination, because this analysis requires no adaptations of the ongoing topic structure of the text. On the other hand, if the preceding discourse context has a one-topic structure, the ambiguity is initially analyzed as an NP-coordination for the same reason. Since the critical sentences in the current experiment were always embedded within a one-topic discourse context, this pragmatic factor always supported an NP-coordination as well.

In sum, even though only situational knowledge was manipulated prior to the onset of the NP-/S-coordination ambiguity, there were two other factors in play - minimal attachment and a pragmatic topic structure principle- which (on the basis of previous results) can be assumed to bias towards an NP-coordination. Therefore, either every factor supported an NP-coordination analysis of the critical sentence, or only situational knowledge supported an S-coordination.

As the results supported the idea that participants initially analyzed the critical sentence as an S-coordination if situational knowledge was supportive of this structure, it seems that situational knowledge overruled both minimal attachment and the pragmatic topic structure principle. This result provides evidence for the idea that different factors constrain processing to a different degree. In other words, a factor can be either *soft* or *hard* constraining (see e.g. MacDonald, 1994; Spivey & Tanenhaus, 1998; McRae, Spivey-Knowlton & Tanenhaus, 1998 for a similar idea; see also section 1.3.5). The idea that a factor can be soft or hard constraining is endorsed in this thesis. A further challenge is to explain why a factor can be soft or hard constraining. Below, an attempt is made to do this.

The semantic properties of a word can affect the pragmatic plausibility of a certain structure. For example, imagine a sentence that starts out with *The students educated....* The semantic properties of both the first NP and the verb make the NP *the students* an unlikely subject of *educated*. After all, students are more likely to be educated than to educate

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somebody else (see e.g. Mak et al., 2002). However, the pragmatic factor is not very constraining in this case, because analyzing *the students* as the subject of the sentence is not impossible, judging the correctness of a sentence like *The students educated the children*.

This is different in a sentence that starts out with *The evidence examined...* (see Ferreira and Clifton, 1986). The semantic properties of the NP *the evidence* not only make the preferred subject interpretation of the NP highly implausible, it even rules out this option: because *the evidence* is an inanimate NP, it cannot possibly *examine* something. Since the semantic information is only soft-constraining in the former scenario and hard-constraining in the latter, it may have a greater impact on processing in the latter scenario. Put differently, semantic information is more likely to overrule other sources of information in the latter than in the former scenario.

Applying this insight to the current study, it can be argued that, considering the presence of an NP-coordination preference on the basis of minimal attachment and a pragmatic topic structure principle, situational knowledge overrules both these factors. This means that situational knowledge outranks the other two factors that were involved. Why would this be the case?

One reason is that disobeying the factor situational knowledge would complicate the processing of the sentence to a larger extent than disobeying the syntax-based and/or the pragmatic principle. More specifically, the latter two principles concern the structure that is the easiest (i.e. most economical) to build from a (sentence/discourse) structural point of view. Ignoring these principles may cause processing difficulty to increase, because it becomes less economical. However, situational knowledge indicates which of the different alternatives is most consistent with one's mental representation of the state of affairs described in the preceding discourse. This mental representation (situation model) is developed by integrating the propositional representation of the text (i.e. the textbase) with general world knowledge (see e.g. Schmalhofer & Glavanov, 1986; Fletcher, 1994; Kintsch, 1998; Zwaan & Radvansky, 1998; Kamalski, 2007; Mulder, 2008). Going against one's situational knowledge representation would entail selecting an analysis of the sentence that is inconsistent with one's situation model representation of the discourse. This is assumed to draw more strongly on the comprehensibility of the sentence than ignoring

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other, less stringent, economy-based factors. Therefore, if situational knowledge and minimal attachment/topic structure principles conflict, situational knowledge prevails. In other words: what you know is what you parse.

Still, as was described above, the factor SV-agreement eventually overruled the initial analysis of the critical sentence, and hence situational knowledge (as indicated by the results for the segment immediately after the relative clause). This was the case both when the morpho-syntactic information of the verb made the initial analysis of the sentence implausible and when this information made the initial analysis ungrammatical.¹ Consequently, the agreement between a verb and its subject appears to be a more constraining factor than situational knowledge. This is discussed further in the next section.

6.5 Generalizing the results

All in all, the current study provides strong evidence that situational knowledge immediately affects the initial analysis of a sentence. However, one could imagine situations in which situational knowledge is less constraining than in the current experiment. For example, previous research has shown that the way readers process and mentally represent a text depends on its genre. Reading time and verification data from Zwaan (1994) showed that readers who were instructed to read a literary text, allocated more processing resources to the surface representation of a text - which captures the exact wording and syntax of sentences -, and to its textbase representation - which captures the meaning of sentence and the relations among them, than to the situation model representation of the text. On the other hand, readers who were instructed that the (identical!) text that they were going to read was a news story, allocated more processing resources to the formation of a good situation model representation than to a good surface and textbase representation.

As was mentioned before, thorough situational knowledge can only be based on a good situation model of the events that are described in a text. Situational knowledge may be a less crucial and therefore a less constraining factor if readers are less likely to form a good situation

¹ A plural relative verb definitively ruled out an S-coordination analysis, whereas a singular relative verb made an NP-coordination analysis implausible, but did not rule it out.

model representation of the text. This may happen in cases in which a situation model representation is less important for the text that is being processed. Apparently, this holds for literary texts. In this situation, factors that concern surface text characteristics (e.g. lexical and syntactic ones) may overrule situational knowledge.

One must note that it is not argued here that readers *make less use* of their situational knowledge in some situations than in others. In other words, readers cannot decide to simply neglect their situational knowledge if they have it. However, it is suggested here, that the quality of readers' situational knowledge representation will vary from one text to another, as a result of varying amounts of detail provided in individual texts: the less detailed the information in the text, the less specified readers' situational knowledge representation will be and the less constraining the knowledge can be during processing. Hence, situational knowledge can be a soft constraining factor in some circumstances as well.

A second important issue questions whether situational knowledge can override *all* parsing preferences. Results by Britt, Perfetti, Garrod and Rayner (1992) showed that discourse context eliminated prepositional phrase attachment ambiguities, whereas this was not the case for the main clause/relative clause ambiguity. The authors explain this difference by the fact that the attachment of a prepositional phrase (at least in some cases) involves a local attachment decision within a major constituent, whereas the analysis of a reduced relative clause involves an attachment decision across a major constituent boundary. Britt (1994) subsequently argues that discourse context can only affect prepositional phrase attachments to optional verb arguments, but not to obligatory verb arguments.²

The distinction between obligatory and non-obligatory constituents plays a role in *construal theory* as well (see e.g. Frazier and Clifton, 1997). This theory distinguishes between so-called primary and non-primary relations. Primary relations include the subject and main predicate of any finite clause and complements and obligatory constituents of primary phrases. These relations are analyzed according to the garden path model. Nonprimary phrases are "*associated*" into the current

² For example, the verb *threw* optionally takes a goal argument (both *she threw the article* and *she threw the article on the table* are grammatical), whereas the goal argument is obligatory for a verb as *put* (*she put the article on the table* is grammatical, whereas *she put the article* is not; examples taken from Britt (1994)).

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thematic processing domain” (Frazier & Clifton, 1997, p.280, italics in the original). This means that an underspecified analysis is assigned to these structures, leaving open several different attachment possibilities. How the phrase is ultimately attached is influenced by non-syntactic information as well, and as long as the phrase is attached within its original thematic processing domain, no revision of the current syntactic commitments is necessary.

According to construal theory, the NP-/S-coordination ambiguity is a primary phrase ambiguity that is always initially analyzed in accordance with the minimal attachment strategy (i.e. as an NP-coordination). However, one could also argue that NP- and S-coordinations involve a more “loose” kind of syntactic relation than for example the relation between verbs and obligatory arguments or subject-verb relations. A reason for this could be that the parser has a lot of freedom when it comes to conjoining syntactic categories: many kinds of different syntactic categories can be conjoined to form grammatical sentences (see e.g. Frazier, Munn and Clifton (2000), for research on the processing of coordinate structures).

Perhaps situational knowledge cannot override syntax-based strategies in cases where disobeying these strategies results, or is very likely to result, in an ungrammatical sentence. This is, for example, the case when a phrase that can fill an obligatory argument slot is analyzed or when following situational knowledge would cause disagreement between a subject and its verb. This idea can also explain why the present results showed that the factor SV-agreement caused the initial analysis of the sentence, as determined by situational knowledge, to be reanalyzed: subject-verb number relations may be rather hard and not easily overridden by factors such as situational knowledge. The question whether this is indeed the case will take additional research to answer.

Nevertheless, this study has shown how situational knowledge that readers acquire by reading textual information, solves syntactic ambiguities of the NP-/S-coordination type. More specifically, it has shown that parsing is a dynamic process that changes in response to the various sources of information provided by the text. This finding provides further insight into the cognitive processes of language interpretation and ultimately into human cognition.

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Appendix 1

Example of a two-paragraph experimental text with an NP-context

Background information

- (1) Schrijver Bart Schut, recensente Manon Thijssen en uitgeefster Francien Koopmans zijn te gast in het tv-programma De Plantage.
- (1) Young writer Bart Schut, reviewer Manon Thijssen and publisher Francien Koopmans are guests in the TV program *The Plantation*.
- (2) Schut is erg boos over Thijssens negatieve recensie van zijn debuut.
- (2) Schut is very angry over Thijssen's negative review of his debut.
- (3) Hij krijgt ook al veel kritiek van uitgeefster Koopmans.
- (3) He is criticized by publisher Koopmans as well.

Message

- (4) Schut was erg kwaad in de uitzending en nam geen blad voor de mond.
- (4) Schut was very angry during the show and did not mince his words.
- (5) Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans vond eigenlijk dat de discussie te veel werd opgeblazen.
- (5) *Free translation:* Schut said that he was very annoyed by the unfounded opinion of Thijssen and Koopmans said repeatedly that the discussion had got completely out of hand.
- (5) *Literal translation:* Schut said to be annoyed by the unfounded opinion of Thijssen and Koopmans found actually that the discussion too much was being blown up.
- (6) Volgende week zal ook *De Volkskrant* een recensie aan het debuut wijden.
- (6) Next week 'De Volkskrant' will publish a review of the debut too.
-

Appendix 2

Appendix 2

Statistical model used to analyze the data of Experiment 1 and 4

Let $D_NP_{i(jk)}$ and $D_S_{i(jk)}$ be dummy-variables that indicate the proportions of continuations i ($i = 1, 2, \dots, I_{(jk)}$) of text j ($j = 1, 2, \dots, J$) of participant k ($k = 1, 2, \dots, K$) in the NP- and the S-condition respectively. If the continuations of the target sentence are denoted with $\Pi_{i(jk)}$, the model to be estimated can be written as:

$$\text{Logit}(\Pi_{i(jk)}) = LN \left[\frac{\Pi_{i(jk)}}{1 - \Pi_{i(jk)}} \right] = \quad (1)$$
$$D_NP_{i(jk)} * (\beta_1 + u_{1j} + v_{1k}) + D_S_{i(jk)} * (\beta_2 + u_{2j} + v_{2k}).$$

In Equation 1 the fixed parameters ($\beta_1 * D_NP_{i(jk)}$ and $\beta_2 * D_S_{i(jk)}$) represent the mean for the NP- and S-condition respectively. The random part consists of two residual scores per condition: the variance between texts (S^2u_{1j} and S^2u_{2j}) and the variance between individuals (S^2v_{1k} and S^2v_{2k}). For the sake of convenience it is assumed that the variance between texts does not vary between conditions (i.e. $S^2u_{1j} = S^2u_{2j}$). The difference between means (i.e. $\beta_1 * D_NP_{i(jk)}$ versus $\beta_2 * D_S_{i(jk)}$) is easily tested by means of a contrast matrix, in which a contrast is made between the fixed parameter estimates (e.g. Winer, 1971; Goldstein, 1995). This procedure results in a (large sample) chi-square distributed testing statistic.

Appendix 3

Mean proportion of S-coordination continuations (Experiment 1)

Mean proportion of S-coordination continuations (*S-continuations*) for two-paragraph texts as a function of situational knowledge (standard errors in parentheses). $s^2_{subj_between}$ denotes the between-subjects variance. * marks a significant difference between conditions.

NP-context	Proportion	0,39*
	S-continuations	
	logit scores (se)	0,47 (0,14)
	$s^2_{subj_between}$ (se)	0,83 (0,21)
S-context	Proportion	0,92*
	S-continuations	
	logit scores (se)	-2,44 (0,21)
	$s^2_{subj_between}$ (se)	1,68 (0,50)

Appendix 4

Appendix 4

Statistical model used to analyze the data of Experiment 2 and 3

Let $D_NP_{i(jk)}$ and $D_S_{i(jk)}$ be dummy-variables that indicate the judgment scores/reading times i ($i = 1, 2, \dots, I_{(jk)}$) of text j ($j = 1, 2, \dots, J$) of participant k ($k = 1, 2, \dots, K$) in the NP- and the S-condition respectively. If the judgment scores/reading times are denoted with $Y_{i(jk)}$, the model can be estimated to be written as:

$$Y_{i(jk)} = D_NP_{i(jk)} * (\beta_0 + e_{0i(jk)} + u_{00j} + v_{00k}) + D_S_{i(jk)} * (\beta_1 + e_{1i(jk)} + u_{10j} + v_{10k}). \quad (2)$$

In Equation 2 the fixed parameters ($\beta_0 * D_NP_{i(jk)}$ and $\beta_1 * D_S_{i(jk)}$) represent the mean for the NP- and S-condition respectively. The random part consists of three residual scores per condition: the variance within individuals ($S^2e_{0i(jk)}$ and $S^2e_{1i(jk)}$), the variance between texts (S^2u_{00j} and S^2u_{10j}) and the variance between individuals (S^2v_{00k} and S^2v_{10k}). For the sake of convenience it is assumed that the variance between texts does not vary between conditions (i.e. $S^2u_{00j} = S^2u_{10j}$). The difference between means (i.e. $\beta_0 * D_NP_{i(jk)}$ versus $\beta_1 * D_S_{i(jk)}$) is easily tested by means of a contrast matrix, in which a contrast is made between the fixed parameter estimates (e.g. Winer, 1971; Goldstein, 1995). This procedure results in a (large sample) chi-square distributed testing statistic.

Appendix 5

Mean judgments for two-paragraph texts (Experiment 2)

Mean judgments for two-paragraph texts on the easiness, plausibility and naturalness of the critical sentence as a function of situational knowledge (five-point scale; standard errors in parentheses). $s^2_{subj_between}$ denotes the between-subjects variance, $s^2_{subj_within}$ the within-subjects variance. * marks a statistically significant difference between conditions.

Easiness		
NP-context	Judgments (se)	3,57 (0,09)*
S-context	Judgments (se)	3,64 (0,09)*
	$s^2_{subj_between}$ (se)	0.42 (0.08)
	$s^2_{subj_within}$ (se)	0.52 (0.02)
Plausibility		
NP-context	Judgments (se)	2,85 (0,08)*
S-context	Judgments (se)	3,04 (0,08)*
	$s^2_{subj_between}$ (se)	0.30 (0.06)
	$s^2_{subj_within}$ (se)	0.93 (0.03)
Naturalness		
NP-context	Judgments (se)	3.07 (0,08)*
S-context	Judgments (se)	3.20 (0,08)*
	$s^2_{subj_between}$ (se)	0.37 (0.07)
	$s^2_{subj_within}$ (se)	0.81 (0.03)

Appendix 6

Experimental texts used in Experiment 3

NB

Sentence containing situational knowledge manipulation in *italics*.

Critical sentence in bold face.

The condition in which situational knowledge supports an S-coordination is referred to as *S-context*, the condition in which situational knowledge supports an NP-coordination is referred to as *NP-context*.

1a. Debuut (S-context)

Jonge schrijver Bart Schut heeft in het tv-programma *De Plantage* fel uitgehaald naar recensente Manon Thijssen. De schrijver vertelde dat hij erg boos is over Thijssens negatieve recensie van zijn debuut. *In de uitzending kreeg Schut daarentegen wel erkenning van uitgeefster Ina Koopmans.* Dat kon hij wél waarderen, zei hij tegen Koopmans. **Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans vond eigenlijk dat de discussie te veel werd opgeblazen.** Volgende week zal ook *De Volkskrant* een recensie wijden aan het debuut.

1b. Debuut (NP-context)

Jonge schrijver Bart Schut heeft in het tv-programma *De Plantage* fel uitgehaald naar recensente Manon Thijssen. De schrijver vertelde dat hij erg boos is over Thijssens negatieve recensie van zijn debuut. *In de uitzending kreeg Schut ook al kritiek van uitgeefster Ina Koopmans.* Ook dat kon hij niet begrijpen, zei hij tegen Koopmans. **Schut zei zich te storen aan het ongegronde oordeel van Thijssen en Koopmans vond eigenlijk dat de discussie te veel werd opgeblazen.** Volgende week zal ook *De Volkskrant* een recensie wijden aan het debuut.

2a. Slechte journalistiek (S-context)

Hoofdredacteur Ferdinand Kooy van *de Gooi- en Eemlander* heeft journaliste Fleur Terpstra tijdens een vergadering met de Redactieraad fel bekritiseerd. De hoofdredacteur vindt namelijk dat Terpstra voor de zoveelste keer een erg slecht artikel heeft geschreven over de oorlog in Irak. *Tijdens de vergadering werd Kooy in zijn standpunt bevestigd door zijn chef Ellen Rietveld.* Dit sterkte hem erg, zei hij tegen Rietveld. **Kooy bekritiseerde het gedrag van Terpstra en Rietveld wilde ook graag haar reactie geven.** Morgen zal een besluit worden genomen over Terpstra's toekomst bij de krant.

2b. Slechte journalistiek (NP-context)

Hoofdredacteur Ferdinand Kooy van de *Gooi- en Eemlander* heeft journaliste Fleur Terpstra tijdens een vergadering met de Redactieraad fel bekritiseerd. De hoofdredacteur vindt namelijk dat Terpstra voor de zoveelste keer een erg slecht artikel heeft geschreven over de oorlog in Irak. *Tijdens de vergadering werd Kooy echter heftig tegengesproken door zijn chef Ellen Rietveld.* Hierdoor werd zijn ongenoegen alleen maar groter, zei hij tegen Rietveld. **Kooy bekritiseerde het gedrag van Terpstra en Rietveld wilde ook graag haar reactie geven.** Morgen zal een besluit worden genomen over Terpstra's toekomst bij de krant.

3a. Concertzender (S-context)

Radiopresentatrice Marian Baars van de *Concertzender* heeft zich op *Radio 1* zeer negatief uitgelaten over zendercoördinator Ad Pieters. De presentatrice verwerpt het idee van Pieters om de zender op te heffen. *Baars kreeg in de uitzending bijval van EO-directeur Andries Knevel.* Dit kon ze erg waarderen, zei ze Knevel in de uitzending. **Baars bekritiseerde de instelling van Pieters en Knevel verklaarde hierna ook duidelijk zijn standpunt.** Eind deze maand zal de directie van de *Publieke Omroep* een besluit nemen.

3b. Concertzender (NP-context)

Radiopresentatrice Marian Baars van de *Concertzender* heeft zich op *Radio 1* zeer negatief uitgelaten over zendercoördinator Ad Pieters. De presentatrice verwerpt het idee van Pieters om de zender op te heffen. *Baars werd in de uitzending ook nog eens aangevallen door EO-directeur Andries Knevel.* Dit kon ze niet waarderen, zei ze Knevel in de uitzending. **Baars bekritiseerde de instelling van Pieters en Knevel verklaarde hierna ook duidelijk zijn standpunt.** Eind deze maand zal de directie van de *Publieke Omroep* een besluit nemen.

4a. Hockey (S-context)

Hockeyster Roos Vis heeft tijdens een persconferentie sterk afgegeven op trainer Ad Kooyman. De sportvrouw protesteerde tegen het besluit van Kooyman om haar uit de selectie te halen. *Tijdens de persconferentie kreeg Vis steun van technisch directeur Ton Bouma.* Bouma's steun was een geweldige opsteker voor haar, verklaarde ze. **Vis bekritiseerde nogmaals de opvatting van Kooyman en Bouma presenteerde ook tamelijk onomwonden zijn mening.** Morgen zal de hockeybond met de betrokkenen overleggen.

4b. Hockey (NP-context)

Hockeyster Roos Vis heeft tijdens een persconferentie sterk afgegeven op trainer Ad Kooyman. De sportvrouw protesteerde tegen het besluit van Kooyman om haar uit de selectie te halen. *Tijdens de persconferentie kreeg Vis geen steun van technisch directeur Ton Bouma.* Bouma's houding maakte het conflict nog pijnlijker voor haar, verklaarde ze. **Vis**

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bekritiseerde nogmaals de opvatting van Kooyman en Bouma presenteerde ook tamelijk onomwonden zijn mening. Morgen zal de hockeybond met de betrokkenen overleggen.

5a. Illegaal downloaden (S-context)

Systeembeheerder Loek Brink van de Universiteit Leiden wil studente Jennie Kamphuis van het netwerk weren. De systeembeheerder weet zeker dat Kamphuis het netwerk heeft misbruikt om illegale programma's te downloaden. *Vorige week kreeg Brink via de mail steun van zijn chef Gaby Schippers.* Dat deed hem goed, zei hij haar tijdens een gesprek. **Brink hekelde in dat gesprek de houding van Kamphuis en Schippers probeerde vooral de feiten op tafel te krijgen.** Morgen vergadert het Leidse College van Bestuur over de kwestie.

5b. Illegaal downloaden (NP-context)

Systeembeheerder Loek Brink van de Universiteit Leiden wil studente Jennie Kamphuis van het netwerk weren. De systeembeheerder weet zeker dat Kamphuis het netwerk heeft misbruikt om illegale programma's te downloaden. *Vorige week kreeg Brink via de mail echter helemaal geen steun van zijn chef Gaby Schippers.* Dat vond hij bespottelijk, zei hij haar tijdens een persoonlijk gesprek. **Brink hekelde in dat gesprek de houding van Kamphuis en Schippers probeerde vooral de feiten op tafel te krijgen.** Morgen vergadert het Leidse College van Bestuur over de kwestie.

6a. Bezuinigingen (S-context)

Voorzitster Bianca Knol van de studentenbond heeft in het tv-programma Nova een vurig debat gevoerd met PvdA-fractieleider Wouter Bos. De studente is het absoluut niet eens met Bos zijn bezuinigingsvoorstellen voor het hoger onderwijs. *De argumenten van Knol kregen in de uitzending bijval van econoom Ben Nyenhuis.* Hier was ze heel erg blij mee, zei ze tegen Nyenhuis. **Knol zei zich enorm te ergeren aan de onrealistische instelling van Bos en Nyenhuis luisterde aandachtig naar haar relaas.** Ook binnen de PvdA-fractie lijkt steeds meer verzet tegen het voorstel te ontstaan.

6b. Bezuinigingen (NP-context)

Voorzitster Bianca Knol van de studentenbond heeft in het tv-programma Nova een vurig debat gevoerd met PvdA-fractieleider Wouter Bos. De studente is het absoluut niet eens met Bos zijn bezuinigingsvoorstellen voor het hoger onderwijs. *De argumenten van Knol werden in de uitzending echter tegengesproken door econoom Ben Nyenhuis.* Hier was ze niet blij mee, zei ze tegen Nyenhuis. **Knol zei zich enorm te ergeren aan de onrealistische instelling van Bos en Nyenhuis luisterde aandachtig naar haar relaas.** Ook binnen de PvdA-fractie lijkt steeds meer verzet tegen het voorstel te ontstaan.

7a. Beperking psychologiestudenten (S-context)

Redactrice Ninke Koops van het tijdschrift Psychologie heeft zware kritiek geuit op professor Henk Smulders. De redactrice stelde in een discussieprogramma op Radio West dat het onaanvaardbaar is dat Smulders het aantal nieuwe psychologiestudenten wil beperken. *De kritiek van Koops werd in de uitzending onderschreven door Rector Magnificus Bert Wessels.* Dit vond ze erg prettig om te horen, zei ze tegen Wessels. **Koops zei dat hij zich ontzettend ergerde aan de kortzichtige houding van Smulders en Wessels vertelde uitgebreid wat zijn visie was.** Volgende week zal het College van Bestuur een besluit nemen.

7b. Beperking psychologiestudenten (NP-context)

Redactrice Ninke Koops van het tijdschrift Psychologie heeft zware kritiek geuit op professor Henk Smulders. De redactrice stelde in een discussieprogramma op Radio West dat het onaanvaardbaar is dat Smulders het aantal nieuwe psychologiestudenten wil beperken. *De kritiek van Koops werd in de uitzending afgekeurd door Rector Magnificus Bert Wessels.* Dit vond ze niet fijn om te horen, zei ze tegen Wessels. **Koops zei dat hij zich ontzettend ergerde aan de kortzichtige houding van Smulders en Wessels vertelde uitgebreid wat zijn visie was.** Volgende week zal het College van Bestuur een besluit nemen.

8a. Klacht over racisme (S-context)

Studente rechten Inge Derks heeft een klacht ingediend over docent Edo Keizer, zo meldde het universiteitsblad deze week. Reden hiervoor is dat de studente Keizers colleges zeer racistisch vindt. *Derks kreeg in een gesprek gelijk van vice-decaan Bram Nijland.* Hier was ze erg blij mee, vertelde ze Nijland. **Derks zei zeer verontwaardigd te zijn over de opstelling van Keizer en Nijland luisterde geduldig naar haar woorden.** Ook De Telegraaf zal deze week aandacht aan de zaak besteden.

8b. Klacht over racisme (NP-context)

Studente rechten Inge Derks heeft een klacht ingediend over docent Edo Keizer, zo meldde het universiteitsblad deze week. Reden hiervoor is dat de studente Keizers colleges zeer racistisch vindt. *Derks kreeg in een persoonlijk gesprek echter geen gelijk van vice-decaan Bram Nijland.* Hier was ze erg kwaad over, vertelde ze Nijland. **Derks zei zeer verontwaardigd te zijn over de opstelling van Keizer en Nijland luisterde geduldig naar haar woorden.** Ook De Telegraaf zal deze week aandacht aan de zaak besteden.

9a. Leerplicht (S-context)

Directeur Ben Schreurs van een Utrechtse scholengemeenschap is in conflict geraakt met wethouder van onderwijs Linda Boonstra. De directeur is tegen Boonstra's idee om

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jongeren net zo lang op school te laten blijven tot ze hun diploma hebben behaald. *Tijdens een onderwijsconferentie bleek dat de kritiek van Schreurs werd gedeeld door hoofdinspecteur Saskia Albers van onderwijs.* Dit stelde hem heel erg gerust, zei hij tegen Albers. **Schreurs zei echt niets te begrijpen van de opvatting van Boonstra en Albers beargumenteerde hierna uitgebreid haar mening.** Binnenkort zal de Utrechtse gemeenteraad zich over het voorstel uitspreken.

9b. Leerplicht (NP-context)

Directeur Ben Schreurs van een Utrechtse scholengemeenschap is in conflict geraakt met wethouder van onderwijs Linda Boonstra. De directeur is tegen Boonstra's idee om jongeren net zo lang op school te laten blijven tot ze hun diploma hebben behaald. *Tijdens een onderwijsconferentie bleek dat de kritiek van Schreurs niet werd gedeeld door hoofdinspecteur Saskia Albers van onderwijs.* Dit stelde hem zeer teleur, zei hij tegen Albers. **Schreurs zei echt niets te begrijpen van de opvatting van Boonstra en Albers beargumenteerde hierna uitgebreid haar mening.** Binnenkort zal de Utrechtse gemeenteraad zich over het voorstel uitspreken.

10a. Buiten haar boekje (S-context)

Wethouder Henk Boers uit Schagen heeft een klacht ingediend bij het College van Burgemeester & Wethouders over zijn stagiaire Francien Verhey. De wethouder stelt dat Verhey buiten haar boekje is gegaan door zijn functioneren kritisch te bespreken met de pers. *Tijdens een vergadering kreeg Boers steun van burgemeester An Schepers.* Dat was fijn om te horen, zo verklaarde hij. **Boers zei zich zeer te ergeren aan de houding van Verhey en Schepers wilde hierna ook nog even het woord nemen.** De Volkskrant zal morgen een artikel wijden aan de kwestie.

10b. Buiten haar boekje (NP-context)

Wethouder Henk Boers uit Schagen heeft een klacht ingediend bij het College van Burgemeester & Wethouders over zijn stagiaire Francien Verhey. De wethouder stelt dat Verhey buiten haar boekje is gegaan door zijn functioneren kritisch te bespreken met de pers. *Tijdens een vergadering kreeg Boers echter geen steun van burgemeester An Schepers.* Dat verbijsterde hem, zo verklaarde hij. **Boers zei zich zeer te ergeren aan de houding van Verhey en Schepers wilde hierna ook nog even het woord nemen.** De Volkskrant zal morgen een artikel wijden aan de kwestie.

11a. Studentenhuisvesting (S-context)

Directrice Tanja Swart van Stichting Studentenhuisvesting Groningen heeft zware kritiek geuit op gemeenteraadslid Ernst Berends. De directrice vindt het onacceptabel dat Berends een aantal studentenhuizen wil slopen. *Swart kreeg deze week tijdens een politiek*

overleg bijoor van burgemeester Wallage. Dit was een enorme opsteker voor haar, verklaarde ze tijdens het overleg. **Swart zei versted te staan van het slechte inzicht van Berends en Wallage verklaarde ook heel duidelijk zijn mening.** Het laatste woord over de plannen is duidelijk nog niet gesproken.

11b. Studentenhuisvesting (NP-context)

Directrice Tanja Swart van Stichting Studentenhuisvesting Groningen heeft zware kritiek geuit op gemeenteraadslid Ernst Berends. De directrice vindt het onacceptabel dat Berends een aantal studentenhuizen wil slopen. *Swart kreeg deze week tijdens een politiek overleg geen bijoor van burgemeester Wallage.* Dit was een enorme teleurstelling voor haar, verklaarde ze tijdens het overleg. **Swart zei versted te staan van het slechte inzicht van Berends en Wallage verklaarde ook heel duidelijk zijn mening.** Het laatste woord over de plannen is duidelijk nog niet gesproken.

12a. Reisvoorlichting (S-context)

Ombudsman Aad Brands heeft zware kritiek geuit op directrice Sandra Jonkers van reisbureau Trip. De ombudsman vindt dat Jonkers klanten bewust verkeerd voorlicht over de kwaliteit van hun accommodatie. *Brands kreeg deze week in reismagazine GO! steun van redactrice Gerda Schutte.* Dit soort aandacht voor de kwestie kon hij erg waarderen, vertelde hij Schutte telefonisch. **Brands zei geïrriteerd te zijn door de opstelling van Jonkers en Schutte wilde graag een artikel gaan wijden aan de kwestie.** Gedupeerde klanten kunnen hun reactie mailen naar reismagazine GO!.

12b. Reisvoorlichting (NP-context)

Ombudsman Aad Brands heeft zware kritiek geuit op directrice Sandra Jonkers van reisbureau Trip. De ombudsman vindt dat Jonkers klanten bewust verkeerd voorlicht over de kwaliteit van hun accommodatie. *Brands werd deze week in reismagazine GO! tegengesproken door redactrice Gerda Schutte.* Dit soort aandacht voor de kwestie kon hij niet waarderen, vertelde hij Schutte telefonisch. **Brands zei geïrriteerd te zijn door de opstelling van Jonkers en Schutte wilde graag een artikel gaan wijden aan de kwestie.** Gedupeerde klanten kunnen hun reactie mailen naar reismagazine GO!.

13a. Stoned in de klas (S-context)

VMBO-directeur Bas Tromp wil zijn leerlinge Petra Vissers van school verwijderen. De directeur is er namelijk van overtuigd dat Vissers meerdere malen stoned in de klas heeft gezeten. *Tijdens een persoonlijk gesprek met mentrix Hester Beckers bleek dat Tromp door haar wordt gesteund in zijn voornemen.* In het gesprek zei hij dat erg fijn te vinden. **Tromp zei geschokt te zijn door de houding van Vissers en Beckers vond het eigenlijk niet nodig**

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om lang over de kwestie te discussiëren. Morgen zal de kwestie in de lerarenvergadering besproken worden.

13b. Stoned in de klas (NP-context)

VMBO-directeur Bas Tromp wil zijn leerlinge Petra Vissers van school verwijderen. De directeur is er namelijk van overtuigd dat Vissers meerdere malen stoned in de klas heeft gezeten. *Tijdens een persoonlijk gesprek met mentrix Hester Beckers bleek echter dat Tromp helemaal niet door haar wordt gesteund in zijn voornemen.* In het gesprek zei hij dat hij dat absoluut onbegrijpelijk vond. **Tromp zei geschokt te zijn door de houding van Vissers en Beckers vond het eigenlijk niet nodig om lang over de kwestie te discussiëren.** Morgen zal de kwestie in de lerarenvergadering besproken worden.

14a. Roddelpers (S-context)

De Belgische zangeres Eliza Klomp heeft haar manager Frido Veldman de deur gewezen, zo stond vandaag te lezen op haar website. De zangeres verwijt Veldman intieme privé-informatie over haar te hebben doorgespeeld aan de roddelpers. *Klomp kreeg in een chatsessie bij TMF hartverwarmende steun van journalist Dik Kersten.* Hier was ze erg blij mee, schreef ze Kersten in een reactie. **Klomp reageerde erg fel op het onfatsoenlijke gedrag van Veldman en Kersten gaf hierna ook een uitgebreide reactie.** Morgen zal het tv-programma Shownieuws aandacht besteden aan de kwestie.

14b. Roddelpers (NP-context)

De Belgische zangeres Eliza Klomp heeft haar manager Frido Veldman de deur gewezen, zo stond vandaag te lezen op haar website. De zangeres verwijt Veldman intieme privé-informatie over haar te hebben doorgespeeld aan de roddelpers. *Klomp kreeg in een chatsessie bij TMF ook nog eens veel kritiek van journalist Dik Kersten.* Hier was ze erg door beledigd, schreef ze Kersten in een reactie. **Klomp reageerde erg fel op het onfatsoenlijke gedrag van Veldman en Kersten gaf hierna ook een uitgebreide reactie.** Morgen zal het tv-programma Shownieuws aandacht besteden aan de kwestie.

15a. Vergoeding medicijnen (S-context)

Hartpatiënt Ton Stolk heeft in het consumentenprogramma Breekijzer geklaagd over verzekeringsagente Anna Feenstra. De hartpatiënt vindt dat Feenstra hem slecht heeft voorgelicht over de vergoeding van zijn medicijnen. *De klacht van Stolk werd terecht bevonden door voorzitter Erica Brinkman van de Geschillencommissie.* Dit was een enorme meevaller voor hem, vertelde hij telefonisch aan Brinkman. **Stolk zei zich benadeeld te voelen door Feenstra en Brinkman zei herhaaldelijk te hopen dat beide partijen het eens zouden worden.** Volgende week zullen de partijen nogmaals om de tafel zitten.

15b. Vergoeding medicijnen (NP-context)

Hartpatiënt Ton Stolk heeft in het consumentenprogramma Breekijzer geklaagd over verzekeringsagente Anna Feenstra. De hartpatiënt vindt dat Feenstra hem slecht heeft voorgelicht over de vergoeding van zijn medicijnen. *De klacht van Stolk werd afgewezen door voorzitter Erica Brinkman van de Geschillencommissie.* Dit was een enorme tegenvaller voor hem, vertelde hij telefonisch aan Brinkman. **Stolk zei zich benadeeld te voelen door Feenstra en Brinkman zei herhaaldelijk te hopen dat beide partijen het eens zouden worden.** Volgende week zullen de partijen nogmaals om de tafel zitten.

16a. Smartlappen (S-context)

Smartlappenzanger Henk Arts heeft zijn impresario Eliza Heynen de deur gewezen. De entertainer vindt dat Heynen de afgelopen tijd veel te weinig optredens voor hem heeft weten te regelen. *Arts kreeg gisteren op 3FM bijval van muzikrecensent Thelma Mulders.* Zelf was hij ook in het radioprogramma aanwezig. **Arts zei in de uitzending echt niet goed te worden van de mentaliteit van Heynen en Mulders wachtte geduldig tot zij het woord kon nemen.** Luisteraars kunnen tot zaterdag hun mening kwijt op de site van 3FM.

16b. Smartlappen (NP-context)

Smartlappenzanger Henk Arts heeft zijn impresario Eliza Heynen de deur gewezen. De entertainer vindt dat Heynen de afgelopen tijd veel te weinig optredens voor hem heeft weten te regelen. *Arts werd gisteren op 3FM echter zelf aangevallen door muzikrecensent Thelma Mulders.* Dit vond hij een rotstreek, zei hij live in de uitzending. **Arts zei echt niet goed te worden van de mentaliteit van Heynen en Mulders wachtte geduldig tot zij het woord kon nemen.** Luisteraars kunnen tot zaterdag hun mening kwijt op de site van 3FM.

17a. Loterij (S-context)

Gelukzoeker Teun Kool overstelpt directrice Frida de Braak van loterij Daily Fun al weken met boze brieven, zo meldde De Telegraaf deze week. De gokker zegt een prijs gewonnen te hebben die nog steeds niet is uitgekeerd. *Kool kreeg gisteren in dezelfde krant onverwacht steun van woordvoerder Ilse Krijger van de Bond voor Kansspelen.* Dat was een goede zaak, vertrouwde hij Krijger later telefonisch toe. **Kool veroordeelde de houding van De Braak en Krijger vertelde daarna nogmaals uitgebreid wat haar mening over de kwestie was.** Daily Fun heeft gezegd morgen met een persbericht naar buiten te komen.

17b. Loterij (NP-context)

Gelukzoeker Teun Kool overstelpt directrice Frida de Braak van loterij Daily Fun al weken met boze brieven, zo meldde De Telegraaf deze week. De gokker zegt een prijs gewonnen te hebben die nog steeds niet is uitgekeerd. *Kool kreeg gisteren in dezelfde krant onverwacht*

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geen steun van woordvoerder Ilse Krijger van de Bond voor Kansspelen. Dat was een slechte zaak, vertrouwde hij Krijger later telefonisch toe. Kool **veroordeelde de houding van De Braak en Krijger vertelde daarna nogmaals uitgebreid wat haar mening over de kwestie was.** Daily Fun heeft gezegd morgen met een persbericht naar buiten te komen.

18a. Bonussen (S-context)

Advocate Carola de Kok heeft in een uitzending van Business Radio gedreigd haar werkgever Jan Lamers voor de rechter te slepen. De juriste wil niet langer meer wachten op de bonussen die ze nog van Lamers tegoed heeft. *Tijdens de uitzending kreeg De Kok telefonisch gelijk van juridisch adviseur Emiel Reinders.* Dit was een grote steun voor haar, verzekerde ze Reinders direct. **De Kok zei woedend te zijn door de rare denkbeelden van Lamers en Reinders zei herhaaldelijk dat dit soort conflicten veel voorkomt.** Deze week zal intern over de zaak worden vergaderd.

18b. Bonussen (NP-context)

Advocate Carola de Kok heeft in een uitzending van Business Radio gedreigd haar werkgever Jan Lamers voor de rechter te slepen. De juriste wil niet langer meer wachten op de bonussen die ze nog van Lamers tegoed heeft. *Tijdens de uitzending kreeg De Kok telefonisch geen steun van juridisch adviseur Emiel Reinders.* Dit vond ze onvoorstelbaar, verzekerde ze Reinders direct. **De Kok zei woedend te zijn door de rare denkbeelden van Lamers en Reinders zei herhaaldelijk dat dit soort conflicten veel voorkomt.** Deze week zal intern over de zaak worden vergaderd.

19a. Gestolen beeld (S-context)

Praeses Babette van Vugt van studentenvereniging Vergilius kreeg tijdens een ontmoetingsdag van studentenverenigingen slaande ruzie met secretaris Mark Meyers van een zustervereniging. Van Vugt is ervan overtuigd dat Meyers een beeld uit de sociëteit heeft gestolen, iets dat vaak uit rivaliteit gebeurt. *Tijdens de bijeenkomst kreeg ze bijval van bestuurslid Pim Nyhuis van de Delftsche Studentenbond.* Dit kon ze erg waarderen, zei de praeses tegen Nyhuis. Van **Vugt zei zich erg op te winden over de opstelling van Meyers en Nyhuis wilde graag weten welke stappen ze wilde gaan ondernemen.** Waar het beeld is gebleven blijft vooralsnog een raadsel.

19b. Gestolen beeld (NP-context)

Praeses Babette van Vugt van studentenvereniging Vergilius kreeg tijdens een ontmoetingsdag van studentenverenigingen slaande ruzie met secretaris Mark Meyers van een zustervereniging. Van Vugt is ervan overtuigd dat Meyers een beeld uit de sociëteit heeft gestolen, iets dat vaak uit rivaliteit gebeurt. *Tijdens de bijeenkomst kreeg ze geen bijval van bestuurslid Pim Nyhuis van de Delftsche Studentenbond.* Dit was zeer onterecht,

zei de praeses tegen Nyhuis. **Van Vugt zei zich erg op te winden over de opstelling van Meyers en Nyhuis wilde graag weten welke stappen ze wilde gaan ondernemen.** Waar het beeld is gebleven blijft vooralsnog een raadsel.

20a. Slechte zorg (S-context)

Bewoner Gerrit Van Hoof van bejaardenhuis Dorrestijn is boos op directrice Annelies Schreuder. De zorg die hij krijgt is veel te karig, zo stelde de oude man tijdens een bijeenkomst voor bewoners. *Van Hoof kreeg tijdens het samenzijn gelijk van maatschappelijk werkster Greet Veldhuis.* Met die steun was hij erg blij, vertelde hij Veldhuis persoonlijk. **Van Hoof uitte tijdens het gesprek felle kritiek op Schreuder en Veldhuis vond dat de oude man zijn mening helder verwoordde.** Volgende week zal de Raad voor Ouderenzorg zich over de kwestie buigen.

20b. Slechte zorg (NP-context)

Bewoner Gerrit Van Hoof van bejaardenhuis Dorrestijn is boos op directrice Annelies Schreuder. De zorg die hij krijgt is veel te karig, zo stelde de oude man tijdens een bijeenkomst voor bewoners. *Van Hoof kreeg tijdens het samenzijn echter geen gelijk van maatschappelijk werkster Greet Veldhuis.* Hier was hij erg boos over, vertelde hij Veldhuis persoonlijk. **Van Hoof uitte tijdens het gesprek felle kritiek op Schreuder en Veldhuis vond dat de oude man zijn mening helder verwoordde.** Volgende week zal de Raad voor Ouderenzorg zich over de kwestie buigen.

21a. Doping (S-context)

Voorzitter Leo de Waal van de Schaatsbond is in conflict geraakt met schaatsster Lara de Ridder. Het hoofd van de bond wil De Ridder uit de kernploeg zetten, omdat hij ervan overtuigd is dat De Ridder doping heeft gebruikt. *De verdenking van De Waal werd gedeeld door sportarts Renate van Gelder, zo bleek uit een artikel in het tijdschrift Sport.* Deze steun kon hij wel gebruiken, vertelde hij Van Gelder in een telefonische reactie. **De Waal zei zich te ergeren aan De Ridder en Van Gelder pleitte voor een betere medische begeleiding van topsporters.** Deze week nog zullen enkele urinemonsters worden onderzocht.

21b. Doping (NP-context)

Voorzitter Leo de Waal van de Schaatsbond is in conflict geraakt met schaatsster Lara de Ridder. Het hoofd van de bond wil De Ridder uit de kernploeg zetten, omdat hij ervan overtuigd is dat De Ridder doping heeft gebruikt. *De verdenking van De Waal werd echter van tafel geveegd door sportarts Renate van Gelder, zo bleek uit een artikel in het tijdschrift Sport.* Dat vond hij onbegrijpelijk, zei hij telefonisch tegen Van Gelder. **De Waal zei zich ontzettend te ergeren aan De Ridder en Van Gelder pleitte voor een betere medische**

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begeleiding van topsporters. Deze week nog zullen enkele urinemonsters worden onderzocht.

22a. Piercings (S-context)

Serveerster Bregje den Boer heeft haar werkgever Tom De Jongh aangeklaagd. De serveerster is namelijk van mening dat De Jongh haar discrimineert, omdat ze geen piercings mag dragen op haar werk. *Tijdens een kort geding kreeg Den Boer steun van FNV-voorzitter Bert Van Rossum.* Hier was ze erg dankbaar voor, zei ze Van Rossum tijdens een persconferentie na afloop. **Den Boer zei korte metten te zullen maken met de discriminerende instelling van De Jongh en Van Rossum formuleerde daarna uiterst scherp zijn oordeel over de kwestie.** De Volkskrant zal volgende week aandacht aan de kwestie besteden.

22b. Piercings (NP-context)

Serveerster Bregje den Boer heeft haar werkgever Tom De Jongh aangeklaagd. De serveerster is van mening dat De Jongh haar discrimineert, omdat ze geen piercings mag dragen op haar werk. *Tijdens een kort geding kreeg Den Boer geen steun van FNV-voorzitter Bert Van Rossum.* Dit vond ze erg raar, zei ze Van Rossum tijdens een persconferentie na afloop. **Den Boer zei korte metten te zullen maken met de discriminerende instelling van De Jongh en Van Rossum formuleerde daarna uiterst scherp zijn oordeel over de kwestie.** De Volkskrant zal volgende week aandacht aan de kwestie besteden.

23a. Verpest haar (S-context)

Fotomodel Tanja van Gils is razend op haar kapper Barry den Hartog. Het model vindt dat Den Hartog haar kapsel blijvend heeft beschadigd door chemische kleurbehandelingen. *Van Gils kreeg in het tv-programma RTL-Boulevard gelijk van visagist Evert Van Zanten.* Dit waardeerde ze heel erg, zei ze in het programma tegen Van Zanten. **Van Gils zei ontzettend boos te zijn op Den Hartog en Van Zanten wilde direct weten welke stappen ze van plan was te gaan ondernemen.** Vanavond zal de kwestie besproken worden in het programma Shownieuws.

23b. Verpest haar (NP-context)

Fotomodel Tanja van Gils is razend op haar kapper Barry den Hartog. Het model vindt dat Den Hartog haar kapsel blijvend heeft beschadigd door chemische kleurbehandelingen. *Van Gils kreeg in het tv-programma RTL-Boulevard heftige tegenspraak van visagist Evert Van Zanten.* Dit maakte haar nog bozer, zei ze in het programma tegen Van Zanten. **Van Gils zei ontzettend boos te zijn op Den Hartog en Van Zanten wilde direct weten welke stappen ze van plan was te gaan ondernemen.** Vanavond zal de kwestie besproken worden in het programma Shownieuws.

24a. Politiek debat (S-context)

Fractievoorzitster Femke Halsema van Groen Links lag deze week in de clinch met minister Remkes van Binnenlandse Zaken. De linkse politica vindt het verwerpelijk dat de minister vijf miljoen euro wil bezuinigen op de WW-uitkeringen. *In een debat op Radio 2 kreeg Halsema steun van prominent VVD-lid Frank De Grave.* Met De Grave viel tenminste te praten, zei ze tijdens de uitzending. **Halsema zei geen begrip te hebben voor de ideeën van Remkes en De Grave luisterde aandachtig naar haar relaas.** Morgen zal de Tweede Kamer over het voorstel vergaderen.

24b. Politiek debat (NP-context)

Fractievoorzitster Femke Halsema van Groen Links lag deze week in de clinch met minister Remkes van Binnenlandse Zaken. De linkse politica vindt het verwerpelijk dat de minister vijf miljoen euro wil bezuinigen op de WW-uitkeringen. *In een debat op Radio 2 kreeg Halsema geen steun van prominent VVD-lid Frank De Grave.* Met De Grave viel ook al niet praten, zei ze tijdens de uitzending. **Halsema zei geen begrip te hebben voor de ideeën van Remkes en De Grave luisterde aandachtig naar haar relaas.** Morgen zal de Tweede Kamer over het voorstel vergaderen.

Appendix 7

Appendix 7

Mean reading time for participants with correct and incorrect answers to the critical statement (Experiment 3)

Mean reading time (msec) for participants with correct and incorrect answers to the critical statement as a function of situational knowledge (standard errors in parentheses).

		<i>Participants with correct answers</i>	<i>Participants with incorrect answers</i>
<i>Koopmans_{C1}</i>			
NP-context	Reading times (se)	503 (16.00)	541 (18.28)
	s ² subj_within (se)	19548.12 (1161.79)	19548.12 (1161.79)
	s ² txt (se)	602.32 (223.02)	602.32 (223.02)
	s ² subj_between (se)	10379.82 (2344.48)	10379.82 (2344.48)
S-context	Reading times (se)	505 (16.95)	512 (16.70)
	s ² subj_within (se)	18562.42 (1096.96)	18562.42 (1096.96)
	s ² txt (se)	602.32 (223.02)	602.32 (223.02)
	s ² subj_between (se)	12123.17 (2663.08)	12123.17 (2663.08)
<i>vond_{C2} (found)</i>			
NP-context	Reading times (se)	486 (12.07)	501 (16.65)
	s ² subj_within (se)	19548.12 (1161.79)	16905.75 (1002.82)
	s ² txt (se)	602.32 (223.02)	602.32 (223.02)
	s ² subj_between (se)	10379.82 (2344.48)	4790.25 (1214.11)
S-context	Reading times (se)	486 (11.90)	479 (15.05)
	s ² subj_within (se)	18562.42 (1096.96)	15080.77 (895.42)
	s ² txt (se)	602.32 (223.02)	602.32 (223.02)
	s ² subj_between (se)	12123.17 (2663.08)	4718.23 (1170.41)

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		<i>Participants with correct answers</i>	<i>Participants with incorrect answers</i>
<i>eigenlijk_{C2+1} (actually)</i>			
NP-context	Reading times (se)	461 (13.55)*	462 (16,61)*
	$s^2_{subj_within}$ (se)	19548.12 (1161.79)	18478.11 (1096.51)
	s^2_{txt} (se)	602.32 (223.02)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	10379.82 (2344.48)	6662.47 (1603.52)
S-context	Reading times (se)	439 (16.95)*	499 (17.79)*
	$s^2_{subj_within}$ (se)	18562.42 (1096.96)	18317.58 (1084.27)
	s^2_{txt} (se)	602.32 (223.02)	602.32 (223.02)
	$s^2_{subj_between}$ (se)	12123.17 (2663.08)	7736.50 (1808.81)

*Note: s^2_{within} denotes the within-subjects variance, s^2_{txt} the between-text variance and $s^2_{subj_between}$ for the between-subjects variance. * marks a significant difference between conditions.*

Appendix 8

Statistical model used to analyze the data of Experiment 5

For Experiment 5, the model in Equation (1) (see Appendix 2) was extended in order to incorporate the effect of SV-agreement. In this, so-called, cell means model four dummy-variables are defined, one for each combination of situational knowledge (supportive of NP- versus S-coordination) and SV-agreement (supportive of NP- versus S-coordination). Let these dummies, say $D_NP_NP_{i(jk)}$, $D_NP_S_{i(jk)}$, $D_S_NP_{i(jk)}$, $D_S_S_{i(jk)}$, be turned 'on' if a score is observed in the denoted condition. Now the model to be estimated can be written as:

$$\begin{aligned}
 \text{Logit}(\Pi_{i(jk)}) &= LN \left[\frac{\Pi_{i(jk)}}{1 - \Pi_{i(jk)}} \right] = \\
 &D_NP_NP_{i(jk)} * (\beta_1 + u_{1j} + v_{1k}) + \\
 &D_NP_S_{i(jk)} * (\beta_2 + u_{2j} + v_{2k}) + \\
 &D_S_NP_{i(jk)} * (\beta_3 + u_{3j} + v_{3k}) + \\
 &D_S_S_{i(jk)} * (\beta_4 + u_{4j} + v_{4k}).
 \end{aligned} \tag{3}$$

In Equation (3) the regression weights ($\beta_1 - \beta_4$) represent the cell means for the four conditions of situational knowledge and SV-agreement. For each of these conditions the variance between texts ($S^2u_{10j}, \dots, S^2u_{4j}$) as well as the variance between individuals ($S^2v_{1k}, \dots, S^2v_{3k}$) is allowed to vary.

Appendix 9

Statistical model used to analyze the data of Experiment 6, 7 and 8

In the model for Experiment 6, 7 and 8 two factors have to be distinguished (situation knowledge and SV-agreement). As both independent variables have two levels, we can estimate the four cell means with four dummy variables. Let, $D_NP_NP_{i(jk)}$ be a dummy-variable which is turned 'on' only if a score was observed in the condition in which both situational knowledge and SV-agreement were supportive of an NP-coordination, this dummy variable is turned 'off' otherwise. $D_NP_S_{i(jk)}$ is a dummy-variable which indicates whether a score is observed in the condition in which situational knowledge was supportive of an NP-coordination and SV-agreement was supportive of an S-coordination, et cetera. We can write the model to be analyzed as:

$$\begin{aligned}
 Y_{i(jk)} = & D_NP_NP_{i(jk)} * (\beta_1 + e_{1i(jk)} + u_{10j} + v_{10k}) + \\
 & D_NP_S_{i(jk)} * (\beta_2 + e_{2i(jk)} + u_{20j} + v_{20k}) + \\
 & D_S_NP_{i(jk)} * (\beta_3 + e_{3i(jk)} + u_{30j} + v_{30k}) + \\
 & D_S_S_{i(jk)} * (\beta_4 + e_{4i(jk)} + u_{40j} + v_{40k}).
 \end{aligned} \tag{4}$$

The cell means for each combination of situational knowledge and SV-agreement are represented by the fixed parameters ($\beta_1 - \beta_4$).

Appendix 10

Appendix 10

Experimental texts used in Experiment 7

NB

Sentence containing situational knowledge manipulation in *italics*.

Critical sentence in bold face.

The condition in which situational knowledge supports an S-coordination is referred to as *S-context*, the condition in which situational knowledge supports an NP-coordination is referred to as *NP-context*.

For each situational knowledge manipulation, the two SV-agreement manipulations (i.e. the relative clause containing the verb *leek* or *leken*) are presented together in the critical sentence, separated by a slash.

1a. S-context

Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen. Ze had het erg naar haar zin. *Ze vond het alleen vervelend dat hun buurman Peter zoveel alcohol dronk.* Toen hij het zoveelste biertje opentrok, besloot ze er wat van te zeggen. **Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek/leken te zien in nog een biertje, en ze keek hen met boze ogen aan.** Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

1b. NP-context

Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen. Ze had het erg naar haar zin. *Ze vond het alleen vervelend dat Ruben en hun buurman Peter zoveel alcohol dronken.* Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen. **Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek/leken te zien in nog een biertje, en ze keek hen met boze ogen aan.** Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

2a. S-context

Lucas was samen met zijn zus Tessa op vakantie in Griekenland. Hij genoot erg van het prachtige land. *Hij vond het alleen irritant dat hun reisleidster Susan zo passief was ingesteld.* Toen ze alweer voorstelde om naar het strand te gaan, besloot hij er wat van te zeggen. **Lucas bekritiseerde de instelling van Susan en Tessa, die helemaal geen moeite leek/leken te hebben met hele dagen luieren, en hij zei behoefte te hebben aan wat meer actie.** De rest van de vakantie trok Lucas maar zijn eigen plan.

2b. NP-context

Lucas was samen met zijn zus Tessa op vakantie in Griekenland. Hij genoot erg van het prachtige land. *Hij vond het alleen irritant dat Tessa en hun reisleidster Susan zo passief waren ingesteld.* Toen ze alweer voorstelden om naar het strand te gaan, besloot hij er wat van te zeggen. **Lucas bekritiseerde de instelling van Susan en Tessa, die helemaal geen moeite leek/leken te hebben met hele dagen luieren, en hij zei behoefte te hebben aan wat meer actie.** De rest van de vakantie trok Lucas maar zijn eigen plan.

3a. S-context

Emiel gaf samen met zijn collega Sanne een presentatie tijdens een symposium. Hij vond het een vruchtbare en leuke bijeenkomst. *Hij kon het alleen niet waarderen dat zijn bazin Manon tijdens de gezamenlijke lunch over andere collega's stond te roddelen.* Toen ze haar zoveelste kletspraatje begon, spuide hij zijn kritiek. **Emiel zei zich te schamen voor de houding van Manon en Sanne, die absoluut niet vies leek/leken te zijn van een sappig verhaal, en hij keek hen vol onbegrip aan.** De rest van de dag bemoeide Emiel zich niet meer met hen.

3b. NP-context

Emiel gaf samen met zijn collega Sanne een presentatie tijdens een symposium. Hij vond het een vruchtbare en leuke bijeenkomst. *Hij kon het alleen niet waarderen dat Sanne en zijn bazin Manon tijdens de gezamenlijke lunch over andere collega's stonden te roddelen.* Toen ze hun zoveelste kletspraatje begonnen, spuide hij zijn kritiek. **Emiel zei zich te schamen voor de houding van Manon en Sanne, die absoluut niet vies leek/leken te zijn van een sappig verhaal, en hij keek hen vol onbegrip aan.** De rest van de dag bemoeide Emiel zich niet meer met hen.

4a. S-context

Lotte hielp haar broer David met het schilderen van zijn huis. Ze deed haar best om de muren zo netjes mogelijk te witten. *Ze vond het daarom irritant dat haar vader Johan haar de hele tijd op de vingers zat te kijken.* Toen hij zijn zoveelste kritische blik wierp, werd ze boos. **Lotte riep schoon genoeg te hebben van de houding van Johan en David, die het erg verstandig leek/leken te vinden om haar te controleren, en ze dreigde naar huis te gaan.** Na deze uitbarsting kon Lotte haar schilderwerk ongestoord voortzetten.

4b. NP-context

Lotte hielp haar broer David met het schilderen van zijn huis. Ze deed haar best om de muren zo netjes mogelijk te witten. *Ze vond het daarom irritant dat David en haar vader Johan haar de hele tijd op de vingers zaten te kijken.* Toen ze hun zoveelste kritische blik wierpen,

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werd ze boos. **Lotte riep schoon genoeg te hebben van de houding van Johan en David, die het erg verstandig leek/leken te vinden om haar te controleren, en ze dreigde naar huis te gaan.** Na deze uitbarsting kon Lotte haar schilderwerk ongestoord voortzetten.

5a. S-context

Merel zat samen met haar collega Jelle bij een toneelvereniging. De repetities voor het nieuwe stuk verliepen op zich goed. *Merel vond alleen dat de regisseur Simon soms nogal vreemde artistieke inzichten had.* Toen hij weer eens met een slecht idee kwam, besloot ze het tijdens de repetities aan te kaarten. **Merel zei vaak te twifelen aan het oordeel van Simon en Jelle, die zelf wel tevreden leek/leken te zijn over de artistieke koers, en ze vertelde wat ze anders wilde.** Op basis van Merels kritiek werd nog een aantal wijzigingen in het stuk doorgevoerd.

5b. NP-context

Merel zat samen met haar collega Jelle bij een toneelvereniging. De repetities voor het nieuwe stuk verliepen op zich goed. *Merel vond alleen dat Jelle en de regisseur Simon soms nogal vreemde artistieke inzichten hadden.* Toen ze weer eens met een slecht idee kwamen, besloot ze het tijdens de repetities aan te kaarten. **Merel zei vaak te twifelen aan het oordeel van Simon en Jelle, die zelf wel tevreden leek/leken te zijn over de artistieke koers, en ze vertelde wat ze anders wilde.** Op basis van Merels kritiek werd nog een aantal wijzigingen in het stuk doorgevoerd.

6a. S-context

Anouk speelde samen met haar vriend Joris in een band. Ze was op zich erg tevreden over hun nieuwe nummers. *Ze vond alleen dat de bassist Remco in één nummer slecht speelde.* Toen hij er zelf geen blijk van gaf dit in te zien, bracht ze het tijdens de repetities subtiel ter sprake. **Anouk zei te twifelen aan de muzikale visie van Remco en Joris, die juist erg ingenomen leek/leken te zijn met het betreffende nummer, en ze kwam met een andere suggestie.** Na een aantal aanpassingen was ook Anouk helemaal tevreden.

6b. NP-context

Anouk speelde samen met haar vriend Joris in een band. Ze was op zich erg tevreden over hun nieuwe nummers. *Ze vond alleen dat Joris en de bassist Remco in één nummer slecht speelden.* Toen ze er zelf geen blijk van gaven dit in te zien, bracht ze het tijdens de repetities subtiel ter sprake. **Anouk zei te twifelen aan de muzikale visie van Remco en Joris, die juist erg ingenomen leek/leken te zijn met het betreffende nummer, en ze kwam met een andere suggestie.** Na een aantal aanpassingen was ook Anouk helemaal tevreden.

7a. S-context

Hanna ging bij haar buurjongen Kevin voetbal kijken. Het was een leuke wedstrijd. *Het stoorde Hanna alleen dat haar buurman Boris zo grof in de mond was.* Toen hij voor de zoveelste keer vloekte, was ze het zat. **Hanna klaagde over de onbehoorlijke houding van Boris en Kevin, die geen enkele moeite leek/leken te hebben met zulke platte taal, en ze besloot naar huis te gaan.** De volgende dag kreeg Hanna een bosje bloemen om het goed te maken.

7b. NP-context

Hanna ging bij haar buurjongen Kevin voetbal kijken. Het was een leuke wedstrijd. *Het stoorde Hanna alleen dat Kevin en haar buurman Boris zo grof in de mond waren.* Toen ze voor de zoveelste keer vloekten, was ze het zat. **Hanna klaagde over de onbehoorlijke houding van Boris en Kevin, die geen enkele moeite leek/leken te hebben met zulke platte taal, en ze besloot naar huis te gaan.** De volgende dag kreeg Hanna een bosje bloemen om het goed te maken.

8a. S-context

Arjan gaf zijn nichtje Sofie bij haar thuis bijles. Hij vond het geen probleem om haar te helpen. *Hij kon het alleen slecht hebben dat zijn tante Marie steeds door zijn uitleg heen zat te praten.* Toen ze maar bleef doorkletsen, werd hij boos. **Arjan zei zich te storen aan de instelling van Marie en Sofie, die geen enkel kwaad leek/leken te zien in een beetje gebabbel, en hij maakte duidelijk dat zijn geduld opraakte.** Vanaf dat moment kon Arjan ongestoord bijles geven.

8b. NP-context

Arjan gaf zijn nichtje Sofie bij haar thuis bijles. Hij vond het geen probleem om haar te helpen. *Hij kon het alleen slecht hebben dat Sofie en zijn tante Marie steeds door zijn uitleg heen zaten te praten.* Toen ze maar bleven doorkletsen, werd hij boos. **Arjan zei zich te storen aan de instelling van Marie en Sofie, die geen enkel kwaad leek/leken te zien in een beetje gebabbel, en hij maakte duidelijk dat zijn geduld opraakte.** Vanaf dat moment kon Arjan ongestoord bijles geven.

9a. S-context

Evert had een groot project overgenomen van zijn cheffin Femke. Hij vond zelf dat hij snelle vorderingen maakte. *Hij was dan ook verbijsterd dat zijn collega Linda tijdens een vergadering aangaf dat ze het tegendeel vond.* Toen ze ook haar twijfels uitte over zijn algemene capaciteiten, werd hij kwaad. **Evert zei zich te ergeren aan de opstelling van Linda en Femke, die helemaal niets verkeerd leek/leken te zien in zulke afbrekende**

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kritiek, en hij keek ze vol verontwaardiging aan. Na deze uitval liep Evert weg uit de vergadering.

9b. NP-context

Evert had een groot project overgenomen van zijn cheffin Femke. Hij vond zelf dat hij snelle vorderingen maakte. *Hij was dan ook verbijsterd dat Femke en zijn collega Linda tijdens een vergadering aangaven dat ze het tegendeel vonden.* Toen ze ook hun twijfels uitten over zijn algemene capaciteiten, werd hij kwaad. **Evert zei zich te ergeren aan de opstelling van Linda en Femke, die helemaal niets verkeers leek/leken te zien in zulke afbrekende kritiek, en hij keek ze vol verontwaardiging aan.** Na deze uitval liep Evert weg uit de vergadering.

10a. S-context

Nienke had een afspraak met haar mondhygiënist Martin voor een gebits-reiniging. Ze was niet nerveus, want de behandeling verliep voorheen altijd pijnloos. *Het viel haar dan ook vies tegen dat de assistent Rutger haar dit keer nogal ruw onder handen nam.* Toen hij haar voor de zoveelste keer pijn deed, schoot ze uit haar stoel. **Nienke uitte felle kritiek op de houding van Rutger en Martin, die helemaal niets verkeers leek/leken te zien in de hardhandig aanpak, en ze begon een beetje te snotten.** Na deze vervelende ervaring besloot ze een andere mondhygiënist te zoeken.

10b. NP-context

Nienke had een afspraak met haar mondhygiënist Martin voor een gebits-reiniging. Ze was niet nerveus, want de behandeling verliep voorheen altijd pijnloos. *Het viel haar dan ook vies tegen dat Martin en de assistent Rutger haar dit keer nogal ruw onder handen namen.* Toen ze haar voor de zoveelste keer pijn deden, schoot ze uit haar stoel. **Nienke uitte felle kritiek op de houding van Rutger en Martin, die helemaal niets verkeers leek/leken te zien in de hardhandig aanpak, en ze begon een beetje te snotten.** Na deze vervelende ervaring besloot ze een andere mondhygiënist te zoeken.

11a. S-context

Wouter schreef een scriptie bij zijn docente Taalkunde Margot. Hij vond zelf dat het een goed stuk werd. *Hij baalde er dan ook van dat zijn tweede begeleidster Renske hem alleen maar commentaar gaf.* Toen ze hem tijdens het volgende overleg weer flink afkraakte, besloot hij er wat van te zeggen. **Wouter klaagde over de opstelling van Renske en Margot, die erg veel nut leek/leken te zien in zulke forse kritiek, en hij liep teleurgesteld de kamer uit.** Na deze aanvaring zocht Wouter andere scriptiebegeleiders.

11b. NP-context

Wouter schreef een scriptie bij zijn docente Taalkunde Margot. Hij vond zelf dat het een goed stuk werd. *Hij baalde er dan ook van dat Margot en zijn tweede begeleidster Renske hem alleen maar commentaar gaven.* Toen ze hem tijdens het volgende overleg weer flink afkraakten, besloot hij er wat van te zeggen. **Wouter klaagde over de opstelling van Renske en Margot, die erg veel nut leek/leken te zien in zulke forse kritiek, en hij liep teleurgesteld de kamer uit.** Na deze aanvaring zocht Wouter andere scriptiebegeleiders.

12a. S-context

Victor had een studentenkamer gevonden bij zijn studiegenootje Maaïke in huis. Hij was er in eerste instantie super blij mee. *Hij merkte echter al gauw dat huisgenote Judith haar schoonmaakbeurt nooit deed.* Toen ze haar plicht weer eens had verzuimd, deed hij tijdens het eten zijn beklag. **Victor hekelde de instelling van Judith en Maaïke, die helemaal niet leek/leken te zitten met de enorme viezigheid, en hij dreigde de huisbaas erover te bellen.** De weken na dit incident werd Victor door zijn huisgenoten straal genegeerd.

12b. NP-context

Victor had een studentenkamer gevonden bij zijn studiegenootje Maaïke in huis. Hij was er in eerste instantie super blij mee. *Hij merkte echter al gauw dat Maaïke en huisgenote Judith hun schoonmaakbeurt nooit deden.* Toen ze hun plicht weer eens hadden verzuimd, deed hij tijdens het eten zijn beklag. **Victor hekelde de instelling van Judith en Maaïke, die helemaal niet leek/leken te zitten met de enorme viezigheid, en hij dreigde de huisbaas erover te bellen.** De weken na dit incident werd Victor door zijn huisgenoten straal genegeerd.

13a. S-context

Laura runde samen met haar broer Menno een restaurant. Ze was best tevreden over de gang van zaken. *Het stoorde haar alleen dat de cheffok Erwin niet te genieten was als hij het druk had.* Toen hij haar weer eens de hele avond zat af te snauwen, besloot ze er na sluitingstijd wat van te zeggen. **Laura zei enorm te balen van de houding van Erwin en Menno, die geen enkele moeite leek/leken te hebben met de geladen sfeer, en ze eiste een directe verandering van mentaliteit.** Na haar uitbarsting werd de sfeer gelukkig iets gemoedelijker.

13b. NP-context

Laura runde samen met haar broer Menno een restaurant. Ze was best tevreden over de gang van zaken. *Het stoorde haar alleen dat Menno en de cheffok Erwin niet te genieten waren als ze het druk hadden.* Toen ze haar weer eens de hele avond zaten af te snauwen, besloot ze er na sluitingstijd wat van te zeggen. **Laura zei enorm te balen van de houding van**

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Erwin en Menno, die geen enkele moeite leek/leken te hebben met de geladen sfeer, en ze eiste een directe verandering van mentaliteit. Na haar uitbarsting werd de sfeer gelukkig iets gemoedelijker.

14a. S-context

Jacob bereidde samen met zijn collega Mieke een reisgids voor over Spanje. Hij was zelf erg tevreden met zijn aandeel. *Het stoorde hem dan ook dat de uitgeefster Karin er tijdens een overleg nogal wat commentaar op had.* Toen ze niets positiefs over zijn bijdrage zei, werd hij boos. **Jacob bekritiseerde de instelling van Karin en Mieke, die zoveel kritiek bevorderlijk leek/leken te vinden voor een goed eindproduct, en hij dreigde ermee op te houden.** Na deze uitbarsting waren de verhoudingen voorgoed verstoord.

14b. NP-context

Jacob bereidde samen met zijn collega Mieke een reisgids voor over Spanje. Hij was zelf erg tevreden met zijn aandeel. *Het stoorde hem dan ook dat Mieke en de uitgeefster Karin er tijdens een overleg nogal wat commentaar op hadden.* Toen ze niets positiefs over zijn bijdrage zeiden, werd hij boos. **Jacob bekritiseerde de instelling van Karin en Mieke, die zoveel kritiek bevorderlijk leek/leken te vinden voor een goed eindproduct, en hij dreigde ermee op te houden.** Na deze uitbarsting waren de verhoudingen voorgoed verstoord.

15a. S-context

Jolien verwachtte samen met haar vriend Marcel een kindje. Ze voelde zich gelukkig erg fit. *Ze kon het daarom niet goed hebben dat haar vader Willem haar steeds tot rust maande.* Toen hij haar tijdens een etentje voor de zoveelste keer bemoeizuchtige goede raad gaf, was ze het zat. **Jolien mopperde over de houding van Willem en Marcel, die het erg verstandig leek/leken te vinden om haar te betuttelen, en ze zei dat ze haar met rust moesten laten.** Ze haastte zich wel te zeggen dat ze begreep dat het allemaal lief was bedoeld.

15b. NP-context

Jolien verwachtte samen met haar vriend Marcel een kindje. Ze voelde zich gelukkig erg fit. *Ze kon het daarom niet goed hebben dat Marcel en haar vader Willem haar steeds tot rust maanden.* Toen ze haar tijdens een etentje voor de zoveelste keer bemoeizuchtige goede raad gaven, was ze het zat. **Jolien mopperde over de houding van Willem en Marcel, die het erg verstandig leek/leken te vinden om haar te betuttelen, en ze zei dat ze haar met rust moesten laten.** Ze haastte zich wel te zeggen dat ze begreep dat het allemaal lief was bedoeld.

16a. S-context

Joris woonde samen met zijn buurvrouw Ingrid een buurtbijeenkomst bij over jongerenoverlast. Hij vond dat er goed over de kwestie werd gediscussieerd. *Het stoorde hem alleen dat buurtgenote Daphne zich zo jolig gedroeg.* Toen ze voor de zoveelste keer een flauwe opmerking maakte, zei hij er wat van. **Joris zei zich te ergeren aan de houding van Daphne en Ingrid, die helemaal geen kwaad leek/leken te zien in zulk uitbundig gedrag, en hij trok een zeer ernstig gezicht.** Na deze kritiek kwam Joris met een serieus voorstel om de jongerenoverlast te beperken.

16b. NP-context

Joris woonde samen met zijn buurvrouw Ingrid een buurtbijeenkomst bij over jongerenoverlast. Hij vond dat er goed over de kwestie werd gediscussieerd. *Het stoorde hem alleen dat Ingrid en buurtgenote Daphne zich zo jolig gedroegen.* Toen ze voor de zoveelste keer een flauwe opmerking maakten, zei hij er wat van. **Joris zei zich te ergeren aan de houding van Daphne en Ingrid, die helemaal geen kwaad leek/leken te zien in zulk uitbundig gedrag, en hij trok een zeer ernstig gezicht.** Na deze kritiek kwam Joris met een serieus voorstel om de jongerenoverlast te beperken.

17a. S-context

Esther had met haar broer Morris een familiedag georganiseerd. Ze vond het erg leuk om iedereen weer te zien. *Het irriteerde haar alleen een beetje dat oom Pieter haar steeds in de maling nam.* Toen hij haar voor de zoveelste keer had beetgenomen, had ze er genoeg van. **Esther klaagde moe te worden van de humor van Pieter en Morris, die erg veel plezier leek/leken te beleven aan haar goedgelovige aard, en ze vroeg hen een ander mikpunt te kiezen.** Na deze woorden werd ze met rust gelaten.

17b. NP-context

Esther had met haar broer Morris een familiedag georganiseerd. Ze vond het erg leuk om iedereen weer te zien. *Het irriteerde haar alleen een beetje dat Morris en oom Pieter haar steeds in de maling namen.* Toen ze haar voor de zoveelste keer hadden beetgenomen, had ze er genoeg van. **Esther klaagde moe te worden van de humor van Pieter en Morris, die erg veel plezier leek/leken te beleven aan haar goedgelovige aard, en ze vroeg hen een ander mikpunt te kiezen.** Na deze woorden werd ze met rust gelaten.

18a. S-context

Sarah nam met haar ploeggenoot Casper deel aan een schaatstoernooi. Haar eerste race verliep aanvankelijk goed. *Daarna verloor ze echter haar concentratie, doordat haar coach Douwe heel hard stond te schreeuwen langs de kant.* Toen hij maar tekeer bleef gaan en ze de race verloor, werd ze boos. **Sarah verfoeide de visie van Douwe en Casper, die erg veel**

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nut leek/leken te zien in zulk hard geschreeuw, en ze ging boos naar de kleedkamer. Tijdens de volgende race kon Sarah ongestoord haar rit uit-rijden.

18b. NP-context

Sarah nam met haar ploeggenoot Casper deel aan een schaatstoernooi. Haar eerste race verliep aanvankelijk goed. *Daarna verloor ze echter haar concentratie, doordat Casper en haar coach Douwe heel hard stonden te schreeuwen langs de kant.* Toen ze maar tekeer bleven gaan en ze de race verloor, werd ze boos. **Sarah verfoeide de visie van Douwe en Casper, die erg veel nut leek/leken te zien in zulk hard geschreeuw, en ze ging boos naar de kleedkamer.** Tijdens de volgende race kon Sarah ongestoord haar rit uit-rijden.

19a. S-context

Laurens was met zijn vriendin Paulien op babybezoek. Hij vond de pas-geborene erg schattig om te zien. *Hij kon het alleen niet waarderen dat de kersverse moeder Chantal de baby steeds bij hem op schoot zette.* Toen ze dit voor de derde keer deed, was hij het zat. **Laurens mopperde over de houding van Chantal en Paulien, die alleen maar vertederd leek/leken te zijn door zijn benauwde gezicht, en hij gaf de baby gauw weer terug.** Na zijn gemopper werd Laurens gelukkig weer even met rust gelaten.

19b. NP-context

Laurens was met zijn vriendin Paulien op babybezoek. Hij vond de pasgeborene erg schattig om te zien. *Hij kon het alleen niet waarderen dat Paulien en de kersverse moeder Chantal de baby steeds bij hem op schoot zetten.* Toen ze dit voor de derde keer deden, was hij het zat. **Laurens mopperde over de houding van Chantal en Paulien, die alleen maar vertederd leek/leken te zijn door zijn benauwde gezicht, en hij gaf de baby gauw weer terug.** Na zijn gemopper werd Laurens gelukkig weer even met rust gelaten.

20a. S-context

Kirsten was bij haar kapper Robbert om te overleggen over haar bruidskapsel. Ze had zelf al een aantal goede ideeën bedacht, zo vond ze zelf. *Het stoorde haar dan ook dat collega-kapper Michiel steeds misprijzend zijn hoofd zat te schudden.* Toen hij weer een afkeurend gebaar maakte, zei ze er wat van. **Kirsten bekritiseerde de houding van Michiel en Robbert, die het heel gewoon leek/leken te vinden om klanten te beledigen, en ze besloot naar een andere salon te gaan.** Tijdens de bruiloft zat Kirstens haar precies zoals ze het had gewild.

20b. NP-context

Kirsten was bij haar kapper Robbert om te overleggen over haar bruidskapsel. Ze had zelf al een aantal goede ideeën bedacht, zo vond ze zelf. *Het stoorde haar dan ook dat Robbert en*

collega-kapper Michiel steeds misprijzend hun hoofd zaten te schudden. Toen ze weer een afkeurend gebaar maakten, zei ze er wat van. **Kirsten bekritiseerde de houding van Michiel en Robbert, die het heel gewoon leek/leken te vinden om klanten te beledigen, en ze besloot naar een andere salon te gaan.** Tijdens de bruiloft zat Kirstens haar precies zoals ze het had gewild.

21a. S-context

Petra ging naar een optreden van de rockband van haar vriend Hidde. Ze genoot met volle teugen van de muziek. *Ze vond het alleen onverantwoordelijk dat de gitarist Ramon de hele tijd in het publiek sprong.* Toen hij bijna iemand verwondde, besloot ze er na het concert in de kleedkamer wat van te zeggen. **Petra klaagde over de houding van Ramon en Hidde, die geen enkel kwaad leek/leken te zien in zulk roekeloos gedrag, en ze zei dat ze hen erg onvolwassen vond.** Na deze woorden ging Petra maar gauw wat te drinken halen.

21b. NP-context

Petra ging naar een optreden van de rockband van haar vriend Hidde. Ze genoot met volle teugen van de muziek. *Ze vond het alleen onverantwoordelijk dat Hidde en de gitarist Ramon de hele tijd in het publiek sprongen.* Toen ze bijna iemand verwondden, besloot ze er na het concert in de kleedkamer wat van te zeggen. **Petra klaagde over de houding van Ramon en Hidde, die geen enkel kwaad leek/leken te zien in zulk roekeloos gedrag, en ze zei dat ze hen erg onvolwassen vond.** Na deze woorden ging Petra maar gauw wat te drinken halen.

22a. S-context

Noortje was toeschouwer bij een hockeywedstrijd van haar broer Lennart. Ze vond het een spannende wedstrijd om te zien. *Het irriteerde haar alleen ontzettend dat de aanvoerder Maurits zijn teamgenoten steeds zo afblafte.* Toen hij zich voor de zoveelste keer liet gaan, besloot ze er na de wedstrijd in de kantine iets van te zeggen. **Noortje zei zich te ergeren aan de mentaliteit van Maurits en Lennart, die helemaal niets onfatsoenlijks leek/leken te zien in zulk onsportief gedrag, en ze zei nooit meer te komen kijken.** Nadat ze haar hart had gelucht, ging Noortje maar gauw naar huis.

22b. NP-context

Noortje was toeschouwer bij een hockeywedstrijd van haar broer Lennart. Ze vond het een spannende wedstrijd om te zien. *Het irriteerde haar alleen ontzettend dat Lennart en de aanvoerder Maurits hun teamgenoten steeds zo afblafte.* Toen ze zich voor de zoveelste keer lieten gaan, besloot ze er na de wedstrijd in de kantine iets van te zeggen. **Noortje zei zich**

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te ergeren aan de mentaliteit van Maurits en Lennart, die helemaal niets onfatsoenlijks leek/leken te zien in zulk onsportief gedrag, en ze zei nooit meer te komen kijken. Nadat ze haar hart had gelucht, ging Noortje maar gauw naar huis.

23a. S-context

Timo woonde met zijn dispuutsgenote Lara een vergadering bij over de ontgroening. Hij verklaarde daar moeite te hebben gekregen met dit ritueel. *Tot zijn ergenis keek de preses Inge hem hierop minachtend aan.* Toen ze ook nog schamper begon te lachen, reageerde hij fel. **Timo zei verbijsterd te zijn over de houding van Inge en Lara, die helemaal niets verkeerds leek/leken te zien in zulk neerbuigend gedrag, en hij besloot naar huis te gaan.** Na dit incident liet Timo weken zijn gezicht niet zien op de sociëteit.

23b. NP-context

Timo woonde met zijn dispuutsgenote Lara een vergadering bij over de ontgroening. Hij vertelde daar moeite te hebben gekregen met dit ritueel. *Tot zijn ergernis keken Lara en de preses Inge hem hierop minachtend aan.* Toen ze ook nog schamper begonnen te lachen, reageerde hij fel. **Timo zei verbijsterd te zijn over de houding van Inge en Lara, die helemaal niets verkeerds leek/leken te zien in zulk neerbuigend gedrag, en hij besloot naar huis te gaan.** Na dit incident liet Timo weken zijn gezicht niet zien op de sociëteit.

24a. S-context

Iris moest autorijexamen doen bij examinerator Hugo. Ze had zelf het gevoel dat het best goed ging. *Ze baalde er dan ook enorm van dat haar rij-instructeur Alex, die ook meereed, voortdurend schamper zat te lachen.* Toen hij wéér minachtend gniffelde, werd ze boos. **Iris zei zich erg te storen aan de houding van Alex en Hugo, die helemaal niets onbeschofts leek/leken te zien in zulk vernederend gedrag, en ze probeerde hierna nog zelfverzekerder te rijden.** Uiteindelijk bleek Iris geslaagd.

24b. NP-context

Iris moest autorijexamen doen bij examinerator Hugo. Ze had zelf het gevoel dat het best goed ging. *Ze baalde er dan ook enorm van dat Hugo en haar rij-instructeur Alex, die ook meereed, voortdurend schamper zaten te lachen.* Toen ze wéér minachtend gniffelden, werd ze boos. **Iris zei zich erg te storen aan de houding van Alex en Hugo, die helemaal niets onbeschofts leek/leken te zien in zulk vernederend gedrag, en ze probeerde hierna nog zelfverzekerder te rijden.** Uiteindelijk bleek Iris geslaagd.

25a. S-context

Vera was bij haar zoon Erik op bezoek. Ze vond het altijd gezellig om even op de koffie te gaan. *Het stoorde haar dit keer alleen dat haar kleinzoon Leon de hele tijd zat te bellen.* Toen hij

ook nog eens driftig begon te sms'en, kon ze zich niet meer bedwingen. **Vera verfoeide de mentaliteit van Leon en Erik, die helemaal niets verkeers leek/leken te zien in zulk intensief belgedrag, en ze keek hen zeer misprijzend aan.** Na deze uitval kreeg Vera de volle aandacht.

25b. NP-context

Vera was bij haar zoon Erik op bezoek. Ze vond het altijd gezellig om even op de koffie te gaan. *Het stoorde haar dit keer alleen dat Erik en haar kleinzoon Leon de hele tijd zaten te bellen.* Toen ze ook nog eens driftig begonnen te sms'en, kon ze zich niet meer bedwingen. **Vera verfoeide de mentaliteit van Leon en Erik, die helemaal niets verkeers leek/leken te zien in zulk intensief belgedrag, en ze keek hen zeer misprijzend aan.** Na deze uitval kreeg Vera de volle aandacht.

26a. S-context

Stefan zat samen met zijn vriendin Mirthe op saxofoonles. Hij vond zo'n uurtje muziek maken heerlijk ontspannend. *Het stoorde hem alleen dat hun muziklerares Jasmijn het gespeelde steeds zo uitgebreid besprak.* Toen ze alweer met een analyse begon, kaartte hij het aan. **Stefan zei erg moe te worden van de opstelling van Jasmijn en Mirthe, die het buitengewoon nuttig leek/leken te vinden om alles te ontleden, en hij trok een erg verveeld gezicht.** Na dit protest mocht hij gelukkig weer gewoon een liedje spelen.

26b. NP-context

Stefan zat samen met zijn vriendin Mirthe op saxofoonles. Hij vond zo'n uurtje muziek maken heerlijk ontspannend. *Het stoorde hem alleen dat Mirthe en hun muziklerares Jasmijn het gespeelde steeds zo uitgebreid bespraken.* Toen ze alweer met een analyse begonnen, kaartte hij het aan. **Stefan zei erg moe te worden van de opstelling van Jasmijn en Mirthe, die het buitengewoon nuttig leek/leken te vinden om alles te ontleden, en hij trok een erg verveeld gezicht.** Na dit protest mocht hij gelukkig weer gewoon een liedje spelen.

27a. S-context

Milan was met zijn vriendin Amber op wintersport. Hij genoot ontzettend van het skiën in de frisse berglucht. *Hij vond het alleen belachelijk dat hun gids Sandra steeds in lawinegevaarlijk gebied wilde afdalen.* Toen ze dit opnieuw voorstelde, werd hij boos. **Milan veroordeelde de opstelling van Sandra en Amber, die helemaal geen kwaad leek/leken te zien in zulk onverantwoordelijk gedrag, en hij besloot naar het hotel te gaan.** De volgende dag trok Milan er maar in zijn eentje op uit.

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27b. NP-context

Milan was met zijn vriendin Amber op wintersport. Hij genoot ontzettend van het skiën in de frisse berglucht. *Hij vond het alleen belachelijk dat Amber en hun gids Sandra steeds in lawinegevaarlijk gebied wilden afdalen.* Toen ze dit opnieuw voorstelden, werd hij boos. **Milan veroordeelde de opstelling van Sandra en Amber, die helemaal geen kwaad leek/leken te zien in zulk onverantwoordelijk gedrag, en hij besloot naar het hotel te gaan.** De volgende dag trok Milan er maar in zijn eentje op uit.

28a. S-context

Otto zat met zijn buurmeisje Anne op salsales. Hij had zelf het gevoel dat hij best goed kon dansen. *Hij was dan ook beledigd toen bleek dat de danslerares Lisa daar heel anders over dacht.* Toen ze maar bleef doorzeuren dat hij stijve heupen had, zei hij er wat van. **Otto klaagde over de houding van Lisa en Anne, die opvallend weinig inzicht leek/leken te hebben in zijn verborgen talenten, en hij dreigde met de cursus te stoppen.** Na deze kritiek kreeg Otto wat meer complimenten.

28b. NP-context

Otto zat met zijn buurmeisje Anne op salsales. Hij had zelf het gevoel dat hij best goed kon dansen. *Hij was dan ook beledigd toen bleek dat Anne en de danslerares Lisa daar heel anders over dachten.* Toen ze maar bleven doorzeuren dat hij stijve heupen had, zei hij er wat van. **Otto klaagde over de houding van Lisa en Anne, die opvallend weinig inzicht leek/leken te hebben in zijn verborgen talenten, en hij dreigde met de cursus te stoppen.** Na deze kritiek kreeg Otto wat meer complimenten.

29a. S-context

Marleen had een afspraak met haar fysiotherapeut Patrick. Ze vond het prettig dat haar spieren even goed werden losgemaakt. *Ze stelde het echter helemaal niet op prijs dat collega-fysiotherapeut Berend steeds luid kletsend de behandelkamer in- en uitliep.* Toen hij dit voor de zoveelste keer deed, zei ze er wat van. **Marleen zei schoon genoeg te hebben van de houding van Berend en Patrick, die de noodzaak niet leek/leken te zien van een rustige behandelomgeving, en ze pakte boos haar kleren bijeen.** Bij de volgende afspraak werd ze wel in alle rust behandeld.

29b. NP-context

Marleen had een afspraak met haar fysiotherapeut Patrick. Ze vond het prettig dat haar spieren even goed werden losgemaakt. *Ze stelde het echter helemaal niet op prijs dat Patrick en collega-fysiotherapeut Berend steeds luid kletsend de behandelkamer in- en uitliepen.* Toen ze dit voor de zoveelste keer deden, zei ze er wat van. **Marleen zei schoon genoeg te hebben van de houding van Berend en Patrick, die de noodzaak niet leek/leken te zien van een**

rustige behandelomgeving, en ze pakte boos haar kleren bijeen. Bij de volgende afspraak werd ze wel in alle rust behandeld.

30a. S-context

Mathijs was samen met zijn vriendin Rachel op een verjaardagsfeestje. Hij vond het best een gezellige avond. *Het irriteerde Mathijs alleen dat de jarige Carlijn hem steeds onder druk zette om karaoke te zingen.* Toen ze hem resoluut een microfoon in zijn handen duwde, werd hij boos. **Mathijs zei zich te storen aan de houding van Carlijn en Rachel, die bijzonder veel lol leek/leken te hebben om zijn hevige verzet, en hij weigerde resoluut om te zingen.** Na deze uitval werd Mathijs niet meer lastig gevallen.

30b. NP-context

Mathijs was samen met zijn vriendin Rachel op een verjaardagsfeestje. Hij vond het best een gezellige avond. *Het irriteerde Mathijs alleen dat Rachel en de jarige Carlijn hem steeds onder druk zetten om karaoke te zingen.* Toen ze hem resoluut een microfoon in zijn handen duwden, werd hij boos. **Mathijs zei zich te storen aan de houding van Carlijn en Rachel, die bijzonder veel lol leek/leken te hebben om zijn hevige verzet, en hij weigerde resoluut om te zingen.** Na deze uitval werd Mathijs niet meer lastig gevallen.

31a. S-context

Jochem was met zijn makelaar Astrid een flat aan het bezichtigen. De flat voldeed redelijk aan zijn wensen. *Jochem vond alleen dat de eigenaresse Moniek over een veel te hoge vraagprijs wilde onderhandelen.* Toen bleek dat ze verwachtte dat hij wel accoord zou gaan, raakte hij geïrriteerd. **Jochem zei zijn twijfels te hebben over de visie van Moniek en Astrid, die helemaal niets mis leek/leken te vinden met de torenhoge prijs, en hij zei op deze manier niet te willen onderhandelen.** Na deze woorden kreeg Jochem al gauw een fatsoenlijkere vraagprijs voorgelegd.

31b. NP-context

Jochem was met zijn makelaar Astrid een flat aan het bezichtigen. De flat voldeed redelijk aan zijn wensen. *Jochem vond alleen dat Astrid en de eigenaresse Moniek over een veel te hoge vraagprijs wilden onderhandelen.* Toen bleek dat ze verwachtten dat hij wel accoord zou gaan, raakte hij geïrriteerd. **Jochem zei zijn twijfels te hebben over de visie van Moniek en Astrid, die helemaal niets mis leek/leken te vinden met de torenhoge prijs, en hij zei op deze manier niet te willen onderhandelen.** Na deze woorden kreeg Jochem al gauw een fatsoenlijkere vraagprijs voorgelegd.

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32a. S-context

Marco was met zijn vriendin Lieke boodschappen aan het doen bij hun buurtsuper. Hij had een hekel aan boodschappen doen en was dan ook blij dat ze snel klaar waren. *Tot zijn grote ergernis begon hun vaste caissière Cindy echter uitgebreid te kletsen.* Toen ze na een paar minuten nog niet was uitgepraat, was hij het zat. **Marco zei erg moe te worden van het geletter van Cindy en Lieke, die een grote passie leek/leken te hebben voor roddel en achterklap, en hij zei dat hij wel wat beters te doen had.** Hierna pakte hij maar gauw de boodschappen in.

32b. NP-context

Marco was met zijn vriendin Lieke boodschappen aan het doen bij hun buurtsuper. Hij had een hekel aan boodschappen doen en was dan ook blij dat ze snel klaar waren. *Tot zijn grote ergernis begonnen Lieke en hun vaste caissière Cindy echter uitgebreid te kletsen.* Toen ze na een paar minuten nog niet waren uitgepraat, was hij het zat. **Marco zei erg moe te worden van het geletter van Cindy en Lieke, die een grote passie leek/leken te hebben voor roddel en achterklap, en hij zei dat hij wel wat beters te doen had.** Hierna pakte hij maar gauw de boodschappen in.

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Experimental texts used in Experiment 8

NB

Sentence containing situational knowledge manipulation in *italics*.

Critical sentence in bold face.

The condition in which situational knowledge supports an S-coordination is referred to as *S-context*, the condition in which situational knowledge supports an NP-coordination is referred to as *NP-context*.

For each situational knowledge manipulation, the two different endings of the critical sentence are presented in the same text, separated by a slash (an NP-coordination ending is referred to as *NP*, an S-coordination ending is referred to as *S*).

1a. S-context

Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen. Ze had het erg naar haar zin. *Ze vond het alleen vervelend dat de buurman van Ruben, Peter, zoveel alcohol dronk.* Toen hij het zoveelste biertje opentrok, besloot ze er wat van te zeggen. **Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, (en ze keek hen met boze ogen aan (NP) / deed alsof hij haar niet hoorde (S)).** Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

1b. NP-context

Ellen gaf samen met haar vriend Ruben een feestje ter gelegenheid van hun verjaardagen. Ze had het erg naar haar zin. *Ze vond het alleen vervelend dat Ruben en zijn buurman Peter zoveel alcohol dronken.* Toen ze het zoveelste biertje opentrokken, besloot ze er wat van te zeggen. **Ellen zei te balen van de houding van Peter en Ruben, die totaal geen kwaad leek te zien in nog een biertje, (en ze keek hen met boze ogen aan (NP) / deed alsof hij haar niet hoorde (S)).** Na deze aanvaring besloot Ellen zich maar niet meer met hen te bemoeien.

2a. S-context

Lucas was samen met zijn zus Tessa op vakantie in Spanje. Hij genoot erg van het prachtige land. *Hij vond het alleen irritant dat het vakantie vriendinnetje van Tessa, Susan, zo passief was ingesteld.* Toen ze alweer voorstelde om naar het strand te gaan, besloot hij er wat van te zeggen. **Lucas bekritiseerde de instelling van Susan en Tessa, die helemaal geen moeite leek te hebben met hele dagen luieren, (en hij zei behoefte te hebben aan**

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wat meer actie (NP) / keek haar broer verbaasd aan (S)). De rest van de vakantie trok Lucas maar zijn eigen plan.

2b. NP-context

Lucas was samen met zijn zus Tessa op vakantie in Spanje. Hij genoot erg van het prachtige land. *Hij vond het alleen irritant dat Tessa en haar vakantieviendinnetje Susan zo passief waren ingesteld.* Toen ze alweer voorstelden om naar het strand te gaan, besloot hij er wat van te zeggen. **Lucas bekritiseerde de instelling van Susan en Tessa, die helemaal geen moeite leek te hebben met hele dagen luieren, (en hij zei behoefte te hebben aan wat meer actie (NP) / keek haar broer verbaasd aan (S)).** De rest van de vakantie trok Lucas maar zijn eigen plan.

3a. S-context

Emiel gaf samen met collega-onderzoeker Sanne een presentatie tijdens een symposium. Hij vond het een vruchtbare en leuke bijeenkomst. *Hij kon het alleen niet waarderen dat de begeleider van Sanne, Manon, tijdens de gezamenlijke lunch over andere collega's stond te roddelen.* Toen ze haar zoveelste kletspraatje begon, spuide hij zijn kritiek. **Emiel zei zich te schamen voor de houding van Manon en Sanne, die absoluut niet vies leek te zijn van een sappig verhaal, (en hij keek hen vol onbegrip aan (NP) / deed alsof haar neus bloedde (S)).** De rest van de dag bemoeide Emiel zich niet meer met hen.

3b. NP-context

Emiel gaf samen met zijn collega-onderzoeker Sanne een presentatie tijdens een symposium. Hij vond het een vruchtbare en leuke bijeenkomst. *Hij kon het alleen niet waarderen dat Sanne en haar begeleider Manon tijdens de gezamenlijke lunch over andere collega's stonden te roddelen.* Toen ze hun zoveelste kletspraatje begonnen, spuide hij zijn kritiek. **Emiel zei zich te schamen voor de houding van Manon en Sanne, die absoluut niet vies leek te zijn van een sappig verhaal, (en hij keek hen vol onbegrip aan (NP) / deed alsof haar neus bloedde (S)).** De rest van de dag bemoeide Emiel zich niet meer met hen.

4a. S-context

Lotte hielp haar beste vriend David met het schilderen van zijn huis. Ze deed haar best om de muren zo netjes mogelijk te witten. *Ze vond het daarom irritant dat de broer van David, Johan, haar de hele tijd op de vingers zat te kijken.* Toen hij zijn zoveelste kritische blik wierp, werd ze boos. **Lotte riep schoon genoeg te hebben van de houding van Johan en David, die het erg verstandig leek te vinden om haar te controleren, (en ze dreigde naar huis te gaan (NP) / liep maar even de kamer uit (S)).** Na deze uitbarsting kon Lotte haar schilderwerk ongestoord voortzetten.

4b. NP-context

Lotte hielp haar beste vriend David met het schilderen van zijn huis. Ze deed haar best om de muren zo netjes mogelijk te witten. *Ze vond het daarom irritant dat David en zijn broer Johan haar de hele tijd op de vingers zaten te kijken.* Toen ze hun zoveelste kritische blik wierpen, werd ze boos. **Lotte riep schoon genoeg te hebben van de houding van Johan en David, die het erg verstandig leek te vinden om haar te controleren, (en ze dreigde naar huis te gaan (NP) / liep maar even de kamer uit (S)).** Na deze uitbarsting kon Lotte haar schilderwerk ongestoord voortzetten.

5a. S-context

Merel zat samen met haar collega Jelle bij een toneel- vereniging. De repetities voor het nieuwe stuk verliepen op zich goed. *Merel vond alleen dat de tegenspeler van Jelle, Simon, soms nogal vreemde artistieke inzichten had..* Toen hij weer eens met een slecht idee kwam, besloot ze het tijdens de repetities aan te kaarten. **Merel zei vaak te twijfelen aan het oordeel van Simon en Jelle, die zelf wel tevreden leek te zijn over de artistieke koers, (en ze vertelde wat ze anders wilde (NP) / luisterde aandachtig naar haar woorden (S)).** Op basis van Merels kritiek werd nog een aantal wijzigingen in het stuk doorgevoerd.

5b. NP-context

Merel zat samen met haar collega Jelle bij een toneel- vereniging. De repetities voor het nieuwe stuk verliepen op zich goed. *Merel vond alleen dat Jelle en zijn tegenspeler Simon soms nogal vreemde artistieke inzichten hadden.* Toen ze weer eens met een slecht idee kwamen, besloot ze het tijdens de repetities aan te kaarten. **Merel zei vaak te twijfelen aan het oordeel van Simon en Jelle, die zelf wel tevreden leek te zijn over de artistieke koers, (en ze vertelde wat ze anders wilde (NP) / luisterde aandachtig naar haar woorden (S)).** Op basis van Merels kritiek werd nog een aantal wijzigingen in het stuk doorgevoerd.

6a. S-context

Anouk speelde samen met haar buurjongen Joris in een band. Ze was op zich erg tevreden over hun nieuwe nummers. *Ze vond alleen dat de vriend van Joris, Remco, in één nummer slecht speelde.* Toen hij er zelf geen blijk van gaf dit in te zien, bracht ze het tijdens de repetities subtiel ter sprake. **Anouk zei te twijfelen aan de muzikale visie van Remco en Joris, die juist erg ingenomen leek te zijn met het betreffende nummer, (en ze kwam met een andere suggestie (NP) / vroeg haar of ze een alternatief had (S)).** Na een aantal aanpassingen was ook Anouk helemaal tevreden.

6b. NP-context

Anouk speelde samen met haar buurjongen Joris in een band. Ze was op zich erg tevreden over hun nieuwe nummers. *Ze vond alleen dat Joris en zijn vriend Remco in één nummer slecht*

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speelden. Toen ze er zelf geen blijk van gaven dit in te zien, bracht ze het tijdens de repetities subtiel ter sprake. **Anouk zei te twifelen aan de muzikale visie van Remco en Joris, die juist erg ingenomen leek te zijn met het betreffende nummer, (en ze kwam met een andere suggestie (NP) / vroeg haar of ze een alternatief had (S))**. Na een aantal aanpassingen was ook Anouk helemaal tevreden.

7a. S-context

Hanna ging bij haar buurjongen Kevin voetbal kijken. Het was een leuke wedstrijd. *Het stoorde Hanna alleen dat de vader van Kevin, Boris, zo grof in de mond was*. Toen hij voor de zoveelste keer vloekte, was ze het zat. **Hanna klaagde over de onbehoorlijke houding van Boris en Kevin, die geen enkele moeite leek te hebben met zulke platte taal, (en ze besloot naar huis te gaan (NP) / moest erg om haar lachen (S))**. De volgende dag kreeg Hanna een bosje bloemen om het goed te maken.

7b. NP-context

Hanna ging bij haar buurjongen Kevin voetbal kijken. Het was een leuke wedstrijd. *Het stoorde Hanna alleen dat Kevin en zijn vader Boris zo grof in de mond waren*. Toen ze voor de zoveelste keer vloekten, was ze het zat. **Hanna klaagde over de onbehoorlijke houding van Boris en Kevin, die geen enkele moeite leek te hebben met zulke platte taal, (en ze besloot naar huis te gaan (NP) / moest erg om haar lachen (S))**. De volgende dag kreeg Hanna een bosje bloemen om het goed te maken.

8a. S-context

Arjan gaf zijn klasgenootje Sofie bij haar thuis bijles. Hij vond het geen probleem om haar te helpen. *Hij kon het alleen slecht hebben dat de moeder van Sofie, Marit, steeds door zijn uitleg heen zat te praten*. Toen ze maar bleef doorkletsen, werd hij boos. **Arjan zei zich te storen aan de instelling van Marit en Sofie, die geen enkel kwaad leek te zien in een beetje gebabbel, (en hij maakte duidelijk dat zijn geduld opraakte (NP) / keek hem met opgetrokken wenkbrauwen aan (S))**. Vanaf dat moment kon Arjan ongestoord bijles geven.

8b. NP-context

Arjan gaf zijn klasgenootje Sofie bij haar thuis bijles. Hij vond het geen probleem om haar te helpen. *Hij kon het alleen slecht hebben dat Sofie en haar moeder Marit steeds door zijn uitleg heen zaten te praten*. Toen ze maar bleven doorkletsen, werd hij boos. **Arjan zei zich te storen aan de instelling van Marit en Sofie, die geen enkel kwaad leek te zien in een beetje gebabbel, (en hij maakte duidelijk dat zijn geduld opraakte (NP) / keek hem met opgetrokken wenkbrauwen aan (S))**. Vanaf dat moment kon Arjan ongestoord bijles geven.

9a. S-context

Evert had een groot project overgenomen van zijn cheffin Femke. Hij vond zelf dat hij snel vorderingen maakte. *Hij was dan ook verbijsterd dat de assistente van Femke, Linda, tijdens een vergadering aangaf dat ze het tegendeel vond.* Toen ze ook haar twijfels uitte over zijn capaciteiten in het algemeen, werd hij kwaad. **Evert zei zich te ergeren aan de opstelling van Linda en Femke, die helemaal niets verkeers leek te zien in zulke afbrekende kritiek, (en hij keek ze vol verontwaardiging aan (NP) / probeerde hem een beetje te kalmeren (S)).** Na deze uitval liep Evert weg uit de vergadering.

9b. NP-context

Evert had een groot project overgenomen van zijn cheffin Femke. Hij vond zelf dat hij snel vorderingen maakte. *Hij was dan ook verbijsterd dat Femke en haar assistente Linda tijdens een vergadering aangaven dat ze het tegendeel vonden.* Toen ze ook hun twijfels uitten over zijn capaciteiten in het algemeen, werd hij kwaad. **Evert zei zich te ergeren aan de opstelling van Linda en Femke, die helemaal niets verkeers leek te zien in zulke afbrekende kritiek, (en hij keek ze vol verontwaardiging aan (NP) / probeerde hem een beetje te kalmeren (S)).** Na deze uitval liep Evert weg uit de vergadering.

10a. S-context

Wouter schreef een scriptie bij zijn docente Taalkunde Margot. Hij vond zelf dat het een goed stuk werd. *Hij baalde er dan ook van dat de collega-begeleider van Margot, Renske, hem alleen maar commentaar gaf.* Toen ze hem tijdens het volgende overleg weer flink afkraakte, besloot hij er wat van te zeggen. **Wouter klaagde over de opstelling van Renske en Margot, die erg veel nut leek te zien in zulke forse kritiek, (en hij liep teleurgesteld de kamer uit (NP) / liet hem maar even uitrazen (S)).** Na deze aanvaring zocht Wouter andere scriptie-begeleiders.

10b. NP-context

Wouter schreef een scriptie bij zijn docente Taalkunde Margot. Hij vond zelf dat het een goed stuk werd. *Hij baalde er dan ook van dat Margot en haar collega-begeleider Renske hem alleen maar commentaar gaven.* Toen ze hem tijdens het volgende overleg weer flink afkraakten, besloot hij er wat van te zeggen. **Wouter klaagde over de opstelling van Renske en Margot, die erg veel nut leek te zien in zulke forse kritiek, (en hij liep teleurgesteld de kamer uit (NP) / liet hem maar even uitrazen (S)).** Na deze aanvaring zocht Wouter andere scriptie-begeleiders.

11a. S-context

Victor had een studentenkamer gevonden bij zijn studiegenootje Maaïke in huis. Hij was er in eerste instantie erg blij mee. *Hij merkte echter al gauw dat het huisvriendinnetje van*

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Maaïke, Judith, haar schoonmaakbeurt nooit deed. Toen ze haar plicht weer eens had verzuimd, deed hij tijdens het eten zijn beklag. **Victor hekelde de instelling van Judith en Maaïke, die helemaal niet leek te zitten met de enorme viezigheid, (en hij dreigde de huisbaas erover te bellen (NP) / haalde onverschillig haar schouders op (S)).** De weken na dit incident werd Victor door zijn huisgenoten straal genegeerd.

11b. NP-context

Victor had een studentenkamer gevonden bij zijn studiegenootje Maaïke in huis. Hij was er in eerste instantie erg blij mee. *Hij merkte echter al gauw dat Maaïke en haar huisvriendinnetje Judith hun schoonmaakbeurt nooit deden.* Toen ze hun plicht weer eens hadden verzuimd, deed hij tijdens het eten zijn beklag. **Victor hekelde de instelling van Judith en Maaïke, die helemaal niet leek te zitten met de enorme viezigheid, (en hij dreigde de huisbaas erover te bellen (NP) / haalde onverschillig haar schouders op (S)).** De weken na dit incident werd Victor door zijn huisgenoten straal genegeerd.

12a. S-context

Laura runde samen met haar broer Menno een restaurant. Ze was best tevreden over de gang van zaken. *Het stoorde haar alleen dat de assistent van Menno, Erwin, niet te genieten was als hij het druk had.* Toen hij haar weer eens de hele avond zat af te snauwen, besloot ze er na sluitingstijd wat van te zeggen. **Laura zei enorm te balen van de houding van Erwin en Menno, die geen enkele moeite leek te hebben met de geladen sfeer, (en ze eiste een directe verandering van mentaliteit (NP) / vond haar uitval nogal overdreven (S)).** Na haar uitbarsting werd de sfeer gelukkig iets gemoedelijker.

12b. NP-context

Laura runde samen met haar broer Menno een restaurant. Ze was best tevreden over de gang van zaken. *Het stoorde haar alleen dat Menno en zijn assistent Erwin niet te genieten waren als ze het druk hadden.* Toen ze haar weer eens de hele avond zaten af te snauwen, besloot ze er na sluitingstijd wat van te zeggen. **Laura zei enorm te balen van de houding van Erwin en Menno, die geen enkele moeite leek te hebben met de geladen sfeer, (en ze eiste een directe verandering van mentaliteit (NP) / vond haar uitval nogal overdreven (S)).** Na haar uitbarsting werd de sfeer gelukkig iets gemoedelijker.

13a. S-context

Jacob bereidde met zijn collega Mieke een reisgids voor over Spanje. Hij was zelf erg tevreden met zijn aandeel. *Het stoorde hem daarom dat de corrector van Mieke, Karin, tijdens een overleg erg veel commentaar had.* Toen ze niets positiefs over zijn bijdrage zei, werd hij boos. **Jacob bekritiseerde de instelling van Karin en Mieke, die zoveel kritiek bevorderlijk leek te vinden voor een goed eindproduct, (en hij dreigde ermee op te**

houden (NP) / vond hem maar een zeurpiet (S)). Na deze uitbarsting waren de verhoudingen voorgoed verstoord.

13b. NP-context

Jacob bereidde met zijn collega Mieke een reisgids voor over Spanje. Hij was zelf erg tevreden met zijn aandeel. *Het stoorde hem daarom dat Mieke en haar corrector Karin tijdens een overleg erg veel commentaar hadden.* Toen ze niets positiefs over zijn bijdrage zeiden, werd hij boos. **Jacob bekritiseerde de instelling van Karin en Mieke, die zoveel kritiek bevorderlijk leek te vinden voor een goed eindproduct, (en hij dreigde ermee op te houden (NP) / vond hem maar een zeurpiet (S)).** Na deze uitbarsting waren de verhoudingen voorgoed verstoord.

14a. S-context

Jolien verwachtte samen met haar vriend Marcel een kindje. Ze voelde zich gelukkig erg fit. *Ze kon het daarom niet goed hebben dat de vader van Marcel, Willem, haar steeds tot rust maande.* Toen hij haar tijdens een etentje weer bemoeizuchtige goede raad gaf, was ze het zat. **Jolien mopperde over de houding van Willem en Marcel, die het erg verstandig leek te vinden om haar te betuttelen, (en ze zei dat ze haar met rust moesten laten (NP) / vond haar geklaag wel vertederend (S)).** Ze haastte zich wel te zeggen dat ze begreep dat het allemaal lief was bedoeld.

14b. NP-context

Jolien verwachtte samen met haar vriend Marcel een kindje. Ze voelde zich gelukkig erg fit. *Ze kon het daarom niet goed hebben dat Marcel en zijn vader Willem haar steeds tot rust maanden.* Toen ze haar tijdens een etentje weer bemoeizuchtige goede raad gaven, was ze het zat. **Jolien mopperde over de houding van Willem en Marcel, die het erg verstandig leek te vinden om haar te betuttelen, (en ze zei dat ze haar met rust moesten laten (NP) / vond haar geklaag wel vertederend (S)).** Ze haastte zich wel te zeggen dat ze begreep dat het allemaal lief was bedoeld.

15a. S-context

Laurens was met zijn vriendin Paulien op babybezoek. Hij vond de pasgeborene erg schattig om te zien. *Hij kon het alleen niet waarderen dat de pas bevallen vriendin van Paulien, Chantal, de baby steeds bij hem op schoot zette.* Toen ze dit voor de derde keer deed, was hij het zat. **Laurens mopperde over de houding van Chantal en Paulien, die alleen maar vertederd leek te zijn door zijn benauwde gezicht, (en hij gaf de baby gauw weer terug (NP) / gaf hem maar gauw een zoen (S)).** Na zijn gemopper werd Laurens gelukkig weer even met rust gelaten.

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15b. NP-context

Laurens was met zijn vriendin Paulien op babybezoek. Hij vond de pasgeborene erg schattig om te zien. *Hij kon het alleen niet waarderen dat Paulien en haar pas bevallen vriendin Chantal de baby steeds bij hem op schoot zetten.* Toen ze dit voor de derde keer deden, was hij het zat. **Laurens mopperde over de houding van Chantal en Paulien, die alleen maar vertederd leek te zijn door zijn benauwde gezicht, (en hij gaf de baby gauw weer terug (NP) / gaf hem maar gauw een zoen (S)).** Na zijn gemopper werd Laurens gelukkig weer even met rust gelaten.

16a. S-context

Kirsten was bij haar kapper Robbert om te overleggen over haar bruidskapsel. Ze had al een aantal goede kapsels bedacht, zo vond ze zelf. *Het stoorde haar dan ook dat de collega van Robbert, Michiel, steeds misprijzend zat te lachen.* Toen hij weer een afkeurend gebaar maakte, zei ze er wat van. **Kirsten bekritiseerde de houding van Michiel en Robbert, die het heel gewoon leek te vinden om klanten te beledigen, (en ze besloot naar een andere salon te gaan (NP) / stuurde haar hierop de salon uit (S)).** Tijdens de bruiloft zat Kirstens haar precies zoals ze het had gewild.

16b. NP-context

Kirsten was bij haar kapper Robbert om te overleggen over haar bruidskapsel. Ze had al een aantal goede kapsels bedacht, zo vond ze zelf. *Het stoorde haar dan ook dat Robbert en zijn collega Michiel steeds misprijzend zaten te lachen.* Toen ze weer een afkeurend gebaar maakten, zei ze er wat van. **Kirsten bekritiseerde de houding van Michiel en Robbert, die het heel gewoon leek te vinden om klanten te beledigen, (en ze besloot naar een andere salon te gaan (NP) / stuurde haar hierop de salon uit (S)).** Tijdens de bruiloft zat Kirstens haar precies zoals ze het had gewild.

17a. S-context

Petra ging naar een optreden van de rockband van haar vriend Hidde. Ze genoot met volle teugen van de muziek. *Ze vond het alleen onverantwoordelijk dat een bandgenoot van Hidde, Ramon, de hele tijd in het publiek sprong.* Toen hij bijna iemand verwondde, besloot ze er na het concert wat van te gaan zeggen. **Petra klaagde over de houding van Ramon en Hidde, die geen enkel kwaad leek te zien in zulk roekeloos gedrag, (en ze zei dat ze hen erg onvolwassen vond (NP) / schaamde zich voor zijn vriendin (S)).** Na deze woorden ging Petra maar gauw wat te drinken halen.

17b. NP-context

Petra ging naar een optreden van de rockband van haar vriend Hidde. Ze genoot met volle teugen van de muziek. *Ze vond het alleen onverantwoordelijk dat Hidde en zijn*

bandgenoot Ramon de hele tijd in het publiek sprongen. Toen ze bijna iemand verwondden, besloot ze er na het concert wat van te gaan zeggen. **Petra klaagde over de houding van Ramon en Hidde, die geen enkel kwaad leek te zien in zulk roekeloos gedrag, (en ze zei dat ze hen erg onvolwassen vond (NP) / schaamde zich voor zijn vriendin (S)).** Na deze woorden ging Petra maar gauw wat te drinken halen.

18a. S-context

Timo woonde met zijn dispuutsgenote Lara een vergadering bij over de ontgroening. Hij vertelde daar dat hij moeite had gekregen met dit ritueel. *Tot zijn ergernis keek een jaarclubgenootje van Lara, Inge, hem hierop minachtend aan.* Toen ze ook nog schamper begon te lachen, reageerde hij fel. **Timo zei verbijsterd te zijn over de houding van Inge en Lara, die helemaal niets verkeers leek te zien in zulk neerbuigend gedrag, (en hij besloot naar huis te gaan (NP) / snoerde hem meteen de mond (S)).** Na dit incident liet Timo weken lang zijn gezicht niet zien op de sociëteit.

18b. NP-context

Timo woonde met zijn dispuutsgenote Lara een vergadering bij over de ontgroening. Hij verklaarde daar dat hij moeite had gekregen met dit ritueel. *Tot zijn ergernis keken Lara en haar jaarclubgenootje Inge hem hierop minachtend aan.* Toen ze ook nog schamper begonnen te lachen, reageerde hij fel. **Timo zei verbijsterd te zijn over de houding van Inge en Lara, die helemaal niets verkeers leek te zien in zulk neerbuigend gedrag, (en hij besloot naar huis te gaan (NP) / snoerde hem meteen de mond (S)).** Na dit incident liet Timo weken lang zijn gezicht niet zien op de sociëteit.

19a. S-context

Iris moest voor de vierde keer autorijexamen doen bij examiner Hugo. Ze had zelf het gevoel dat het best goed ging. *Ze baalde er dan ook enorm van dat de collega van Hugo, Alex, die ook meereed, voortdurend schamper zat te lachen.* Toen hij wéér minachtend gniffelde, werd ze boos. **Iris zei zich erg te storen aan de houding van Alex en Hugo, die helemaal niets onbeschofts leek te zien in zulk vernederend gedrag, (en ze probeerde hierna nog zelfverzekerder te rijden (NP) / vond haar uitbarsting erg ongepast (S)).** Uiteindelijk bleek Iris toch geslaagd.

19b. NP-context

Iris moest voor de vierde keer autorijexamen doen bij examiner Hugo. Ze had zelf het gevoel dat het best goed ging. *Ze baalde er dan ook enorm van dat Hugo en zijn collega Alex, die ook meereed, voortdurend schamper zaten te lachen.* Toen ze wéér minachtend gniffelden, werd ze boos. **Iris zei zich erg te storen aan de houding van Alex en Hugo, die helemaal niets onbeschofts leek te zien in zulk vernederend gedrag, (en ze probeerde hierna nog**

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zelfverzekerder te rijden (NP) / vond haar uitbarsting erg ongepast (S)). Uiteindelijk bleek Iris toch geslaagd.

20a. S-context

Milan was met zijn vriendin Amber op wintersport. Hij genoot ontzettend van het skiën in de frisse berglucht. *Hij vond het alleen belachelijk dat het ski-maatje van Amber, Esmee, steeds in lawinegevaarlijk gebied wilde afdalen.* Toen ze dit opnieuw voorstelde, werd hij boos. **Milan veroordeelde de opstelling van Esmee en Amber, die helemaal geen kwaad leek te zien in zulk onverantwoordelijk gedrag, (en hij besloot naar het hotel te gaan (NP) / probeerde hem nogmaals te overtuigen (S)).** De volgende dag trok Milan er maar in zijn eentje op uit.

20b. NP-context

Milan was met zijn vriendin Amber op wintersport. Hij genoot ontzettend van het skiën in de frisse berglucht. *Hij vond het alleen belachelijk dat Amber en haar ski-maatje Esmee steeds in lawinegevaarlijk gebied wilden afdalen.* Toen ze dit opnieuw voorstelden, werd hij boos. **Milan veroordeelde de opstelling van Esmee en Amber, die helemaal geen kwaad leek te zien in zulk onverantwoordelijk gedrag, (en hij besloot naar het hotel te gaan (NP) / probeerde hem nogmaals te overtuigen (S)).** De volgende dag trok Milan er maar in zijn eentje op uit.

21a. S-context

Marleen had een afspraak met haar fysiotherapeut Patrick. Ze vond het prettig dat de spieren van haar bovenlijf even goed werden losgemaakt. *Ze stelde het echter helemaal niet op prijs dat de collega van Patrick, Berend, steeds luid kletsend de behandelkamer in- en uitliep.* Toen hij dit voor de zoveelste keer deed, zei ze er wat van. **Marleen zei schoon genoeg te hebben van de houding van Berend en Patrick, die de noodzaak niet leek te zien van een rustige behandelomgeving, (en ze pakte boos haar kleren bijeen (NP) / reageerde geschrokken op haar woorden (S)).** Bij de volgende afspraak werd ze wel in alle rust behandeld.

21b. NP-context

Marleen had een afspraak met haar fysiotherapeut Patrick. Ze vond het prettig dat de spieren van haar bovenlijf even goed werden losgemaakt. *Ze stelde het echter helemaal niet op prijs dat Patrick en zijn collega Berend steeds luid kletsend de behandelkamer in- en uitliepen.* Toen ze dit voor de zoveelste keer deden, zei ze er wat van. **Marleen zei schoon genoeg te hebben van de houding van Berend en Patrick, die de noodzaak niet leek te zien van een rustige behandelomgeving, (en ze pakte boos haar kleren bijeen (NP) / reageerde**

geschrokken op haar woorden (S)). Bij de volgende afspraak werd ze wel in alle rust behandeld.

22a. S-context

Jochem was met zijn makelaar Astrid een flat aan het bezichtigen. De flat voldeed redelijk aan zijn wensen. *Jochem vond alleen dat de assistent van Astrid, Moniek, die er ook bij was, over een veel te hoge vraagprijs wilde onderhandelen.* Toen bleek dat ze wel op zijn instemming rekende, raakte hij geïrriteerd. **Jochem zei zijn twijfels te hebben over de visie van Moniek en Astrid, die helemaal niets mis leek te vinden met de torenhoge prijs, (en hij zei op deze manier niet te willen onderhandelen (NP) / keek hem zeer verontwaardigd aan (S)).** Na deze woorden kreeg Jochem al gauw een fatsoenlijkere vraagprijs voorgelegd.

22b. NP-context

Jochem was met zijn makelaar Astrid een flat aan het bezichtigen. De flat voldeed redelijk aan zijn wensen. *Jochem vond alleen dat Astrid en haar assistent Moniek, die er ook bij was, over een veel te hoge vraagprijs wilden onderhandelen.* Toen bleek dat ze wel op zijn instemming rekenden, raakte hij geïrriteerd. **Jochem zei zijn twijfels te hebben over de visie van Moniek en Astrid, die helemaal niets mis leek te vinden met de torenhoge prijs, (en hij zei op deze manier niet te willen onderhandelen (NP) / keek hem zeer verontwaardigd aan (S)).** Na deze woorden kreeg Jochem al gauw een fatsoenlijkere vraagprijs voorgelegd.

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Parameter estimates regarding the proportion of first-pass fixations and regressions (Experiment 8)

The parameter estimates (in logits) regarding the proportion of first-pass fixations (*FP fixations*) and regressions as a function of situational knowledge (standard errors in parentheses). $s^2_{subj_betw.}$ denotes the variance between subjects and s^2_{txt} the variance between texts.

<i>Peter_{C1-1}</i>				
NP-context	FP fixations	1.12 (0.20)	Regressions	-2.67 (0.27)
	$s^2_{subj_betw.}$ (se)	0.84 (0.31)	$s^2_{subj_betw.}$ (se)	0.90 (0.57)
S-context	FP fixations	0.68 (0.17)	Regressions	-2.59 (0.21)
	$s^2_{subj_betw.}$ (se)	0.50 (0.21)	$s^2_{subj_betw.}$ (se)	<0.01 (<0.01)
	s^2_{txt} (se)	0.09 (0.07)	s^2_{txt} (se)	0.12 (0.17)
<i>en Ruben_{C1} (and Ruben)</i>				
NP-context	FP fixations	2.09 (0.23)	Regressions	-2.02 (0.22)
	$s^2_{subj_betw.}$ (se)	0.85 (0.43)	$s^2_{subj_betw.}$ (se)	0.65 (0.37)
S-context	FP fixations	2.86 (0.23)	Regressions	-1.46 (0.20)
	$s^2_{subj_betw.}$ (se)	0.01 (0.39)	$s^2_{subj_betw.}$ (se)	0.60 (0.29)
	s^2_{txt} (se)	0.02 (0.12)	s^2_{txt} (se)	0.10 (0.10)
<i>geen_{C2-2} (no)</i>				
NP-context	FP fixations	0.38 (0.14)	Regressions	-1.64 (0.15)
	$s^2_{subj_betw.}$ (se)	0.07 (0.10)	$s^2_{subj_betw.}$ (se)	0.08 (0.17)
S-context	FP fixations	0.03 (0.15)	Regressions	-2.24 (0.19)
	$s^2_{subj_betw.}$ (se)	0.19 (0.13)	$s^2_{subj_betw.}$ (se)	0.21 (0.28)
	s^2_{txt} (se)	0.16 (0.08)	s^2_{txt} (se)	0.05 (0.09)
<i>leek_{C2} (appeared)</i>				
NP-context	FP fixations	-0.10 (0.12)	Regressions	-1.89 (0.19)
	$s^2_{subj_betw.}$ (se)	0.01 (0.08)	$s^2_{subj_betw.}$ (se)	0.14 (0.21)
S-context	FP fixations	-0.03 (0.14)	Regressions	-2.07 (0.23)
	$s^2_{subj_betw.}$ (se)	0.23 (0.14)	$s^2_{subj_betw.}$ (se)	0.65 (0.36)
	s^2_{txt} (se)	0.08 (0.06)	s^2_{txt} (se)	0.20 (0.14)

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The parameter estimates (in logits) regarding the proportion of first-pass fixations (*FP fixations*) and regressions as a function of situational knowledge and sentence type (standard errors in parentheses). $s^2_{subj_betw.}$ denotes the variance between subjects and s^2_{txt} the variance between texts.

		Sentence type	
		NP-coordination	S-coordination
<i>en ze_{C3} (and she)/deed alsof_{C3} (pretended)</i>			
NP-context	FP fixations	-0,26 (0,17)	-0,04 (0,17)
	$s^2_{subj_betw.}$ (se)	0,52 (0,22)	0,52 (0,22)
S-context	FP fixations	-0,32 (0,23)	0,20 (0,13)
	$s^2_{subj_betw.}$ (se)	1,07 (0,42)	< 0,01 (<0,01)
	s^2_{txt} (se)	0,05 (0,05)	
NP-context	Regressions	-1,91 (0,25)	-2,51 (0,29)
	$s^2_{subj_betw.}$ (se)	0,19 (0,33)	<0,01 (<0,01)
S-context	Regressions	-2,60 (0,30)	-2,33 (0,32)
	$s^2_{subj_betw.}$ (se)	<0,01 (<0,01)	0,64 (0,58)
	s^2_{txt} (se)	0,31 (0,19)	
<i>keek hen_{C4} (looked them) /alsof_{C4} (as if)</i>			
NP-context	FP fixations	2,43 (0,29)	0,33 (0,17)
	$s^2_{subj_betw.}$ (se)	0,23 (0,49)	< 0,01 (<0,01)
S-context	FP fixations	2,70 (0,54)	0,52 (0,17)
	$s^2_{subj_betw.}$ (se)	5,62 (2,18)	0,05 (0,14)
	s^2_{txt} (se)	0,27 (0,13)	
NP-context	Regressions	-1,37 (0,26)	-1,78 (0,22)
	$s^2_{subj_betw.}$ (se)	0,81 (0,45)	0,33 (0,34)
S-context	Regressions	-1,53 (0,21)	-2,31 (0,24)
	$s^2_{subj_betw.}$ (se)	0,41 (0,34)	<0,01 (<0,01)
	s^2_{txt} (se)	<0,01 (<0,01)	

Samenvatting

Stel je voor: je zit achter je computer en leest een e-mail die als volgt begint: *Je zult het niet geloven! Ellen kuste Peter en Ruben* Dit is het laatste wat je leest voordat je computer crasht. Als je enige voorkennis hebt over de beschreven situatie, dan zou je de verdere strekking van de zin kunnen raden. Als je bijvoorbeeld weet dat Ellen stiekem verliefd is op zowel Peter als Ruben en je weet dat ze een bepaalde reputatie heeft, dan zou je kunnen verwachten dat ze zowel Peter als Ruben heeft gekust. Aan de andere kant, als je weet dat Ellen smoorverliefd is op Peter, maar zeker niet op Ruben, dan is het waarschijnlijker dat de zin bijvoorbeeld als volgt afloopt: *(Ellen kuste Peter en Ruben) ging nog maar even wat te drinken halen.*

In dit proefschrift wordt onderzocht of lezers hun voorkennis over de beschreven situatie onmiddellijk toepassen bij het structureel analyseren (ook wel *ontleden* of *parseren*) van een zin. In deze studie wordt zulke voorkennis aan de lezer verstrekt door middel van tekst en wordt *situationele kennis* genoemd. De onderzoeksvraag sluit aan bij de meer algemene vraag of niet-syntactische factoren de structurele analyse van een zin direct beïnvloeden. Weinig psycholinguïsten zullen tegenspreken dat alle mogelijke vormen van informatie (lexicale, syntactische, semantische en pragmatische) uiteindelijk een rol spelen bij de parsing van een zin. De meningen over de vraag *op welk moment* niet-syntactische informatiebronnen dit proces precies beïnvloeden zijn echter wel verdeeld.

In Hoofdstuk 1 wordt een overzicht gepresenteerd van een aantal van de bekendste zinsverwerkingstheorieën. Er kan grofweg een onderscheid gemaakt worden tussen de modulaire en interactieve visie op parsing. Deze visies kunnen worden beschouwd als twee uitersten van een schaal, waarop tal van tussenposities mogelijk zijn.

Aan de modulaire kant van de schaal staat bijvoorbeeld de *garden path* theorie. Volgens deze theorie wordt de initiële syntactische analyse van een zin uitsluitend bepaald door syntaxis-gebaseerde principes. Niet-syntactische kennis speelt pas een rol bij de evaluatie en (eventuele) herziening van deze aanvankelijke analyse. Volgens de referentiële theorie worden in geval van een syntactische ambiguïteit (een zin met meerdere mogelijke syntactische analyses) verschillende analyses

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geactiveerd en wordt uit deze mogelijkheden één analyse geselecteerd. Referentiële factoren, zoals het aantal referenten in de context voor een bepaald zelfstandig naamwoord, spelen hierbij een prominente rol. Ook zogenaamde constraint-gebaseerde interactieve modellen stellen dat in geval van een syntactische ambiguïteit meerdere mogelijke analyses worden geactiveerd. Deze modellen stellen echter dat bepaalde factoren, bijvoorbeeld syntaxis-gebaseerde principes, in principe geen voorrang hebben boven andere factoren, bijvoorbeeld kennis van de wereld. De meest geschikte analyse wordt dus op basis van alle beschikbare kennisbronnen geselecteerd. Zogeheten sterk interactieve modellen, ten slotte, gaan nog een stapje verder door te stellen dat in geval van een syntactische ambiguïteit alle beschikbare kennisbronnen tegelijkertijd meebepalen welke structuur in eerste instantie geconstrueerd wordt, in plaats van dat deze bronnen aangewend worden om de meest geschikte analyse uit meerdere mogelijke analyses te selecteren.

Het hoofddoel van de voorliggende studie is om aan te tonen dat parsing een interactief proces is: de initiële analyse van een zin is geen zogenaamd *syntax-eerst* proces is, maar wordt direct beïnvloed door situationele kennis.

De vraag of niet-syntactische factoren de parsing van een zin onmiddellijk beïnvloeden is veelvuldig onderzocht. De voorliggende studie verschilt in diverse opzichten van voorgaande studies. In de eerste plaats heeft eerder onderzoek zich voornamelijk gericht op de invloed van talige factoren, zoals lexicaal semantiek en de referentiële context. Situationele kennis kan worden beschouwd als een niet-talige informatiebron. Het betreft een soort episodische kennis, kennis over gebeurtenissen, die een lezer normaal gesproken verwerft door het meemaken van deze gebeurtenissen of door het kijken naar een film of het lezen van een boek. Het kan dus worden beschouwd als een soort wereldkennis, die lezers in deze studie verwerven door middel van het lezen van een tekstje. Kortom, de voorliggende studie kan de bestaande kennis over de invloed van niet-syntactische informatiebronnen op het parsingproces uitbreiden met kennis over de invloed van wereldkennis die een lezer pas tijdens het lezen van een tekst verwerft.

Een tweede verschil met voorgaande relevante studies is dat vele hiervan zich gericht hebben op de verwerking van het desambiguerende deel van een syntactische ambiguïteit. Het probleem hiervan is dat resultaten voor dit deel van de zin vaak niet eenduidig zijn. Stel, van een

structureel ambigue zin is uiteindelijk van alle mogelijke syntactische structuren de moeilijkste de juiste. Als verwerkingsproblemen voor de desambiguerende positie in deze zin uitblijven, dan wordt dit vaak geïnterpreteerd als steun voor een interactieve parsingtheorie. Volgens interactieve theorieën zijn doorgaans namelijk ook andere dan syntactische factoren bepalend voor de eerste analyse van een zin (misschien was de moeilijkste syntactische structuur bijvoorbeeld op basis van de wereldkennis van de lezer wel de meest waarschijnlijke). Volgens modulaire theorieën kiest de lezer altijd de structureel meest eenvoudige zin eerst, wat in dit geval tot verwerkingsproblemen had moeten leiden voor de desambiguerende positie in de zin.

Echter, een modulaire theorie kan dit resultaat toch ook verklaren: mogelijk is de aanvankelijke analyse van de zin wél alleen bepaald door syntax-gebaseerde strategieën, maar heeft de lezer deze analyse nog vóór het lezen van de definitief desambiguerende informatie geëvalueerd en herzien onder invloed van niet-syntactische informatie. Hierdoor blijven verwerkingsproblemen op dit punt uit.

Om deze discussie te beslechten en om de kans op eenduidige resultaten te optimaliseren, wordt in dit proefschrift de invloed van situationele kennis onderzocht vanaf het beginpunt van de ambiguïteit in plaats van alleen op het eindpunt.

In de derde plaats is het doel van de huidige studie niet alleen om te onderzoeken *of* situationele kennis het parsingproces onmiddellijk beïnvloedt, maar ook om meer inzicht te verwerven in *de manier waarop* dit proces verloopt. Om dit te doen wordt niet alleen onderzocht *of* situationele kennis het parsingproces direct beïnvloedt, maar ook *hoe* de invloed van deze kennis zich verhoudt tot de invloed van een andere desambiguerende factor, namelijk de congruentie tussen subject en werkwoord. De manipulatie van de verschillende factoren zal in het vervolg worden uitgelegd.

Manipulaties

In Hoofdstuk 2 wordt de opzet van het onderzoek uiteen gezet. Het modulariteit-of-interactie vraagstuk zal aan de hand van de volgende structuren worden onderzocht:

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- (1) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben op het feest. (NP-coördinatie)
- (2) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben luisterde aandachtig naar haar woorden. (S-coördinatie)

Zin (1) als (2) zijn tot en met het woord *Ruben* syntactisch ambigu tussen een NP- en een S-coördinatie. In een NP-coördinatie zoals (1) maakt het woord *Ruben* onderdeel uit van het object *het gedrag van Peter en Ruben*, terwijl dit woord in een S-coördinatie zoals in (2) het onderwerp/topic vormt van de tweede deelzin.

Uit eerder onderzoek is gebleken dat lezers een NP-/S-coördinatie ambigüiteit bij voorkeur analyseren als een NP-coördinatie. Deze preferentie is verklaard met behulp van zowel syntax-gebaseerde als pragmatische principes. In de eerste plaats kan op basis van het syntactische *minimal attachment principe* gesteld worden dat het vormen van de syntactische structuur van een NP-coördinatie eenvoudiger is dan die van een S-coördinatie. Een NP-coördinatie-analyse van de zin is daarom een economischer keus dan een S-coördinatie-analyse. In de tweede plaats kan de preferentie voor een NP-coördinatie verklaard worden door middel van een pragmatisch principe met betrekking tot de topicstructuur van een zin. Een topic is kort gezegd die- of datgene waar de zin over gaat. Een NP-coördinatie heeft één topic (*Ellen* in voorbeeld (1)), terwijl een S-coördinatie er twee heeft (*Ellen* en *Ruben* in zin (2)). Ook in dit opzicht is het dus economischer om de zin als een NP-coördinatie te analyseren dan als een S-coördinatie. De topicstructuur van de voorafgaande context blijkt hierbij echter van meer belang dan de topicstructuur van de zin zelf. Als de voorafgaande context één topic heeft, dan wordt de zin bij voorkeur als een NP-coördinatie geanalyseerd, maar als de voorafgaande context twee topics heeft, dan wordt de zin bij voorkeur als een S-coördinatie geanalyseerd. Het lijkt erop dat de lezer een voorkeur heeft voor die analyse die de topicstructuur van de tekst ongewijzigd laat.

In het voorliggende onderzoek hebben alle experimentele teksten een één-topicstructuur. Hoewel dus syntax-gebaseerde principes en de topicstructuur van de experimentele teksten constant werden gehouden, kan op basis van voorafgaand onderzoek gesteld worden dat beide factoren in alle gevallen aanstuurden op een NP-coördinatie analyse van de kritieke zin. De essentie van de huidige studie is aan te tonen dat

situationele kennis de parsingpreferentie voor een NP-coördinatie kan doorbreken.

De manipulatie van situationele kennis en de congruentie tussen subject en werkwoord (hierna *SW-congruentie*) wordt geïllustreerd aan de hand van de volgende voorbeeldzinnen:

- (3) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben, die helemaal geen kwaad *leek* te zien in nog een biertje, deed alsof hij haar niet hoorde. (S-coördinatie)
- (4) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben, die helemaal geen kwaad *leken* te zien in nog een biertje, en ze keek hen met boze ogen aan. (NP-coördinatie)

Situationele kennis wordt gemanipuleerd door middel van de context voorafgaande aan NP-/S-coördinatie ambiguïteiten zoals in voorbeeld (3) en (4). Stel dat zin (3) of (4) wordt ingebed in een context waarin staat dat Ellen een feestje geeft en er flink van baalt dat Peter en Ruben zo veel drinken. Deze informatie maakt het voor de lezer aannemelijk dat Ellen zich ergert aan zowel Peter als Ruben, wat leidt tot een NP-coördinatie analyse: *Ellen zei zich te ergeren aan het gedrag van [Peter en Ruben]....* Aan de andere kant, als zin (3) of (4) wordt ingebed in een context waarin staat dat Ellen een feestje geeft en alleen baalt van het drinkgedrag van Peter, dan is het voor de lezer aannemelijk dat ze zich ergert aan Peter, maar niet aan Ruben. Als situationele kennis het parsingproces onmiddellijk beïnvloedt, zal deze gevolgtrekking ertoe leiden dat de lezer de zin direct analyseert als een S-coördinatie: *[Ellen zei zich te ergeren aan het gedrag van Peter] en [Ruben...]*. Kortom, hoewel syntaxgebaseerde en topicstructuurprincipes naar een NP-coördinatie sturen, zal de juiste situationele kennis deze voorkeur doorbreken, zo is de verwachting. Resultaten in overeenstemming met deze verwachting zouden sterke evidentie vormen voor een interactief parsingproces.

De factor SW-congruentie wordt gemanipuleerd door middel van het werkwoord van een relatieve bijzin die wordt ingebed in de NP- of S-coördinatie (zie voorbeeld (3) en (4)). De bijzin in voorbeeld (3) bevat een enkelvoudig werkwoord (*leek*). Dit wijst erop dat de inhoud van de bijzin alleen betrekking heeft op *Ruben*, wat de lezer zou kunnen aansporen om de zin te analyseren als een S-coördinatie (een NP-coördinatie is nog steeds mogelijk, maar minder waarschijnlijk). De

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bijzin in zin (4) daarentegen, bevat een persoonsvorm in meervoud (*leken*), wat erop duidt dat de inhoud van de bijzin betrekking heeft op zowel *Peter* als *Ruben*. Dit verplicht de lezer tot het analyseren van de frase *Peter en Ruben* als een NP-coördinatie (een S-coördinatie zou tot een ongrammaticale zin leiden: **Ellen zei zich te ergeren aan het gedrag van Peter en Ruben, die helemaal geen kwaad leken te zien in nog een biertje, deed alsof hij haar niet hoorde*).

Samengevat, zowel situationele kennis als SW-congruentie worden gemanipuleerd om te sturen naar een NP- of een S-coördinatie. Beide factoren kunnen dus in overeenstemming met elkaar zijn of juist niet. In het vervolg zullen de resultaten van de verschillende experimenten uit Hoofdstuk 3 t/m 5 worden besproken. In deze experimenten wordt de invloed van situationele kennis en SW-congruentie onderzocht op (1) lezersverwachtingen met betrekking tot de structuur van een zin, (2) lezersbeoordelingen van de moeilijkheid, plausibiliteit en moeilijkheid van een zin en (3) de structurele analyse van een zin. De eerste twee aspecten hebben betrekking op het product van het leesproces, het laatste aspect op het leesproces zelf.

Lezersverwachtingen met betrekking tot de structuur van een zin

Experiment 1, 4 en 5 zijn continueringsexperimenten waarin wordt onderzocht wat de invloed van situationele kennis en SW-congruentie is op lezersverwachtingen met betrekking tot de structuur van een zin. De kritieke zin is ambigu tussen een NP- en een S-coördinatie. Om de invloed van situationele kennis alleen te onderzoeken, wordt de kritieke zin afgebroken na de derde naam in de zin (*Ruben* in bovenstaande voorbeeldzinnen). Dit is de positie in de zin waar de lezer een keuze moet maken tussen een NP-coördinatie (*Ruben* wordt onderdeel van het object) en een S-coördinatie (*Ruben* wordt het subject/topic van de tweede deelzin). Als zowel situationele kennis als SW-congruentie worden gemanipuleerd, wordt de zin afgebroken na de bijzin (na *biertje*, in voorbeeld (3) en (4)).

De resultaten laten zien dat situationele kennis de structuurverwachtingen van lezers beïnvloedt: de zin werd vaker als een S-coördinatie afgemaakt als situationele kennis aanstuurde op een S-coördinatie-analyse (hierna: in een *S-context*) en vaker als een NP-coördinatie als situationele kennis aanstuurde op een NP-coördinatie-analyse (hierna: in een *NP-context*). Ook SW-congruentie beïnvloedt de

structuurverwachtingen van de lezer: proefpersonen voltooiden de zin vaker als een NP-coördinatie als SW-congruentie aanstuurde op een NP-coördinatie-analyse en vaker als een S-coördinatie als SW-congruentie aanstuurde op een S-coördinatie-analyse.

Uit de resultaten blijkt verder dat SW-congruentie een sterker effect heeft op de structuurverwachtingen van lezers dan situationele kennis. Dit kan worden verklaard door het feit dat situationele kennis een van beide structuren alleen maar aannemelijker maakte, terwijl SW-congruentie een S-coördinatie in geval van een meervoudig werkwoord uitsloot als mogelijke structuur van de zin. Daarnaast werd SW-congruentie dichterbij het afbreekpunt van de zin gemanipuleerd dan situationele kennis. Dit kan ook een rol hebben gespeeld.

Lezersbeoordelingen van de structuur en de betekenis van een zin

In Experiment 2 en 6 wordt onderzocht in hoeverre situationele kennis en SW-congruentie de mentale representatie beïnvloeden die lezers van een zin vormen. Dit wordt gedaan door middel van een beoordelingstaak, waarbij proefpersonen op een vijfpuntschaal een oordeel geven over de moeilijkheid, plausibiliteit en natuurlijkheid van de kritieke zin. Er is voor deze schalen gekozen, omdat ze verschillende aspecten van zinsverwerking sonderen. De moeilijkheid van een zin omvat de algehele begrijpelijkheid ervan. De verwachting is dat zowel situationele kennis als SW-congruentie de beoordelingen van dit aspect beïnvloeden. De plausibiliteit van een zin omvat de aanvaardbaarheid van zijn betekenis binnen de context. De verwachting is dat de beoordelingen van dit aspect vooral door situationele kennis worden beïnvloed, omdat deze factor door middel van de context wordt gemanipuleerd. De natuurlijkheid van een zin, tenslotte, omvat voornamelijk de structurele aspecten van deze zin. Dit aspect wordt naar verwachting het meest beïnvloed door SW-congruentie, omdat deze factor structurele eigenschappen van een zin weerspiegelt.

In Experiment 2 wordt alleen de invloed van situationele kennis onderzocht. De kritieke zin is altijd een S-coördinatie. De resultaten laten zien dat situationele kennis inderdaad invloed heeft op de mentale representatie die lezers van een zin vormen: alle drie de onderzochte aspecten werden positiever beoordeeld als de S-coördinatie was ingebed in een S-context dan als hij was ingebed in een NP-context.

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In Experiment 6 wordt de invloed van zowel situationele kennis als SW-congruentie onderzocht. De kritieke zin is altijd een NP-coördinatie. De resultaten laten de verwachte interactie zien tussen situationele kennis en SW-congruentie. Hiermee wordt het idee bevestigd dat de perceptie van verschillende aspecten van een zin (betekenis versus structuur) in verschillende mate door beide factoren wordt beïnvloed en dat de verschillende schalen inderdaad verschillende aspecten van zinsverwerking weerspiegelen.

De invloed van situationele kennis en SW-congruentie op het leesproces

Het hoofddoel van de voorliggende studie is om te onderzoeken of situationele kennis het parsingproces direct beïnvloedt. Tevens wordt onderzocht wat de interactie tussen situationele kennis en SW-congruentie is tijdens dit proces. Hierbij worden zowel S-coördinaties onderzocht (Experiment 3 en 8) als NP-coördinaties (Experiment 7 en 8). Gebruik wordt gemaakt van de zogeheten *self-paced reading*-methode (Experiment 3 en 7), waarbij leestijden per woordgroep worden geregistreerd, en van oogbewegingsregistratie (Experiment 8), waarbij de proportie first-pass fixaties en regressies wordt geanalyseerd.

Voor het gemak worden voorbeeld (3) en (4) hier nogmaals herhaald, als (5) en (6).

- (5) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben, die helemaal geen kwaad *leek* te zien in nog een biertje, deed alsof hij haar niet hoorde. (S-coördinatie)
- (6) Ellen zei zich te ergeren aan het gedrag van Peter en Ruben, die helemaal geen kwaad *leken* te zien in nog een biertje, en ze keek hen met boze ogen aan. (NP-coördinatie)

De initiële beslissing om de kritieke zin te analyseren als een NP- of een S-coördinatie wordt naar verwachting genomen tijdens de verwerking van de 1^e naam na de conjunctie *en* (*Ruben* in bovenstaande voorbeelden). Gesteld wordt dat het vormen van een S-coördinatie analyse van de zin bewerkelijker is dan een NP-coördinatie analyse. Dit zal naar verwachting leiden tot langere leestijden en meer first-pass fixaties en regressies op deze positie in geval van een S-coördinatie-analyse dan in geval van een NP-coördinatie-analyse.

In Experiment 3 wordt de invloed van situationele kennis op de verwerking van S-coördinaties onderzocht. De resultaten laten zien dat situationele kennis de verwerking van S-coördinaties faciliteert. Dit effect wordt echter pas zichtbaar op het woord ná het desambiguerende werkwoord (*alsof* in voorbeeld (5)). Hierdoor kunnen de resultaten zowel door een modulaire als een interactieve parsingtheorie worden verklaard.

Om de kans op eenduidige resultaten te optimaliseren, wordt de ambigue regio van de kritieke zin in de vervollexperimenten vergroot. Dit wordt gedaan door middel van een relatieve bijzin, die wordt ingebed in de kritieke zin (zie voorbeeld (5) en (6)). De relatieve bijzin scheidt het beginpunt van de NP-/S-coördinatie ambiguïteit (*Ruben*) van het desambiguerende deel van de zin (het deel na de relatieve bijzin)¹, waardoor een effect van situationele kennis op de initiële analyse van de zin beter kan worden onderscheiden van een effect op de heranalyse van de zin.

De factor SW-congruentie wordt gemanipuleerd door middel van het werkwoord van de relatieve bijzin. Op deze manier kan worden onderzocht hoe situationele kennis de initiële analyse van de zin beïnvloedt en hoe deze factor vervolgens interactie vertoont met SW-congruentie. SW-congruentie wordt alleen gemanipuleerd in Experiment 7; in Experiment 8 is het werkwoord van de relatieve bijzin altijd enkelvoudig, waardoor het altijd aanstuurt op een S-coördinatie analyse.

In Hoofdstuk 6 worden de resultaten van Experiment 7 en 8 aan de hand van voorbeeld (5) en (6) als volgt samengevat.

1. *Beginpunt van de ambiguïteit (Ruben)*

De resultaten voor het beginpunt van de ambiguïteit (*Ruben*) laten een toename in leestijd en het aantal first-pass fixaties en regressies zien in een S-context ten opzichte van een NP-context. Deze resultaten bieden evidentie voor het idee dat situationele kennis een directe invloed heeft op de initiële analyse van de zin.

¹ Als het werkwoord van de relatieve bijzin meervoudig is, dan is een S-coördinatie analyse van de zin vanaf dat punt uitgesloten. Desambiguering van de zin vindt in dit geval dus eerder plaats dan na de relatieve bijzin. In dit geval zijn begin- en eindpunt van de ambiguïteit echter nog steeds door een aantal woorden gescheiden.

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2. De relatieve bijzin

De resultaten voor de bijzin bevestigen het idee dat situationele kennis de initiële analyse van de zin heeft beïnvloed. Kijken we naar de precieze locatie, dan beginnen we op de positie twee segmenten vóór het werkwoord (*geen* in bovenstaande voorbeelden). Hier zijn minder first-pass fixaties en regressies in een S-context dan in een NP-context. Dit resultaat kan verklaard worden doordat de relatieve bijzin in geval van een S-coördinatie slechts ingebed hoeft te worden in de tweede deelzin, terwijl de relatieve bijzin in geval van een NP-coördinatie opgenomen moet worden in de hele zin. Gesteld wordt dat het inbedden van de relatieve bijzin in het laatste geval bewerkelijker is.

In de tweede plaats zijn de leestijden voor het segment na het werkwoord van de relatieve bijzin (*te zien*) korter wanneer het getal van het werkwoord van de relatieve bijzin overeenkomt met wat op basis van situationele kennis kan worden verwacht (een meervoudig werkwoord in een NP-context en een enkelvoudig werkwoord in een S-context) dan wanneer dit niet zo is. Als er geen overeenstemming is tussen situationele kennis en SW-congruentie, dan is de toename in leestijd groter in geval van een meervoudig werkwoord dan in geval van een enkelvoudig werkwoord. Dit kan verklaard worden door het feit dat een NP-coördinatie-analyse verplicht tot een meervoudig relatief werkwoord, terwijl een S-coördinatie-analyse slechts aanstuurt op een enkelvoudig werkwoord.

3. Het desambiguerende deel van de ambiguïteit

De resultaten vanaf het eerste woord na de relatieve bijzin laten zien dat proefpersonen de zin op dat punt analyseren in overeenstemming met SW-congruentie. In Experiment 7 bleek dit uit het feit dat de leestijden voor deze regio korter waren wanneer SW-congruentie aanstuurde op de correcte structuur van de zin dan wanneer dit niet zo was. In Experiment 8 stuurde SW-congruentie in alle gevallen naar een S-coördinatie. Dit verklaart waarom er in dit experiment geen verschillen werden gevonden in de regio na de bijzin.

Blijkbaar zorgt SW-congruentie er voor dat de aanvankelijke analyse van de zin, die in overeenstemming was met situationele kennis, later wordt verworpen en herzien. Dit is zowel het geval bij een enkelvoudig als bij een meervoudig werkwoord. De resultaten vanaf het tweede segment na de relatieve bijzin laten zien dat situationele kennis weer wordt gebruikt

om de zin te heranalyseren, mocht SW-congruentie toch hebben aangestuurd op de verkeerde analyse.

Algemene conclusies

In Hoofdstuk 6 worden op basis van de verschillende leesexperimenten de volgende conclusies geformuleerd.

- (1) Situationele kennis heeft een onmiddellijke invloed op de initiële analyse van een zin. Dit betekent dat ook niet-linguïstische factoren het parsingproces direct beïnvloeden. Sterker nog, dit proces wordt zelfs direct beïnvloed door wereldkennis die een lezer nog niet heeft voorafgaand aan het lezen van een tekst, maar pas verwerft tijdens het lezen ervan.
- (2) SW-congruentie heeft een sterkere invloed op parsing dan situationele kennis. Dit is zowel het geval wanneer SW-congruentie aanstuurt op een bepaalde analyse (een S-coördinatie in geval van een enkelvoudig werkwoord van de relatieve bijzin), als wanneer SW-congruentie verplicht tot een bepaalde analyse (een NP-coördinatie in geval van een meervoudig werkwoord van de relatieve bijzin).
- (3) Wanneer de uiteindelijke analyse, zoals bepaald door SW-congruentie, onjuist blijkt, wordt situationele kennis weer aangewend om het heranalyseproces te faciliteren.

Welk type parsingmodel kan de huidige resultaten het beste verklaren? De resultaten bieden duidelijke evidentie tegen een modulair parsingmodel, dat stelt dat de initiële analyse van een zin wordt gevormd op basis van alleen syntax-gebaseerde principes. Aangezien de referentiële theorie zich richt op de invloed van de referentiële context, is ook deze theorie niet geschikt om de effecten van situationele kennis te verklaren. Zowel zogenaamde constraint-gebaseerde als sterk interactieve modellen kunnen de huidige resultaten wel goed verklaren. Volgens een constraint-gebaseerd parsingmodel is er sprake van competitie tussen verschillende mogelijke analyses van een syntactische ambiguïteit. Welke structuur geselecteerd wordt als initiële analyse van de zin wordt bepaald door alle soorten kennis die de lezer ter

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beschikking heeft. Volgens een variant van dit model, het competitie-integratie model, is de competitie tussen verschillende mogelijke analyses langduriger naarmate meer mogelijke structuren ongeveer evenveel steun krijgen van de beschikbare informatiebronnen.

In de huidige studie stuurden zowel syntax-gebaseerde als topicstructuurprincipes naar een NP-coördinatie-analyse van de kritieke zin. Hierdoor was de competitie tussen een NP- en een S-coördinatie analyse van de zin heviger als situationele kennis aanstuurde op een S-coördinatie-analyse dan als situationele kennis ook aanstuurde op een NP-coördinatie-analyse. Deze parsingprocedure kan verklaren waarom de leestijden en het aantal first-pass fixaties en regressies voor de beginpositie van de NP-/S-coördinatie ambiguïteit toenamen in een S-context ten opzichte van een NP-context.

Een sterk interactief parsingmodel voorspelt dat niet-syntactische factoren zelfs meebepalen welke structuur in eerste instantie wordt geconstrueerd, in plaats van dat deze factoren meebepalen welke van meerdere mogelijke analyses van een zin als initiële analyse wordt geselecteerd. Dit parsingmodel kan de huidige resultaten ook verklaren: situationele kennis bepaalt of proefpersonen in eerste instantie een NP- of een S-coördinatie construeren. Dit model kan ook verklaren waarom de leestijden en het aantal first-pass fixaties en regressies voor de beginpositie van de NP-/S-coördinatie ambiguïteit toenemen op de beginpositie in een S-context ten opzichte van een NP-context: de vorming van een S-coördinatie is bewerkelijker dan de vorming van een NP-coördinatie.

Kortom, de resultaten van dit proefschrift bieden duidelijke evidentie voor een interactief parsingproces waarbij alle beschikbare kennisbronnen onmiddellijk van invloed zijn. Dat situationele kennis de aanvankelijke analyse van de zin bleek te bepalen, betekent echter dat deze factor een sterkere invloed heeft op het parsingproces dan syntax-gebaseerde en topicstructuurprincipes, die altijd aanstuurden op een NP-coördinatie-analyse van de zin. Hoe kan deze verhouding worden verklaard?

Gesteld wordt dat alle beschikbare factoren het parsingproces direct beïnvloeden, maar dat sommige factoren dit proces sterker beïnvloeden dan andere. Gesteld wordt verder dat de sterkte van de invloed van een

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bepaalde factor wordt bepaald door de gevolgen die het voorbijgaan aan deze factor heeft voor het zinsverwerkingsproces.

Het in acht nemen van syntax-gebaseerde en topicstructuurprincipes zorgt ervoor dat de zin op de meest economische manier wordt geanalyseerd met het oog op de zins- of tekststructuur. Het in acht nemen van situationele kennis zorgt ervoor dat een zin wordt geanalyseerd op een manier die consistent is met de mentale representatie die tot op dat punt van de tekst is gevormd. Deze representatie, ook wel *situatiemodelrepresentatie* genoemd, wordt gevormd door de integratie van de propositionele representatie van een tekst met wereldkennis.

Gesteld wordt dat het zinsverwerkingsproces in sterkere mate wordt bemoeilijkt als de zin niet geanalyseerd wordt in overeenstemming met situationele kennis dan als de zin niet geanalyseerd wordt in overeenstemming met syntax-gebaseerde en/of topicstructuurprincipes. In andere woorden, als situationele kennis en syntax-gebaseerde en/of topicstructuurprincipes in conflict zijn, dan “wint” situationele kennis. Kortom, *wat je weet is wat je ontleedt!*

Toch lieten de resultaten zien dat SW-congruentie het parsingproces sterker beïnvloedt dan situationele kennis. Dit kan verklaard worden uit het feit dat het negeren van SW-congruentie in sommige gevallen een ongrammaticale zin oplevert. Dit bemoeilijkt het zinsverwerkingsproces mogelijk in sterkere mate dan het kiezen van de structuur die niet in overeenstemming is met situationele kennis. Vervolgonderzoek is nodig om aan te tonen of dit inderdaad zo is.

Curriculum vitae

Nina Versteeg was born on the 3th of Januari 1979 in Hilversum, The Netherlands. She attended Gemeentelijk Gymnasium in Hilversum, where she obtained her diploma in 1997. In 2002, she received her MA Dutch Language and Culture at Utrecht University (specialization: Communication studies). After being a lecturer in Language and Communication for a semester at the Department of Dutch Language and Culture of Utrecht University, Nina started her PhD research in 2003 at the Utrecht Institute of Linguistics OTS (UiL-OTS). During this time she taught a yearly course entitled *Cognitive processes of reading and writing*, for Bachelor students of Dutch and Communication and Information sciences. Since 2007, she is a lecturer in Language and Communication at the Department of Dutch Language and Culture of Utrecht University.