

MSC THESIS COGNITIVE NEUROSCIENCE

RADBOUD UNIVERSITY

Relative Clauses In Context

An EEG study on the influence of topicality cues on
grammatical role assignment

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August 28th, 2017

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Abstract

Relative clauses in Dutch provide an ideal environment for testing the relative strength of syntactic, semantic and pragmatic cues the listener might employ to link subject- and object roles to sentence constituents. This thesis investigates the interplay between two such cues – discourse topicality and inherent topicality – in an EEG experiment using short discourse contexts. The Topichood Hypothesis, introduced by Mak (2001) and reported in Mak et al. (2002, 2006, 2008), will be refined and further explored by directly contrasting two types of topicality introduced to account for processing biases in relative clause processing: the discourse topicality of a nominal referent and the inherent topicality of a pronominal referent. Despite behavioural evidence for an effect of both topicality factors on relative-clause processing in Dutch, we did not find a clear reflection of processing preferences in ERPs.

1 Introduction

Transitive sentences continually present listeners with a puzzle to be solved: ‘Who does what to whom?’ Three constituents need to be identified: The verb, denoting the event, and two further constituents each denoting one of two roles: the entity that initiates the action, i.e. the subject, and the entity that is at the receiving end of the action, i.e. the object. A correct interpretation of the sentence crucially depends on the following question: Which entity is present in which role?

In everyday communication we hardly even notice there is a puzzle to be solved. Languages may provide the listener with a wide variety of cues to accomplish the task: syntactic cues such as word order, case, and agreement, semantic cues such as animacy, and pragmatic cues such as topicality or definiteness (Lamers & de Swart, 2011). Cues may overlap or conflict within languages and may differ in precedence, strength or applicability across languages, but hard constraints in one language show up as processing preferences in others, betraying a universal set of possible solutions to the listener’s problem (Bresnan et al., 2001; see e.g. Givón, 1979; Bates & MacWhinney, 1989; Bornkessel-Schlesewsky & Schlewsky, 2009, for different models incorporating this idea).

Take for example the following English sentence:

- (1) The joggers see a hiker.

Semantic cues offer no resolution: both joggers and hikers are capable of initiating the action denoted by the verb. In this case the resolution is found instead in syntactic cues: in English, the first constituent *the joggers* must be the grammatical subject and therefore the agent of the sentence, because English has a strict SVO structure: the subject precedes the verb which in turn precedes the object. Another indication that *the joggers* is the subject of (1) is that the verb *see* is plural. Since the verb agrees with the subject, *the joggers* must be the subject by virtue of its plural marker.

Languages in which word order is less strict may enlist other syntactic cues to disambiguate between subjects and objects. Consider (2) in German:

- (2) *Den Jogger sieht der Wanderer.*
the.ACC jogger.ACC sees the.NOM hiker.NOM
‘The hiker sees the jogger.’

Whilst German, like English, has a preference for SO order, case may intercede to change the interpretation: by overtly marking the first constituent

as the grammatical object (by means of the accusative), the correct interpretation is that the second constituent should be the grammatical subject.

In other languages, semantic cues may come to overrule syntactic cues entirely. Consider first the sentence in (3), from Fore (Scott, 1978):

- (3) *Mási wá agaye*
 boy man see
 ‘The boy saw the man.’

Absent any syntactic cues but word order, the interpretation gained is one in which the first constituent is the grammatical subject. Consider now (4), again absent any syntactic cue but word order:

- (4) *Yaga: wá aegye*
 pig man bite
 ‘The man bit the pig.’

Here, the semantic cue of animacy alters the interpretation: since the most natural transitive sentence is one in which the subject outranks the object in animacy (Comrie, 1989:128), the correct interpretation of (4) is one in which the second constituent is the grammatical subject. This interaction may also be found a lot closer to home. Consider the English sentence in (5):

- (5) The corpse hid John.

Despite semantic cues signalling that the inanimate corpse does not make for a very good Agent, the strict word order cue forces the listener to interpret it as the grammatical subject. Its Dutch translation in (6) is more flexible, however:

- (6) *Het lijk verstopte Jan.*
 the corpse hid John
 ‘The corpse hid John’/‘John hid the corpse’

Grammatical role assignment here is ambiguous. We might still interpret the corpse as either being animate or being ‘a thing behind which John is hidden’ as in English, but an interpretation in which the second constituent is the grammatical subject is preferred, in which case the semantically-guided interpretation trumps the syntactically biased one. The second interpretation may be further facilitated by embedding (6) into a context that generates an explicit or implicit contrast, such that (6) can be understood as an answer

to the question of ‘who is hiding what’, having introduced multiple options. This may be loosely translated as (7).

- (7) *Het lijk verstopte Jan*
the corpse hid John
‘As to the corpse, John hid it’

The additional cue at work here is a pragmatic one: topicality. Topicality is notoriously hard to define, but is commonly understood to indicate *aboutness*, i.e., ‘what the sentence is about’ (Brunetti, 2009:263; Crasborn et al., 2009; Lambrecht, 1994; Reinhart, 1981). A sentence’s topic is often (coreferential with) its grammatical subject in subject-prominent languages (cf. Li & Thompson, 1976), since sentences also tend ‘to be about’ the grammatical subject (Crasborn et al., 2009). Indeed, subjects are grammaticalised topics (Lehman, 1976; cf. Comrie, 1988) and may be regarded as the default topical element in a sentence. A default implies that this need not always be the case, however. In instances in which the sentence topic is distinct from the grammatical subject, it may take precedence over the grammatical subject as the sentence-initial argument (Bouma, 2008), as in (7). This makes topicality as a cue rather difficult to use: a sentence-initial argument will often turn out to be the sentence’s topic as well as its grammatical subject, thus strengthening the association of subjects and topicality, but grammatical objects will more often be encountered in sentence-initial positions if they are topical, thus strengthening the association between topics and sentence-initial objects instead. The interaction of the topicality cue with word order on the assignment of subjecthood will be explored further in Section 2.3.

Of interest in the psycholinguistic literature are 1) the linguistic nature of these cues and 2) their neural correlates, 3) the timescale in which cues of different natures contribute to sentence comprehension, and 4) the relative strength with which they contribute. This thesis will focus on the neural correlates and relative strength of two pragmatic cues related to topicality: discourse topicality and pronouns. To investigate the above-mentioned factors we explore the processing of relative clauses in Dutch.

2 Testing cues: The case of relative clauses

A strict word order, as in the English main clause in (1), solves the listener’s problem so neatly as to make exploration of the relative strength of other cues nearly impossible. Subject-object ambiguities rarely arise during incremental processing under this cue, as the subject-role is immediately assigned to the first noun phrase encountered.¹

To explore to what extent other factors influence the assignment of subject- and object roles during on-line sentence comprehension, then, we will need a sentence structure in which role assignment remains ambiguous until both have been encountered, i.e. sentences in which no strict word order or overt syntactic marking exists so that predictions must be generated on the basis of other cues. Crucially for the psycholinguistic paradigm, however, we will need to disambiguate the sentence shortly following the subject and object in order to test the generated predictions by means of violating them, i.e. the ambiguity must be local rather than global. Relative clauses in Dutch satisfy both criteria. Consider (8a) and (8b):

- (8) a. *De wandelaar, die de joggers gezien heeft...*
the hiker that the joggers seen has
‘The hiker, who has seen the joggers...’
- b. *De wandelaar, die de joggers gezien hebben...*
the hiker that the joggers seen have
‘The hiker, whom the joggers have seen...’

Whilst the same constituents are present in the same word order, they differ in their relation to one another: in (8a), it is *de wandelaar* ‘the hiker’ who is doing the seeing, resulting in a subject-relative clause (SR); in (8b), this role is taken by *de joggers* ‘the joggers’, resulting in an object-relative clause (OR). Thus, which grammatical roles are assigned to the relative pronoun² and the relative-clause internal constituent respectively remains ambiguous in the absence of a strict word order until after both are encountered –

¹That is not to say no violations may occur due to e.g. syntactic ambiguity: the first noun phrase may turn out to be the head of a reduced relative clause upon encountering the second constituent rather than the subject of a transitive sentence, as in the classic example *the defendant examined by the lawyer turned out to be unreliable*. (Ferreira & Clifton, 1986). Important here is that there are no role-assignment ambiguities: the defendant will not turn out to be the object of the main clause.

²Note that in Dutch, no distinction is made on the relative pronoun based on animacy or case, as in the English translation, leaving its surface form truly ambiguous.

leaving room for predictions to be generated on the basis of other cues – and strict disambiguation is facilitated by the strong syntactic cue of agreement on the auxiliary shortly after – allowing the predictions to be tested by means of a violation.

2.1 Relative clause interpretation

Because of the local ambiguity in role-assignment presented by relative clauses, this construction has been a fruitful area of research in psycholinguistics in a wide variety of frameworks as these have evolved over the years. The most robust finding is that object-relative clauses generally lead to processing difficulties compared to subject-relative clauses, as indicated by e.g. longer reading times, higher error rates and larger deflections in event-related potentials (Frazier, 1987a; King & Just, 1991; Schriefers et al., 1995; Friederici et al., 1998; Gibson, 1998; Staub, 2010 to name a few oft-cited examples), a so called *subject relative bias* in interpretation.

An early syntactic account for the subject-relative bias can be found in Frazier’s (1987a) Active Filler Strategy (AFS). The AFS is a syntax-first account based on transformational grammar. According to theories in transformational grammar the relative pronoun originates in the relative clause – either in its subject position in the case of subject-relative clauses or its object position in the case of object-relative clauses – and is moved to clause-initial position, leaving behind a gap at its original position. According to the AFS the parser will actively attempt to insert the relative pronoun into the earliest possible gap during incremental interpretation. The earliest possible gap thus encountered is the relative clause’s subject position. To illustrate, see (9), in which gaps are indicated by an underscore:

- (9) a. De wandelaar, die _ de joggers gezien heeft,... (SR)
- b. De wandelaar, die (__) de joggers _ gezien hebben,... (OR)

In both instances in (9), the parser will insert the relative pronoun into the first possible gap in the relative clause, directly following *die*. In the case of the object-relative (9b) this is a pseudo-gap (indicated by parentheses): the origin of the relative pronoun is instead located after *de joggers*, which the number marking on the auxiliary later makes clear. This leads to a reanalysis of the sentence structure which comes with a processing cost.

This account is in essence prediction-based, and a precursor to contemporary, structurally-focused theories to account for the difficulty in object-relative clause processing: expectation-based accounts (Hale, 2001; Levy, 2008; Staub, 2010).

Expectation-based accounts are related to the notion of syntactic surprisal (Gennari & MacDonald, 2008; Levy, 2008), and are based on the idea that the parser anticipates likely sentence continuations based on previous exposure. Building a less frequent syntactic structure is more difficult than building one with which the language user has more experience. Processing difficulties with object-relative clauses under this account follow from the frequency distribution of subject- and object-relative sentences: Since subject-relative sentences are much more frequent than object-relative sentences (at least with two animate constituents, see corpus studies by e.g. Roland, Dick & Elman, 2007 for English, Mak, Vonk & Schriefers, 2002 for Dutch and German), the parser will expect a subject-relative clause to follow the relative pronoun, i.e. expect the relative pronoun to be the relative-clause subject, similar to the predictions made by the AFS. The violation of this expectation in object-relative clauses leads to the slowdown that is observed in processing studies and is hypothesized to be due to the rejection of the subject-relative structure and subsequent reanalysis (in two-stage approaches, e.g. Frazier, 1987b) or reordering of sentence structures built up in parallel (in more contemporary dual route approaches).

Whilst frequency or syntactic surprisal is an established factor in syntactic processing, the predictions made by surprisal-based accounts are contradicted by e.g. Grodner & Gibson (2005) who show that the processing difficulties with object-relative clauses arise not at the point where the syntactic structure becomes more rare as opposed to the subject-relative, but at the point where it becomes structurally more complex. The hypothesis that structural complexity rather than structural frequency is at the heart of the subject-relative bias is formulated in another class of structural accounts: memory-based accounts (Gibson, 1998, Warren & Gibson, 2002, Grodner & Gibson, 2005; Lewis & Vasishth, 2005). Memory-based accounts depart from the principle that language is a linear system, which necessitates that parts of the input must be held in working memory during incremental processing until such time as this information can be integrated, i.e. syntactically combined with other elements. To see how object-relative processing difficulties arise under this theory, consider (10a) and (10b), from Gibson (1998):

- (10) a. The reporter who attacked the senator admitted the error (SR)
- b. The reporter who the senator attacked admitted the error (OR)

Words in both sentences generate syntactic predictions of later integrations. For instance, ‘the reporter’ in both sentences generates a prediction for a matrix verb, which is only later encountered in ‘admitted’. The sentences

differ in the integration costs present in the relative clause, however. In the subject-relative (10a), the verb ‘attacked’ may be immediately linked to its subject, the gap in the relative clause’s subject position left by ‘the reporter’. In the object-relative clause, not one but two predictions need to be maintained in working memory and integrated when ‘attacked’ is encountered: the subject of ‘attacked’ – the noun phrase ‘the senator’, and its object – the subject-gap left by ‘the reporter’. The increased distance between two syntactic elements and the additional integration cost required predict a slow-down in object-relative clauses and predicts this slow-down to occur at the embedded verb, which is exactly what processing studies indicate (Fedorenko et al., 2012; cf. Staub, 2010).

2.2 Beyond structure

What connects the theories discussed so far is a focus on structural information as the main or single cue that (initially) guides the listener’s interpretation of a relative clause, or specifically, the explanation as to why the parser would experience processing difficulty with object-relative clauses. As has been discussed, semantic and pragmatic cues may also play a role in the assignment of grammatical roles and may thus influence predictions in relative-clause processing.

All theories of sentence processing account for the influence of semantic and pragmatic cues on interpretation, but syntactic cues had long been thought to hold a privileged position during processing (e.g. Frazier, 1987b; Ferreira & Clifton, 1986), with the influence of semantic and pragmatic cues visible only after a syntax-initial interpretation had concluded. Most contemporary models no longer assume the initial parse is guided purely by syntactic principles. Constraint-based accounts (e.g. MacDonald, 1994; Trueswell & Tanenhaus, 1994; Trueswell et al., 1994) assume all syntactic, semantic and pragmatic cues are taken into account in a single stage of processing. Applied to relative clauses, this approach predicts that whatever semantic or pragmatic cues serve to make a relative clause head less prototypical as a grammatical subject will immediately contribute to attenuate or even reverse the subject-relative bias during processing. Evidence for this approach comes from a series of self-paced reading and eye-tracking experiments by Mak, Vonk and Schriefers (2002, 2006, 2008). As these studies – in particular, Mak, Vonk & Schriefers (2008) – form the basis of the current study, these will be discussed extensively below, in turn.

The first studies by Mak et al. (2002, 2006) were targeted at the semantic cue of animacy. These studies depart from Trueswell et al. (1994), who

demonstrated convincingly the immediate influence of animacy on syntactic predictions. This is illustrated in the following example:

- (11) The defendant examined by the lawyer ...

The sentence in (11) leads to a garden-path effect: What later turns out to be the antecedent of a reduced relative clause is initially analysed as the grammatical subject of the relative clause's embedded verb. This leads to processing difficulties at the by-phrase when the parser realises the error. Trueswell et al. (1994) observed that this processing difficulty disappears in (12):

- (12) The evidence examined by the lawyer ...

The same syntactic information is present in (12) to lead the reader down the garden path, but the semantic cue (indicating the inanimate 'evidence' is a poor thematic fit as the subject of 'examined', which requires an Agentive subject) is able to interfere immediately to guide the reader to the correct interpretation.

Mak et al. (2002) find that an inanimate relative clause antecedent has similar effects on processing. When participants are presented with an object-relative clause containing an inanimate antecedent and an animate relative-clause internal constituent, the subject-relative bias disappears. In fact, the object-relative in (13a) is processed as easily as the subject-relative in (13b):

- (13) a. *De rots, die de wandelaars beklommen hebben, ... (OR)*
 the rock that the hikers climbed have
 'The rock that the hikers climbed ...'
- b. *De wandelaars, die de rots beklommen hebben, ... (SR)*
 the hikers that the rock climbed have
 'The hikers that climbed the rock ...'

In a follow-up experiment, Mak et al. (2006) explored possible causes for this effect. One hypothesis could be that inanimate relative-clause heads bias towards object-relative readings, regardless of the nature of the relative-clause internal constituent. When contrasting relative clauses with two inanimate noun phrases, however, this turns out not to be the case: in relative clauses containing two constituents with equal animacy values, the subject-relative bias is maintained. Combining these observations, two factors emerge: a bias towards interpreting the first constituent as the subject, and a bias towards

interpreting the animate constituent as the subject (cf. Lamers & de Hoop’s (2014) Subject First and Animate First principles for production). Mak et al. (2006) present two further processing studies that contrast these principles and find that the greatest processing difficulties emerge when the relative clause violates both, as in the object-relative (14):

- (14) *In het dorp zijn de wandelaars, die de rots verpletterd heeft,*
 In the town are the hikers, that the rock crushed has,
het gesprek van de dag.
 the talk of the day
 ‘In the town the hikers, that the rock has crushed, are the talk of
 the day.’

Mak et al. (2006) explain the interaction between the syntactic and semantic cues here in a broader perspective which also includes pragmatic cues. For this reason, we will first discuss Mak, Vonk and Schriefers (2008), which explored two such pragmatic cues in context, before returning to their account.

2.3 Relative clauses in context

Mak et al. (2008) looked at the effects of topicality on the processing of relative clauses in two experiments, targeting pronouns and discourse topicality, respectively.

The influence of a discourse context on processing syntactic ambiguities was demonstrated convincingly by Altmann and Steedman as early as 1988. In Altmann and Steedman (1988) participants were presented with sentences containing a syntactic ambiguity such as (15):

- (15) The fireman smashed down the door with the rusty lock.

In isolation, sentences such as these lead to processing difficulties since the parser will initially assume ‘with the rusty lock’ to modify the verb rather than the object, since this analysis does not postulate new syntactic nodes (the principle of Minimal Attachment, see Frazier, 1987b). Altmann and Steedman (1988) found that these processing difficulties disappear when (15) is embedded into a discourse context that evokes a contrast, as in (16):

- (16) A fireman was running to the scene of a fire carrying a heavy axe.
 He had to smash down a door. When he got to the scene of the fire,
 he found a door which had a rusty lock and a door which was nailed
 shut.

The fireman smashed down the door with the rusty lock but smoke overcame him.

Given that there are two doors in the discourse model, the likelihood of a modifier phrase following the object is increased. This discourse information is immediately applied to alter syntactic predictions of the following sentence which explains the disappearance of the processing difficulty observed in isolation.

Similarly Hoeks, Vonk and Schriefers (2002), focusing explicitly on topic structure, found that discourse modulates NP-coordination biases. Consider (17a) and (17b):

- (17) a. The model embraced the designer and the photographer at the party.
- b. The model embraced the designer and the photographer laughed.

When presented with (17b) in isolation, participants experienced processing difficulty at ‘laughed’, since the parser had anticipated coordination to be local to the object (according the principle of Late Closure, see Frazier 1987b), as in the preferred (17a). Hoeks et al. (2002) show that this processing difficulty may be overcome when (17b) is embedded into a discourse context that introduces both the model as well as the photographer as topics, as in (18).

- (18) When they met the fashion designer after the show, the model and the photographer were very enthusiastic. The model embraced the designer and the photographer laughed.

The hypothesis here is that the parser has a preference not for late closure per se, but for the sentence as being about one topic by default. The presence of two topics instead leads to an expectation of two comments, which is confirmed in the continuation in (18), but violated by a continuation as in (17a), leading to a reversal of the processing bias.

In Hoeks et al. (2002) the sentence topic referred to the discourse topic. This need not always be the case. The clearest illustration of this is the phenomenon of grounding (Fox & Thompson, 1990), whereby a new discourse referent is introduced by linking it to an established one, as in the relative clause in (19):

- (19) The car that she borrowed had a low tire.

In (19), the sentence topic is the noun phrase ‘the car’; the sentence is

‘about’ the car. ‘She’ embeds the sentence in a discourse that is about a female referent, and what happened to her car is part of a larger narrative. The use of the anaphoric pronoun ‘she’ rather than a definite noun phrase implies this discourse referent has already been introduced. First or second person pronouns function in a similar way, in that they are assumed to be part of the discourse by default, and thus need no prior introduction. Thus, pronouns are generally used to refer to discourse topics or discourse-salient entities (e.g. Ariel, 1990; see Kaan, 2001:533 for a short overview).

Due to the differences in discourse status between pronouns and noun phrases, differences in processing difficulties might be expected. Warren and Gibson (2002), working from a memory-based account, contrast the processing of relative clauses with nominal or pronominal relative clause internal constituents as in (20):

- (20) a. The reporter who the senator attacked admitted the error.
 b. The reporter who you attacked admitted the error.

As discussed earlier, the object-relative clause in (20a) leads to processing difficulty as compared to its subject-relative alternative. Recall that in Gibson (1998) this is explained as the result of an increased integration cost associated with holding an additional constituent in memory: ‘the reporter’, or rather its trace in the relative clause, needs to be retained across the introduction of an additional discourse referent ‘the senator’ until both can be integrated. When the second constituent is replaced by the personal pronoun ‘you’ as in (20b), processing difficulty decreases. This is explained in Warren and Gibson (2002) by referring to the discourse status of the personal pronoun: ‘you’ does not *introduce* a new discourse referent the same way ‘the senator’ does, as ‘you’ is already assumed to be a default participant in the discourse and is thus more easily accessed.

Note that Warren and Gibson (2002) do not directly contrast subject-relative clauses with object-relative clauses. Whether the pronoun is chosen as the subject of the relative clause, resulting in an object-relative bias, thus remains unclear. Kaan (2001) presents a self-paced reading study that does directly contrast these, in Dutch. Crossing relative-clause structure with relative-clause internal constituent type, she arrives at the following four example sentences:³

³Ellipses represent additional modifier material that did not differ across sentences nor was expected to have an effect on processing across conditions, omitted here in the interest of clarity.

- (21) *De buurjongen die de meisjes (...) heeft proberen te pesten, ...*
the neighbour.boy who the girls (...) has tried to tease, ...
‘The boy next door who tried to tease the girls ...’
- (22) *De buurjongen die de meisjes (...) hebben proberen te pesten, ...*
the neighbour.boy who the girls (...) have tried to tease, ...
‘The boy next door whom the girls tried to tease ...’
- (23) *De buurjongen die jullie (...) heeft proberen te pesten, ...*
the neighbour.boy who you.PL (...) has tried to tease, ...
‘The boy next door who tried to tease you ...’
- (24) *De buurjongen die jullie (...) hebben proberen te pesten, ...*
the neighbour.boy who you.PL (...) have tried to tease, ...
‘The boy next door whom you tried to tease ...’

Kaan (2001) finds a clear reflection of the subject-relative bias contrasting the noun phrase conditions (21) and (22). Differences in reading time between the pronominal (23) and (24) were inconclusive, however: there was no significant processing advantage for either sentence structure. She concludes that the subject-relative preference was much weaker or even absent in clauses containing a pronoun as the relative clause internal constituent. A reversal of the subject-relative bias (i.e. an object-relative bias) as predicted based on the discourse salience of the pronoun was not observed, however. We will return to possible explanations for this.

The first experiment by Mak et al. (2008) is similar to Kaan (2001). In a self-paced reading study, participants were presented with embedded Dutch relative clauses containing noun phrases or case-ambiguous pronouns as the relative-clause internal constituent. Examples of the latter condition are presented in (25) and its object-relative counterpart in (26).

- (25) *Ongerust kijkt de hardloper, die jullie (...) gegroet heeft, ...*
worried looks the jogger, who you (...) greeted has, ...
‘The jogger, who has greeted the strollers in the park, ...’
- (26) *Ongerust kijkt de hardloper, die jullie (...) gegroet hebben, ...*
worried looks the jogger, who you (...) greeted have, ...
‘The jogger, whom you have greeted in the park, ...’

Mak et al. (2008) find additional evidence for the subject-relative bias in the noun phrase condition. Contrary to Kaan (2001) however, Mak et al. (2008) also find a clear processing advantage for the object-relative (26) compared to (25). They ascribe the absence of the effect in Kaan (2001) to ‘subtle differences in materials’ (Mak et al., 2008:176), but these are

left unexplained.⁴ We will return to possible explanations for this difference later.

Discourse topicality was further explored in experiment II. This self-paced reading experiment manipulated the discourse status of noun phrases indirectly, rather than explicitly through constituent type (i.e. noun phrases versus pronouns).

Participants were presented with relative clauses containing two animate full noun phrases (in light of Mak et al., 2002; 2006). These were preceded by a short introduction in two conditions: a neutral condition and a topical condition. In the neutral condition neither the relative-clause antecedent nor the relative-clause internal noun phrase were explicitly mentioned. By contrast, in the topical condition, the relative-clause internal noun phrase was introduced as the discourse topic. An example sentence with a neutral and topical introduction are presented below.

Neutral context:

Onlangs is er ingebroken in een grote villa in deze wijk. De inbraak heeft veel opschudding veroorzaakt. Ook heeft de zaak veel aandacht gekregen in de media.

‘Recently there has been a burglary in a villa in this area. The burglary has caused a lot of excitement. The media have devoted much attention to the case.’

Topical context:

De inbreker was opgepakt bij een inbraak in een grote villa. Hij wilde enkele dure juwelen stelen uit het pand. Ook wilde hij geld meenemen.

‘The burglar has been arrested during a burglary in a large villa. He wanted to steal some expensive jewelry from the house. He also wanted to take some money.’

Relative clause:

De politie heeft de bewoners, die de inbreker hebben/heeft

The police have the occupants, that the burglar have/has

⁴Differences may include the word order in the matrix clause (Mak et al. place the subject in post-verbal position, which might serve to attenuate the topicality of the matrix clause subject and hence the relative-clause antecedent, see Bouma, 2008) and the verb-auxiliary word order (allowing verb semantics to be integrated before number marking on the auxiliary disambiguates grammatical role assignment). In addition, the semantic verb in Kaan (2001) was further modified by an infinitive immediately following the auxiliary, giving rise to a crossed dependency which adds further complexity and delay to verb integration as compared to Mak et al. (2008).

neergeslagen, verteld dat de man nog meer misdaden heeft
knocked.down, told that the man even more crimes has
gepleegd.
committed.

‘The police have told the occupants, who have knocked down the burglar/whom the burglar has knocked down, that the man has committed more crimes.’

Reading times for relative clauses following a neutral context match the pattern found in isolation, i.e. participants presented a subject-relative bias. Following a topical context, however, there was no significant main effect of sentence structure, i.e. the subject-relative bias disappeared.

Combined, Mak et al. (2002; 2006; 2008) attribute their results to the Topichood Hypothesis. The Topichood Hypothesis states that the choice of one of the entities as the subject of the relative clause is determined by the *topicworthiness* of the entities. Topicworthy entities tend to be the grammatical subject (Crasborn et al., 2009, Bouma, 2008), and topicworthiness may be defined along several hierarchies (adapted from Mak et al., 2008).⁵

- (27) i. Relative clause antecedent > Relative clause internal
- ii. Discourse topic > Not discourse topic
- iii. Pronoun > Full noun phrase
- iv. Animate > Inanimate

(27i) explains the subject-relative bias in absence of other cues: a relative clause is a statement about the antecedent, i.e. its sentence topic (Mak et al., 2006, following Lambrecht, 1988). (27ii) indicates that topicworthiness extends beyond the relative clause: discourse topics, when placed in the relative-clause internal position, may bias towards an object-relative reading. (27iii) captures the notion that pronouns are generally used to refer to discourse-salient entities, either previously introduced in case of third person or implicit in first- and second person and are thus likely to be chosen as the relative clause’s subject, and (27iv) reflects the inherent cognitive saliency associated with animate entities (e.g. Prat-Sala & Branigan, 2000) and their subsequent preference for grammatical subjecthood and discourse topicality (see e.g. Dahl & Fraurud, 1996).

The Topichood Hypothesis bears a resemblance to processing theories

⁵The hierarchies defined here echo some earlier hierarchies developed to capture the dimensions of topichood, e.g. Givón (1976:152), which identifies human > non-human, definite > indefinite, more involved participant > less involved participant, and the person hierarchy.

based on the linguistic notion of prominence (e.g. Bornkessel-Schlesewsky & Schlewsky, 2009) in its combination of several cues (among which those named in (27)) which serve to render a constituent more or less prototypical for a given grammatical role. Prominence or topicworthiness thus guides interpretation through making constituents either more or less suitable as grammatical subjects. Interpretation is easier when prominence cues align (according the principle of Harmonic Alignment, cf. Aissen, 1999), while misalignment of cues leads to processing difficulties (as observed in Mak et al., 2002).

Whether defined as topicworthiness or prominence, Mak et al. (2008) provide strong evidence that both inherent topicality (the relative-clause internal constituent being either a pronoun or noun phrase) as well as discourse topicality (a relative-clause internal noun made topical in a short preceding discourse context) contribute to grammatical role assignment and thus relative-clause interpretation. However, the relative strength of inherent topicality and discourse topicality is still unclear. Mak et al. (2008)’s first experiment shows a reversal of the subject-relative bias in relative clauses containing a pronoun, such that object-relative sentences are actually read faster than subject-relative sentences. This is in opposition to Kaan (2001), who only found an attenuation of the subject-relative bias. Kaan (2001) hypothesises that the absence of an object-relative bias in her study is due to the role of the relative clause in the matrix clause in her materials. Since the relative clause always modified the matrix clause subject, the relative pronoun in turn always referred to the matrix clause subject. The sentence topicality of the matrix clause subject had served to attenuate the object-relative bias induced by the relative-clause internal pronoun. The results by Mak et al. (2008) indicate that this cannot be the complete explanation, however, as here too the relative clause always modified the matrix clause subject.

In addition, Mak et al. (2008)’s second experiment, in which the relative clause does modify the matrix clause object, shows an attenuation of the subject-relative bias rather than its reversal when a relative-clause internal noun phrase is made more prominent through its discourse topicality. To summarise the influence of topicality on relative clause processing discussed so far:

- (28) i The head of the relative clause has a *sentence topicality*, which biases towards subject-relative readings.
- ii Pronouns possess an *inherent topicality*, which biases towards object-relative readings when embedded in a relative clause,

- serving to attenuate or reverse the subject-relative bias.
- iii *Discourse topicality* may serve to increase the prominence of a constituent when embedded in a relative clause, thereby attenuating the subject-relative bias.

2.4 The current study

The aim of this thesis will be to further explore the relative strength and neural correlates of topicality cues on relative clause processing. Mak et al. (2008) contrasted inherent and discourse topicality to sentence topicality, by increasing the relative-clause internal constituent's prominence at the cost of the relative pronoun's. So far, inherent and discourse topicality have not been directly contrasted in competition in the same relative clause, which would shed light on their relative strength. In order to do so one of these two prominence factors must be applied to the relative pronoun, or, in pragmatic terms, its antecedent (the head of the relative clause). Discourse topicality is the likely candidate as the factor to apply to the head of the relative clause, by elimination: Pronouns typically do not undergo modification (at least in Germanic languages, cf. Siewierska 2004), and as such are rare as heads of relative clauses. De Schepper (2013:91-92) carried out a corpus study in Dutch, finding 13838 second person singular pronouns and 543 second person plural pronouns, of which a mere 6 and 10 were modified, respectively. Note that relative clauses are a subset of modifiers, further reducing these numbers.

Thus, we necessarily arrive at relative clauses in which the discourse topicality of the relative clause head directly competes with the inherent topicality of the relative clause internal pronoun. Crossing the binary factors of inherent and discourse topicality we arrive at four conditions: Inherent topicality, which is realised in the relative-clause internal constituent being either a noun phrase (inherently less topicworthy) or a pronoun (inherently topicworthy), and discourse topicality of the relative-clause antecedent, which is realised through short discourse contexts preceding the relative clause in which the relative-clause antecedent was either omitted or made discourse prominent.

An illustration of the factor of inherent topicality is given in (29):

- (29) a. *De inbreker, die de bewoners neergeslagen heeft/hebben, ...*
 The burglar, that has knocked the occupants down, ...
 The burglar, that the occupants have knocked down, ...
 b. *De inbreker, die jullie neergeslagen heeft/hebben, ...*

The burglar, that has knocked you down, ...

The burglar, that you have knocked down, ...

In isolation, we would expect to find a subject-relative reading for (29a) and an object-relative reading for (29b), in line with (28i-ii) and Mak et al. (2008): the pronoun possesses an inherent topicality that the noun in (29a) lacks, which attracts grammatical subjecthood. Embedding the relative clauses in a neutral context is not expected to alter these biases, as in (30):

- (30) *Er was al vaker ingebroken in de dure villa's. De inbraken hebben veel opschudding veroorzaakt in de buurt. De rechercheur vertelde de bewoners: "De inbreker die jullie neergeslagen heeft/hebben was al langer een bekende van de politie."*

There had been several burglaries in the expensive villas. The burglaries have caused much commotion in the neighbourhood. The detective told the occupants: "The burglar, that you have knocked down/that has knocked you down, has been known to the police."

However, consider now (31), in which the relative clause in (29b) is embedded in a short discourse context which serves to increase the discourse topicality of the relative clause antecedent:

- (31) ***De inbreker** was al een tijdje actief in de buurt. Nadat **hij** bij een inbraak in de grote villa was opgepakt vertelde de rechercheur de bewoners: "**De inbreker** die jullie neergeslagen heeft/hebben was al langer een bekende van de politie."*

The burglar had been active in the neighbourhood for a while. After **he** was caught at a burglary in the large villa, the detective told the occupants: "**The burglar**, that you have knocked down/that has knocked you down, has been known to the police."

The pronoun's inherent topicality and the relative clause antecedent's discourse topicality are now in direct competition, both biasing towards grammatical subjecthood. Here the question becomes whether we will find an object-relative preference due to the pronoun's inherent topicality or a subject-relative preference due to the relative-clause antecedent's discourse topicality. From this we might deduce the relative strength of the two cue types. Considering the relatively weaker effect of discourse prominence as compared to pronominal prominence in Mak et al. (2008), we predict this competition to result in an attenuated object-relative bias rather than an attenuated

subject-relative bias. Crossing the effects of both types of topicality in relative clauses we arrive at the following concrete predictions:

- (32) i A subject-relative bias in conditions containing an additional noun phrase as the relative-clause internal constituent, in the absence of other cues.
- ii An object-relative bias in conditions containing a pronoun as the relative clause-internal constituent, in the absence of other cues.
- iii An independent bias towards interpreting the discourse topic as the subject of the relative clause, attenuating biases in (i) and (ii).

Recall our focus was on the relative strength of the pragmatic cues and their neural correlates. To investigate the latter our design was realised as an EEG experiment, measuring brain activity as participants read subject- and object-relative sentences in context. The biases in (32) generate syntactic expectations, specifically for number marking on the auxiliary to agree with the syntactic subject. Violations of these syntactic expectations are expected to lead to a bigger deflection in the EEG signal, allowing us to deduce what expectations were generated.

Two ERP components that have been linked to syntactic processing are left anterior negativities (LAN) and the syntactic positive shift (P600).

The LAN is an ERP component occurring between 300 and 500 milliseconds after word onset, characterised by a negative deflection with a left anterior distribution. The LAN has been observed in object-relative clause processing (King & Kutas, 1995) and has been claimed to reflect an early lexical processing stage indexing difficulties with lexical retrieval or storage in verbal working memory (Kaan, 2002), or syntactic incongruities such as word category violations (Friederici et al., 1996).

The second ERP component associated with syntactic processing difficulty is the P600, a positive component starting 600 milliseconds after target word onset characterised by a central-parietal scalp distribution (Osterhout & Holcomb, 1992; Hagoort, Brown & Groothusen, 1993; Kaan et al., 2000). The P600 is observed following the LAN, but may also occur without it (Kaan et al., 2000). Unlike the LAN, the P600 is observed not just for ungrammatical sentence continuations or word category incongruities but may also reflect syntactic surprisal in grammatical but locally ambiguous sentences following words that are syntactically unexpected given the preferred reading of the preceding context, such as an auxiliary not agreeing in

number with the preferred sentence subject.

To our knowledge we present the first EEG study on relative clause processing in Dutch. EEG studies on relative clauses in English (e.g. King & Kutas, 1995) are consistent in indicating a subject-relative bias in processing, but give no indication of the ERP component to be expected in our study: In English, word order rather than number agreement is the disambiguating factor. Thus, the ERP is expected to reflect grammatical category or lexical selection violations, which might give rise to different components than the P600 expected in our study (King & Kutas, 1995 report LAN and even N400 components in object-relative processing).

EEG studies on more comparable languages can be found in German (Mecklinger et al., 1995; Friederici et al., 1998) and Spanish (Carreiras et al., 2004). Mecklinger, Schriefers, Steinhauer and Friederici (1995) contrasted the processing of subject-relative and object-relative clauses in high and low-span readers in German. In case-ambiguous sentences, where disambiguation also proceeded on the auxiliary, they report early positive components (P375) to object-relative disambiguations. In a similar study on German relative-clause processing, Friederici, Steinhauer, Mecklinger and Meyer (1998) find both early (300-400ms) and late (600ms) positive components following auxiliaries disambiguating towards an object-relative reading. Carreiras, Salillas and Barber (2004) contrast high and low attachment ambiguities in Spanish relative clauses, where attachment is disambiguated by gender marking on the adjective in the relative clause (e.g. ‘The servant (masc) of the actress (fem) who was divorced (masc)/(fem)’). They find a positive component 600 ms following the adjective in response to the disfavoured attachment.

Following the above, if biases in the processing of Dutch relative clauses are reflected in the preferred number agreement on the auxiliary, we expect to find a positive deflection 600 milliseconds after auxiliary onset in conditions where the ambiguity resolution does not conform to these biases as compared to the conditions in which it does.

3 Experiment

The relative strength of inherent and discourse topicality cues on grammatical role assignment will be explored by means of their interaction in Dutch relative clauses following a short discourse context. The assignment of subject and object roles in Dutch relative clauses is not strictly constrained by word order and is only disambiguated syntactically after both candidate constituents have been processed. This provides us with an ideal linguistic environment to ascertain when and to what extent inherent topicality (a constituent being a noun phrase or pronoun) and discourse topicality (whether or not the constituent refers to the discourse topic) contribute to the preferential assignment of grammatical roles in transitive sentences. Specifically, we varied 1) inherent topicality of the relative-clause internal constituent (nominal or pronominal) and 2) discourse topicality of the relative-clause antecedent, by means of topical or neutral contexts (antecedent was or was not the topic of the discourse). Grammatical number between relative clause constituents always differed, such that number marking on the auxiliary syntactically disambiguated between subject- and object-relative readings. This disambiguation could either be congruent or incongruent with the participants' preferential interpretation up to that point, which allows us to deduce biases in relative-clause processing and thus, grammatical role assignment, introduced by both topicality cues.

We pretested our predictions in an off-line sentence completion task. A slightly modified design was subsequently used for an on-line EEG experiment. This section will describe both experiments in turn.

3.1 Sentence completion task

The potential attenuation and reversal of the subject-relative bias under topicality cues was pretested using a sentence completion task. Participants ($N = 14$, all students of Radboud University with no knowledge of psycholinguistics) were presented with incomplete relative clauses preceded by either a neutral or a topic context, containing a relative-clause internal constituent which could be either a pronoun or a noun phrase. In the noun phrase condition the topic context biased towards the relative-clause internal noun phrase; in the pronoun condition the discourse biased towards the antecedent noun phrase. Materials consisted of a small subset of our experimental items (15) across all four conditions, cut off just after the relative-clause internal constituent. An example (a pronoun condition following a topic context) can be found in (33).

- (33) *De inbreker was al een tijdje actief in de buurt. Nadat hij bij een inbraak in de grote villa was opgepakt vertelde de rechercheur de bewoners: “De inbreker die jullie...”*

The burglar had been active for a while in the neighbourhood. After he was caught at a burglary in the large villa, the detective told the residents: “The burglar that ...”

The contexts were presented to the participants on paper as short stories which they were asked to complete in a natural way using one or two sentences. Sentence continuations naturally required a verb phrase. As the constituents in the relative clause always differed in number, this allowed us to annotate agreement on the verb phrase, which in turn reflects a subject- or object-relative bias. Number was counterbalanced between constituents.

To reiterate, the predictions made for the experiment are as follows:

- (34) i A subject-relative bias in conditions containing a noun phrase as the relative-clause internal constituent.
 ii A reversal of the subject-relative bias in conditions containing a pronoun as the relative clause-internal constituent.
 iii An attenuation of the bias towards relatively more subject-relative readings in the pronoun condition and relatively more object-relative readings in the noun phrase condition under the influence of topic contexts, i.e. a bias towards interpreting the discourse topic as the subject of the relative clause.

While responses varied greatly in terms of both the length and content of sentence continuations between participants, annotating verb phrase agreement proved relatively straightforward. Sentence continuations were scored as either subject-relative or object-relative contingent on number agreement with the respective constituents. Figure 1 presents the results in terms of the percentage of subject-relative clauses used.

The results display a clear main effect of constituent type: Relative-clause internal noun phrases resulted in a subject-relative continuation in 73% of cases, whilst this effect was reversed for relative clauses containing a relative-clause internal pronoun (25%), $\chi^2(1) = 27.84$, $p < 0.01$. The interaction of constituent type and context was more subtle and did not reach significance, but is in the expected direction: a topic context biasing towards the noun phrase antecedent of the relative clause generated relatively more subject-relative continuations, a topic context biasing towards the relative clause internal noun phrase in the noun phrase condition generated relatively more object-relative continuations.

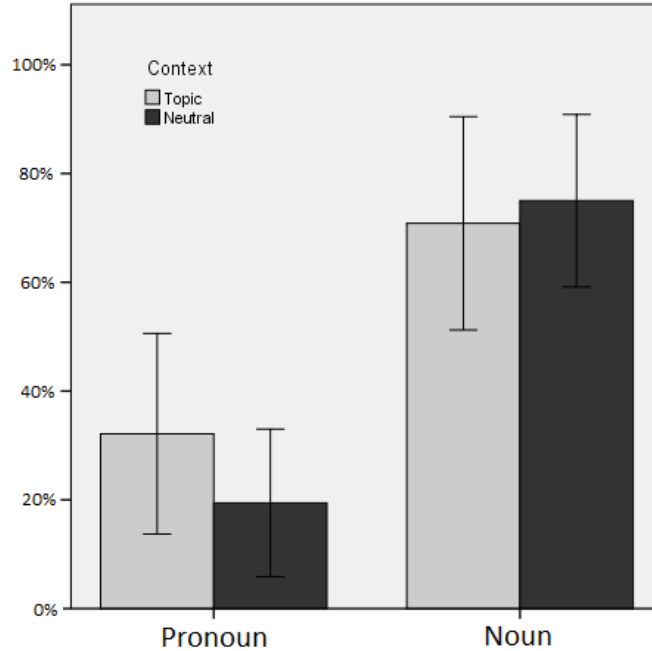


Figure 1: *Results of the sentence-completion pretest, following neutral or topical discourse contexts and pronominal or nominal relative-clause internal constituents. The y-axis represents the percentage of subject-relative continuations by relative-clause internal constituent type by context, i.e. the percentage of relative clauses in which the first constituent was chosen as the grammatical subject. Error bars represent 95% confidence intervals. Results indicate a significant main effect of constituent type.*

3.2 EEG experiment

Behavioural data from Mak et al. (2008) and our sentence-completion task suggest an effect of both types of topicality on the subject-relative bias. We further explored possible neural mechanisms driving this effect by means of an EEG study taking place over two sessions.

3.2.1 Participants

Seventeen Dutch native speakers, who did not take part in the sentence-completion task, participated in the EEG experiment (14 female, mean age 24.6, sd 7.3). All were right handed and had normal or corrected-to-normal vision. Participants provided informed consent and reported no history of reading disability or neurological impairment. The study was approved by the ethics committee of the faculty of social sciences (ECSW) at Radboud University. Two participants (1 female) were excluded for failure to attend the second session. Participants were paid once both sessions had been completed to the sum of 25 euros in vouchers.

3.2.2 Materials and design

For the EEG experiment we used a modified design, focusing more on the interaction between discourse topicality and inherent topicality, i.e. relative clauses containing a relative-clause internal pronoun following topical or neutral discourse contexts. The factor of discourse topicality on the interpretation of relative clauses containing two noun phrases was dropped. This was done due to time constraints imposed by having 30 sentences per condition in the EEG experiment as this condition would essentially be a replication of Mak et al. (2008). Relative clauses containing two noun phrases were still included, but following a neutral context only. These served to distract from the discourse manipulation in the pronoun conditions and as an experimental control for the neural correlates of the subject-relative bias in the processing of relative clauses with double noun phrases. Thus, our experimental materials were divided in two relative-clause internal *constituent types*, of which the pronominal constituent type also varied along two *context types*. Note that constituent type differs between items whereas context type differs within items.

(35) **Constituent type: Pronominal, context type: Neutral**

Er was al vaker ingebroken in de dure villa's. De inbraken hebben veel opschudding veroorzaakt in de buurt. De rechercheur vertelde de bewoners: "De inbreker die **jullie** neergeslagen heeft/hebben was al langer een bekende van de politie".

There had been several burglaries in the expensive villas. The burglaries have caused much commotion in the neighbourhood. The detective told the occupants: "The burglar, who has knocked you down/whom you have knocked down, has been known to the police."

- (36) **Constituent type: Pronominal, context type: Topic**
 De inbreker was al een tijdje actief in de buurt. Nadat hij bij een inbraak in de grote villa was opgepakt vertelde de rechercheur de bewoners: “De inbreker die **jullie** neergeslagen heeft/hebben was al langer een bekende van de politie”.
The burglar had been active in the neighbourhood for a while. After he was caught at a burglary in the large villa, the detective told the occupants: “The burglar, who has knocked you down/whom you have knocked down, has been known to the police.”
- (37) **Constituent type: Nominal, context type: Neutral**
 Bij de feestelijke opening van de schouwburg waren veel hoogwaardigheidsbekleders aanwezig. De organisatoren zijn dan ook erg in hun nopjes. Na afloop vragen journalisten de burgemeesters, die **de koningin** begroet heeft/hebben, hoe het gesprek verlopen is.
At the grand opening of the theatre many dignitaries are present. The organisers are rightly very pleased. Afterwards journalists ask the mayors, who have greeted the queen/whom the queen has greeted, how the conversation went.

Given the relevance of possible cues such as animacy, case and definiteness as outlined above, care was taken to keep these factors constant. All constituents in the relative clause were animate, nominal constituents were definite and for all pronominal constituents the case-ambiguous pronouns *jullie* ‘you.PL’ and *je* ‘you.SG’ were used.⁶ Number of the constituents always differed between the relative-clause head and the relative-clause internal constituent in order for disambiguation to proceed based on auxiliary agreement. The auxiliary either agreed with the first constituent for a subject-relative reading or the second constituent for an object-relative reading, thus introducing a third factor of *sentence type*: the same relative clauses and contexts were presented in either a subject- or object-relative clause version.

Number was also counterbalanced between items. In half of our sentences, the first constituent was singular, in the other half of our sentences, the second constituent was singular. This was to control for length and frequency of the auxiliary (‘heeft’ versus ‘hebben’) and possible inherent top-

⁶Dutch still exhibits case in its pronominal system, with the notable exception of the second person pronouns, the current forms of which were introduced to the language at a later stage. Second person singular forms do express case in their stressed versions: ‘jij’ and ‘jou’ for nominative and dative/accusative, respectively. These unreduced forms are mainly used to indicate contrast, but their reduced, case-ambiguous alternative ‘je’ may be substituted in most cases and sounds perfectly natural in our sentences. In addition, reduction of form is correlated with increases in topicality, which suits our purposes.

icworthiness of plural versus singular constituents within the same sentence type.

Contexts always consisted of two sentences. The first context type – the neutral context – consisted of two sentences introducing a situation without referring to specific entities in the relative clause.⁷ Relative clauses containing two noun phrases were always preceded by a neutral context.

Relative clauses containing a pronominal relative-clause internal constituent could also be preceded by topic contexts. Topic contexts are of similar length and content to the neutral contexts, with the crucial difference that here the relative clause antecedent is introduced in the prior discourse. These were also created in a fixed format: The first sentence contained the topic as its grammatical subject in the form of a definite noun phrase, e.g. *de inbreker*. In the second sentence the topic is realised as an anaphoric pronoun, e.g. *hij*, again syntactically expressed as the grammatical subject of the sentence. The second sentence also introduces the referent of the relative clause internal pronoun, realised as a definite noun phrase, in addition to a third discourse referent external to the relative clause. The third sentence in the pronoun condition is shared in both neutral and topic conditions, and is an utterance by the third discourse referent realised as a sentence in direct speech. Using direct speech, the relative clause internal pronoun referred to the addressee, which enabled the use of the ambiguous second person pronouns ‘je’ and ‘jullie’. The utterance contains the relative clause and a sentence continuation.

We used 120 relative clauses, 60 per constituent type. Within constituent types, 30 relative clauses had singular relative-clause antecedents, and 30 had singular relative-clause internal constituents. All relative clauses were essentially doubled, as they could include either singular or plural auxiliary agreement consistent with subject-relative or object-relative readings. 180 contexts were created, 60 neutral contexts for the nominal condition, and 120 (2x60) for the pronominal condition. We took care to control for length of both the relative clause (continuation) and its context within constituent

⁷To create natural discourse contexts, synonyms or hypernyms of noun phrases in the relative clause were unavoidable in some cases (e.g. *hoogwaardigheidsbekleders* ‘dignitaries’ are a superset of *burgemeesters* ‘mayors’ and *koningin* ‘queen’). In other cases, the first sentences created a location in which one encounters the entities referred to by the noun phrases in the relative clause (e.g. ‘hospital’ introducing a relative clause containing ‘doctors’ and ‘patients’). In this sense neutral contexts were never truly neutral since a natural discourse is one in which expectations on upcoming relative clauses may reasonably be generated; neutral in our case refers to the fact that care was taken to avoid contexts in which one of the relative clauses’ constituents was made more prominent. These expectations were not pretested.

asked ‘who did what to whom’ within the relative clause, and were counterbalanced to result in an equal number of affirmative or negative answers when answered correctly.

Our materials entered into a design in which participants saw 120 relative clauses in context in one session, and an additional 120 relative clauses in context in a second session. Note that with a total of 120 relative clauses in our materials this entailed that all relative clauses were repeated; for this reason, sessions were separated by at least one week. Four lists were created; half of our participants saw the first two lists, the second half saw the last two lists, divided by session.

To reiterate, materials differed along three dimensions: constituent type (pronominal or nominal), context type (neutral or topical; applicable to pronominal conditions only) and sentence type (subject-relative or object-relative, as determined by auxiliary agreement). The first two lists, both presented to the same participants, differed on context type in the pronominal condition and sentence type in the nominal condition. Thus, a participant would see a given pronominal subject-relative clause preceded by a neutral context in the first week, and the same pronominal subject-relative clause preceded by a topic context the second week, or vice versa, and a nominal relative-clause preceded by a neutral context as a subject-relative in the first week, and following the same neutral context as an object-relative in the second week, or vice versa. A second set of lists, presented to the second half of participants, varied from the first two lists on sentence type for the pronominal condition and order of presentation for the nominal condition within items, i.e. items presented as a pronominal subject-relative following a topical context in the first two lists were now presented as a pronominal object-relative following a topical context in the latter two lists, and those items that were presented in the *first* session as a nominal subject-relative following a neutral context in the first two lists were now presented as a nominal subject-relative following a neutral context in the *second* session. In addition, all of the above was counterbalanced between lists such that all conditions were present in each session. Table 1 illustrates the design by means of three example sentences.

Whilst the resulting design is intimidating in its complexity, the counterbalancing ensured that participants would be hard-pressed to predict sentence continuations from memory based on context or relative clause constituents between sessions: in cases where the context was the same, the auxiliary agreement differed, in cases where it was not, auxiliary agreement remained the same. Due to the existence of neutral contexts in both constituent type conditions, the mere presence of a neutral context was not a re-

liable predictor for stable or unstable auxiliary agreement between sessions. The design also ensured an equal number of sentence types, i.e. subject- and object-relative sentences, such that predictions could not be generated due to priming of a specific sentence type, and ensured that the number of pronominal and nominal relative clauses remained equal, and stable between sessions, again with the aim of avoiding within-experiment priming.

Table 1: *Schematic representation of the experimental design. Four lists were created, each containing all 120 relative clauses constructed for the experiment, divided here into four quadrants: two sessions ('Session') per participant group ('Version'). 'Item' refers to an exemplar experimental item, a relative clause stable across all four lists; item 1 and 2 represent a relative clause with a pronominal constituent type, item 3 represents a relative clause with a nominal constituent type. 'SR' and 'OR' refer to levels of sentence type, 'Topic' and 'Neutral' refer to levels of context type. As an example, item 1 in version 1 and session 1 may correspond to 'De inbreker, die jullie neergelagen heeft, ...' following a topic context; in version 2 session 2 this item is now 'De inbreker, die jullie neergeslagen hebben, ...' following a neutral context.*

	Version 1	Version 2
Item	Session 1	Session 1
1	Pronoun, SR, Topic	Pronoun, OR, Topic
2	Pronoun, OR, Neutral	Pronoun, SR, Neutral
3	Noun, SR, Neutral	Noun, OR, Neutral
Item	Session 2	Session 2
1	Pronoun, SR, Neutral	Pronoun, OR, Neutral
2	Pronoun, OR, Topic	Pronoun, SR, Topic
3	Noun, OR, Neutral	Noun, SR, Neutral

3.2.3 Procedure and apparatus

The experiment was implemented in Presentation (Neurobehavioral Systems, www.neurobs.com), and was presented on a 24 inch BenQ computer screen with a refresh rate of 60Hz at a resolution of 1920x1080. Items were displayed in white on a black background, in the Consolas font at fontsize 20. Participants were seated approximately 60 centimetres from the screen in a dimly lit, sound attenuating booth and were provided with a botton-box situated in front of them containing two unlabelled buttons, corresponding

to ‘yes’ (right) and ‘no’ (left).

Presentation of the experimental materials was preceded by a fixation cross at the centre of the screen for 992 milliseconds. This was followed by the sentence context which was presented in its entirety in the centre of the screen, aligned to the left margin. Participants were asked to press any button on the button-box to proceed once they had finished reading the story. This brought up another fixation cross for 992 milliseconds, after which the relative clause and its continuation were presented word for word in the centre of the screen, at intervals of 344 milliseconds per word with 242 milliseconds of a blank, black screen in between words. This phase was optionally followed by a question slide, which presented one of the verification statements and ‘correct’ or ‘incorrect’ answer options. The question was presented centrally, answer options were aligned at the bottom of the screen with a left and right alignment corresponding to the button-box. Pressing either button on the button-box continued onto the next item. Verification statements occurred every 10 trials, and were related to any of the 10 trials directly preceding the verification statement (mean interval 2.2 trials, minimally 0 trials, maximally 7 trials) to ensure participants did not develop a strategy of paying attention only to every tenth sentence. When no verification statement was presented, a button press was also required to move on to the next item. Materials were presented pseudorandomly to participants, such that no sentence type or constituent type occurred more than three times in a row. This randomisation was the same between participants within lists.

The experiment started with an instruction and a practise block containing four sentences in context. During the instruction participants were told they would be seeing short stories, and to press the button to read the final sentence of the story word-by-word. They were informed that some of the stories would be followed by questions, which required a response. In addition, participants were reminded to move as little as possible during the experiment and to keep eye-blinks to a minimum. To help with this, participants were told they were allowed to take some time to regain their focus or blink between trials or before proceeding to the final, word-by-word sentence. This instruction was also given to the participants orally, and questions could be asked before or after the practice block. The four trials in the practice block consisted of four non-relative clause sentences presented word-by-word following a short context, similar in length and presentation to the experimental items, and included a final verification statement following the fourth trial, related to the third trial in the practice block. Once the participant completed the practice block and indicated they understood the task,

the experiment could begin.

In total, the experiment consisted of four blocks; the practice block and three blocks of equal length (40 sentences in context, 4 verification statements) separated by breaks of a length preferred by the participant within reason, and lasted about 40 minutes excluding 20 to 30 minutes of EEG preparation time. The experimenter checked in on the participant during breaks between blocks to ensure there was no discomfort, and to remind the participant that excessive movement would distort the EEG signal should this have occurred. A button press by the participant started the next block when ready.

3.2.4 Data acquisition

Response accuracy was gathered as the correspondence of the intended answer and the button-box input given by the participant, to be compared to chance level performance.

The EEG signal was recorded continuously, using Brain Vision Recorder with 27 active electrodes placed in an elastic cap (ActiCAP; Brain Products, www.brainproducts.com). These included five midline electrodes (Fz, FCz, Cz, Pz and Oz) and 22 lateral electrodes (F3/4/7/8, FC1/2/5/6, T7/8, C3/4, CP1/2/5/6, P3/4/7/8 and O1/2). An additional two electrodes served, respectively, as reference, placed on the left mastoid, and ground, placed at a central position (AFz). For off-line re-referencing to both mastoids, an electrode was placed on the right mastoid corresponding to the reference electrode position. Eye blinks and movements were monitored by an EOG, using two electrodes above and below the right eye for vertical eye movements and two electrodes at the outer canthi for horizontal eye movements. Electrodes were kept at impedance levels below 10k Ω with the exception of EOG electrodes, which were kept at impedance levels below 20k Ω . The EEG signal was amplified (time constant 10 seconds, bandpass filter 250Hz upper-bound) and digitized with a 16-bit converter, sampled at an interval of 2000 μ s (500Hz). A marker was placed in the EEG signal at the onset of the critical word, the relative-clause internal auxiliary, during word-by-word relative clause presentation, as well as a marker indicating the experimental item.

3.2.5 Data analysis

The EEG data analysis was carried out using BrainVision Analyser (Brain Products, www.brainproducts.com). After re-referencing to the mean of

both mastoids, the EEG signal was segmented for ERP analysis. The first segmentation was accomplished using the experimental item marker based on the longest trial, 10,000 milliseconds in duration, such that only the word-by-word relative clause (continuation) data entered into the analysis. These signals were further segmented around the critical word onset marker to derive the ERP data. These segments were created from 250 milliseconds preceding the marker and up to 1000 milliseconds following the marker. Baseline correction then proceeded from -250 milliseconds to 0 milliseconds. To examine artefacts, semi-automatic artefact rejection was applied. Trials containing excessive movement or amplifier saturation were excluded.

For the purposes of the analyses, the factors carried over between sessions within the same participant were considered to be between participants, i.e. data from participant 1 in session 1 and data from the same participant in session 2 were treated as being from two distinct participants, due to inevitable differences in cap placement and impedances. The inter-session interval of at least one week made it less likely that experimental strategies or parsing biases would carry over from one set of experimental stimuli to the next.

The critical word segments were averaged over trials by condition. This resulted in six average ERPs per participant, based on the three manipulations in our design: Constituent type, Context type and Sentence type:

- (39) i Pronoun - Topic - SR
- ii Pronoun - Topic - OR
- iii Pronoun - Neutral - SR
- iv Pronoun - Neutral - OR
- v Noun - Neutral - SR
- vi Noun - Neutral - OR

Repeated measures ANOVAs were carried out on the mean amplitudes of all active electrodes following critical word onset using Electrode as a within-subject factor. Considerable variation exists in the time windows reported for late positive syntactic shifts, from around 500 to 900 milliseconds after stimulus onset (e.g. Regel et al., 2014; Coulson et al., 1998), but we chose an a priori 600-800 window following previous studies in our lab (e.g. Visers et al., 2010; Verhees et al., 2015) to calculate mean amplitudes. We performed two separate analysis on the ERP signals, distinguished on constituent type. First, in order to test the hypothesis that a subject-relative bias should emerge in the absence of other cues, we compared the aggregate of all ERPs following *subject-relative* auxiliary agreement in relative clauses

containing a relative-clause internal noun phrase following a neutral context with those following *object-relative* agreement in the same condition, i.e. (39v) versus (39vi), using Sentence type and Electrode as within-subject factors. The second analysis was concerned with relative clauses containing a relative-clause internal pronoun. We compared main effects of sentence type separated between context types, i.e. (39i) versus (39ii) and (39iii) versus (39iv). The latter contrast is hypothesised to result in an object-relative bias under the influence of inherent topicality, whereas the preference in the former contrast is the result of the competition between inherent and discourse topicality. Thus, an interaction effect of sentence type with context type should emerge. Unless otherwise stated, Greenhouse-Geisser correction was applied when the assumption of sphericity was violated, reporting uncorrected degrees of freedom for the sake of clarity.

3.3 Results

3.3.1 Behavioural data

Responses to verification statements were scored for response accuracy, for participant (by version, nested) by session. Overall response accuracy was high (mean = 0.867, sd = 0.34). Response accuracy did not differ significantly between versions (mean version 1 = 0.875; mean version 2 = 0.859, $\chi^2(1) = .189$, $p = .66$), but we did observe a slight but significant difference between sessions (mean session 1 = 0.828; mean session 2 = 0.906, $F(1,14) = 4.71$, $p < .05$). No participant was excluded based on response accuracy; the lowest response accuracy observed on the participant level was 0.708. Figures 2 and 3 detail response accuracies split by participant and the order of the question in the experiment, respectively. While response accuracies did not statistically diminish as a function of experiment duration, response accuracy on the final question presents a markedly low outlier. This effect was driven by poor, below chance performance on one version*session (mean response accuracy 0.25), with the remaining three lists at stable values. We can offer no explanation for this as the question was clear and coded correctly, and participants were given no overt indication the experiment was concluded at this point.

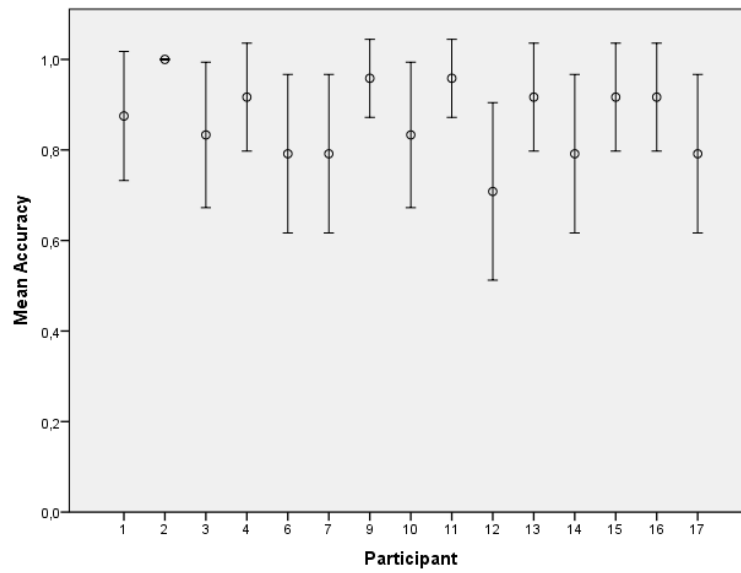


Figure 2: *Mean response accuracy by participant, aggregated over both sessions. Error bars represent 95% confidence intervals. The minimum average response accuracy was presented by participant 12, at 0.708, or 71%.*

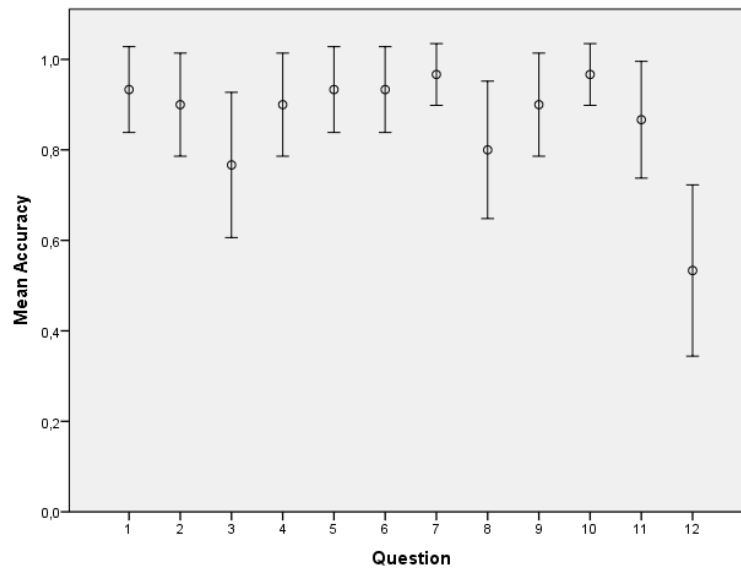


Figure 3: *Mean response accuracy by position of the question in the experiment, aggregated over both sessions. Error bars represent 95% confidence intervals. Question 12 presents an unexplained outlier, driven by one of the four lists.*

3.3.2 EEG data

Three sentence type contrasts were made for the EEG analysis. The first contrast was between conditions containing a relative-clause internal noun phrase and the second two between relative-clauses containing a relative-clause internal pronoun in topic or neutral contexts, respectively. Grand average ERPs to the auxiliary per condition by electrode are presented in order in Figure 4, Figure 5 and Figure 6. Black lines represent subject-relative agreement, red lines represent object-relative agreement.

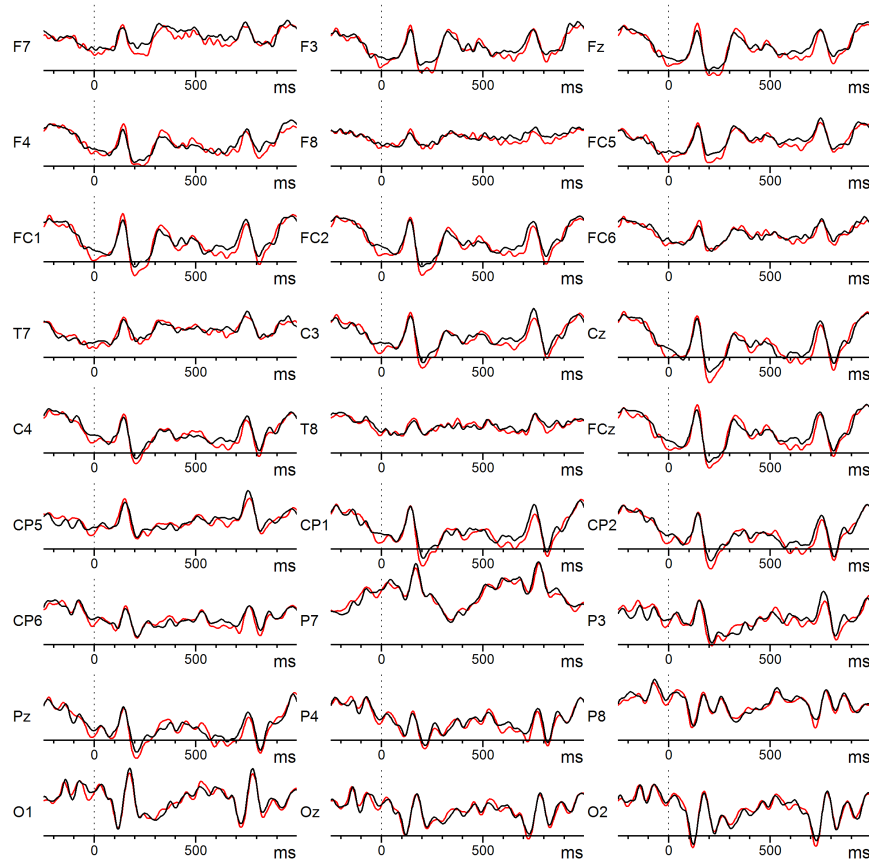


Figure 4: *Grand average ERPs as a response to auxiliary presentation for the noun phrase constituent type, contrasted by sentence type. Black lines represent subject-relative agreement, red lines represent object-relative agreement.*

A marginally significant main effect of sentence type was obtained for the noun phrase condition: $F(1,14) = 4.42$, $p = .054$, reflecting a larger P600

amplitude in response to object-relative auxiliary agreement following relative clauses with a relative-clause internal noun phrase following a neutral context. To further investigate this effect, we performed an subsequent ROI analysis on twelve lateral centroparietal electrodes that typically yield P600 effects (C3/4, CP1/2, CP5/6, P3/4, P7/8, O1/2). In this analysis, no significant main effects of sentence type were maintained: $F(1,14) = 3.37$, $p = .074$.

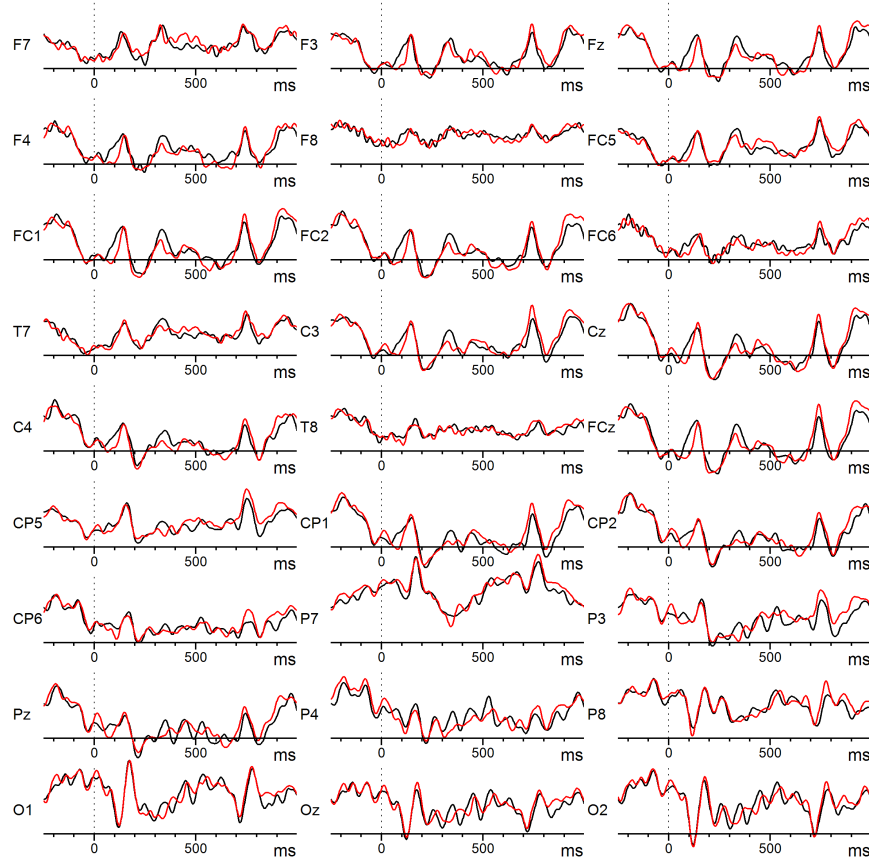


Figure 5: *Grand average ERPs as a response to auxiliary presentation for the pronominal constituent type following a topic context, contrasted by sentence type. Black lines represent subject-relative agreement, red lines represent object-relative agreement.*

Subject-relative auxiliary agreement resulted in higher average amplitudes in the 600-800 ms time window for relative-clauses following topic contexts,

but this effect was not significant: $F(1,14) = .462$, $p = .51$.

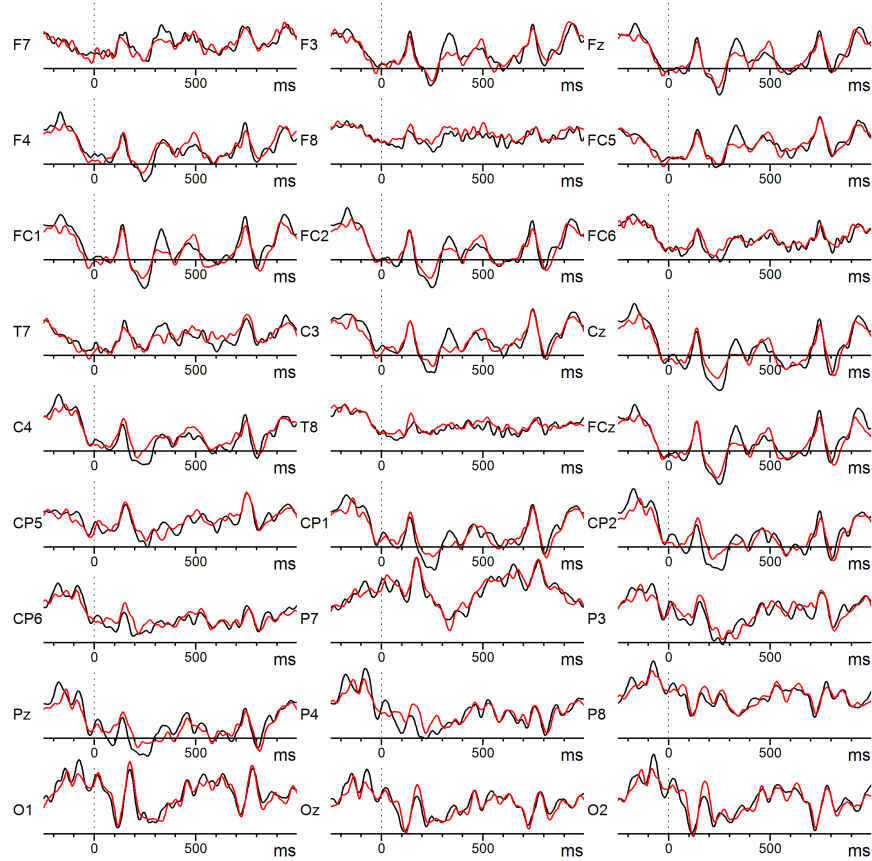


Figure 6: *Grand average ERPs as a response to auxiliary presentation for the pronominal constituent type following a neutral context, contrasted by sentence type. Black lines represent subject-relative agreement, red lines represent object-relative agreement.*

Similar to the topic condition, subject-relative auxiliary agreement resulted in higher average amplitudes in the 600-800 ms time window for relative-clauses following neutral contexts, but again this effect did not reach statistical significance: $F(1,14) = .710$, $p = .41$.

Aggregating the effect of sentence type across context type in a subsequent analysis with the within-subject factors Electrode, Sentence type and Context type, we find a higher amplitude in the P600 window to subject-relative auxiliary agreement compared to object-relative auxiliary agreement

for relative clauses containing a relative-clause internal pronoun regardless of context, but this effect again did not reach statistical significance: $F(1,14) = 0.69$, $p = .42$. No significant interaction of context type and sentence type was obtained: $F(1,14) = .002$, $p = \text{n.s.}$.

4 Discussion

This thesis has attempted to examine the relative strength of two topicality cues on grammatical role-assignment in locally ambiguous relative clauses in Dutch: discourse topicality, applied to the relative-clause head, and the inherent topicality of the relative clause internal constituent, realised through noun phrases or pronouns. Previous studies have indicated that both features serve as cues that bias the listener towards subject- or object-relative readings of the relative clause, either through a reversal of a syntactically-based subject-relative bias or its attenuation. Results of a direct competition between both cues were yet unknown, as were the neural correlates associated with these pragmatic cues in Dutch. We presented a sentence-completion task and an EEG experiment that attempted to examine the effects of inherent and discourse topicality on relative clause processing and their interaction, in relative clauses containing either pronouns or noun phrases as the relative-clause internal constituent, embedded in either topic or neutral contexts.

Consistent with earlier behavioural evidence from Dutch (Mak et al., 2008; Kaan, 2001) our sentence completion task revealed clear indications of a subject-relative bias following relative clauses containing a relative-clause internal noun phrase, and the disappearance of this preference when the relative-clause internal constituent was pronominal – an effect of inherent topicality. Thus, we hypothesised our EEG experiment to find reflections of these biases in ERPs: a P600 in response to object-relative auxiliary agreement as opposed to subject-relative agreement for conditions with a relative-clause internal noun phrase, and a P600 response to subject-relative auxiliary agreement as opposed to object-relative auxiliary agreement for conditions with a relative-clause internal pronoun. In addition, extrapolating from Mak et al. (2008), we expected that discourse topicality would give rise to a separate bias towards interpreting the discourse topic as the grammatical subject of the relative clause, i.e. an attenuating bias towards subject-relative agreement for relative clauses with a discourse topical antecedent and relative-clause internal pronoun. The results of our sentence-completion task are consistent with this hypothesis, and thus, we hypothe-

sised our EEG experiment to show the ERPs to subject-relative as opposed to object-relative auxiliary agreement to be diminished in relative-clauses containing a pronominal constituent when these followed a discourse context, as opposed to a neutral context.

These predictions were not borne out in the ERP data. We found indications of processing difficulty for object-relative clauses as opposed to subject-relative clauses in the P600 as a response to relative clauses containing a nominal relative-clause internal constituent, consistent with a subject-relative bias in isolation, but subsequent ROI analysis indicated this was not highly significant. In the pronominal condition, ERPs indicated no significant difference in processing preference between subject- or object-relative auxiliary agreement. This is consistent with behavioural evidence from Kaan (2001), who finds no clear processing bias for either structure following a relative-clause internal pronoun, but is in opposition to behavioural evidence from Mak et al. (2008), whose experimental materials were more comparable to ours, as well as to our sentence-completion task. Furthermore, as might be expected from the absence of main effects of sentence type in both topical and neutral context conditions, no significant interaction of discourse and inherent topicality emerged, i.e. discourse was not able to attenuate biases in the processing of relative-clauses containing relative-clause internal pronouns.

The most probable explanations for the absence of the effects lie in procedural issues. Whilst the number of items per condition in the experiment was high, we tested only 15 participants over 2 sessions, which may not have been a sufficiently large number for a grand average ERP to emerge. Furthermore, again considering the high number of experimental items in the context of experiment duration, fillers were not included in the experiment. Exit interviews with participants indicated that whilst they noticed that the experimental materials were always very similar in structure, they were unable to ascertain the goal of the experiment, i.e. participants were not conscious of the fact that context or constituent types were being manipulated. Regardless, the lack of filler items does present a major problem in light of syntactic priming, in which prior exposure to a certain syntactic structure facilitates the production or comprehension of said syntactic structure. Syntactic priming is well-established (Levitt & Kelter, 1982; Dell & Ferreira, 2016) and its influence has previously been attested in relative-clause processing, e.g. in the choice between subject- and object-relative continuations (Wells et al., 2009) or high- and low attachment ambiguities (Scheepers, 2003). We took efforts to counteract strong priming effects, in that lists were constructed in such a way as to never repeat any given clause type more

than three times in a row. We also took care to prevent participants from generating expectations in the second session based on memory from the first session, in that neither context nor relative-clause constituents could be a reliable predictor of relative-clause continuation. Nevertheless, since clause type was a binary, counterbalanced factor, the relative frequency of subject- and object-relative continuations in our experiment was the same, i.e. 50%. This presents a significant deviation from natural language use, where, as discussed in the introduction, subject-relative continuations are highly frequent as opposed to object-relative continuations. We cannot rule out a learning effect, which resulted in our participants' processing biases reflecting the statistics within the experiment rather than in the real world, nor can we rule out that this effect persisted over sessions, as structural priming has been shown to be quite robust (e.g. Bock & Griffin, 2000). Reasoning from an expectation-based account, the absence of a subject-relative bias, or indeed any bias at all, at least in conditions not subjected to topicality manipulations, is to be expected given the frequency distribution of the clause types in our study. The addition of filler materials in which the first argument in a clause is its grammatical subject, consistent with general word order distributions in Dutch, would have mitigated these issues.

Acknowledgements

The process of writing this thesis has taught me many things: a solid theoretical background in the world of relative-clause processing, the practical aspects of EEG research, and the intricacies of data analysis. But, above all else, time management. Indeed, the completion of this thesis has taken many months, not all of them good. It is through the assistance and patience of many that I may proudly present it now, for which words of thanks are due.

First of all, I would like to thank Herbert Schriefers for being my first supervisor. I have greatly enjoyed our discussions, which had a habit of meandering away from the thesis topic or even linguistics altogether. You taught me that any study is only as good as its materials and design. Thank you, for making the third, fourth and fifth iteration on our materials as fun and meaningful as the first, and for helping me create the most complicated experimental design I have ever had the pleasure of attempting to understand.

A word of thanks also to Dorothee Chwilla for being willing to serve as a second reader for this thesis. Criticism is not supposed to be pleasant, but if it's as swift and constructive as yours the final product is well worth it. Thank you, too, for your willingness to improve on the data analysis together.

Thanks to Suhas Vijayakumar, for your help with the presentation script. Thanks to Laura Griffioen, Randi Goertz and Xiaochen Zheng, for your assistance with the EEG data collection. Thanks to Marijtje Jongsma, for answering questions on data preprocessing, and thanks to Theresa Redl for your helpful comments on an earlier draft.

Finally, a big word of thanks to Helen de Hoop. Your enthusiasm and conviction introduced me to linguistics, and it is through your encouragement that I was able to find my place in it. Thank you for your incredible patience and continued confidence.

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