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Attraction Effects in Referential Dependencies

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ATTRACTION EFFECTS IN REFERENTIAL DEPENDENCIES

by

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DISSERTATION

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ABSTRACT

Attraction Effects in Referential Dependencies

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This dissertation explores the differences in the real-time processing of long-distance dependencies and how the processing of these dependencies functions within a cue-based retrieval model. During subject-verb agreement (SVA) comprehension, the processing of the verb is influenced by attractor noun phrases (NPs) that cannot control agreement. Referential dependencies, however, are less susceptible to such attraction effects. Many studies examining ungrammatical sentences in which a reflexive or pronoun mismatches with its antecedent in number/gender have indicated that the processing of these referentially dependent elements is largely uninfluenced by grammatically unavailable attractor NPs. These disparities have been taken to indicate that SVA and referential dependencies engage qualitatively different processing procedures. Recent research, however, has shown that when a reflexive and its antecedent mismatch on two features, grammatically unavailable antecedents can give rise to attraction effects. These findings have been interpreted to indicate that dependency processing engages a common cue-based retrieval system, but that different weightings are assigned to syntactic cues based on the elements involved. Additionally, syntactic cue weightings may relate to the predictability of the dependency, with these cues weighted more heavily for unpredictable

dependencies (e.g., reflexives) than for predictable ones (e.g., SVA). The present study uses two bidirectional self-paced reading experiments to investigate this retrieval-based model by examining whether attraction effects for pronouns –an unpredictable referential dependency – are comparably modulated by the degree of the mismatch with the antecedent. The results for both experiments showed reliable processing difficulty for ungrammatical sentences at and immediately after the pronoun, with no attenuation of this difficulty in sentences with matching attractors. That is, the processing of pronouns was not susceptible to attraction effects, even in cases of severe mismatch with the antecedent. These findings indicate a clear difference in processing of pronouns and reflexives even though both introduce unpredictable referential dependencies.

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Chapter 1

Attraction Effects in Dependency Processing

1.1 Overview

This dissertation aims to examine the real-time processing of sentences and the mechanisms that underlie the building of syntactic structures. During language comprehension, an element within a sentence – such as a pronoun or reflexive – must refer to a previously occurring element – e.g., an antecedent – and these linked elements are often labeled long-distance dependencies. Additionally, these elements are often separated by large intervening material, which may, in certain cases, impede the linking of these elements. Therefore, in order to closely examine the processing of long-distance dependencies, a series of reading tasks were conducted as these tasks can offer insight into real-time processing through quantitative measures, such as the reading time of an individual word. More specifically, this study investigates the underlying processes involved in constructing pronominal dependencies, a type of long-distance dependency.

During sentence comprehension, both morphological and syntactic constraints are important when forming grammatical dependencies between elements. For instance, in English, a pronoun must be linked to an antecedent that matches in morphological features (e.g., *The boys$_i$ said that it$_i$ likes candy.), and that antecedent can only occupy certain structural positions (e.g., *The boy$_i$ likes him$_i$.). However, the application (or strength) of these constraints during online sentence processing seems to be contingent in part on the type of dependency.

In the comprehension of sentences involving subject–verb agreement, for instance, a number of studies have shown that the processing of the agreement target (i.e., the agreeing verb) can be influenced by noun phrases (NPs) that are in structural positions that cannot control

agreement (Clifton et al., 1999; Dillon et al., 2013; Pearlmutter et al., 1999; Van Dyke, 2007; Wagers et al., 2009). This type of influence is often referred to as an "attraction" or "intrusion" effect from the grammatically unavailable agreement controller. These effects have been taken to indicate that the processing of this type of dependency is not rigidly guided by relevant syntactic constraints.

Research investigating referential dependencies, however, has shown a different pattern regarding the strength of these constraints (Chow et al., 2014; Clifton et al., 1999; Cunnings & Sturt, 2014; Dillon et al., 2013; Lee & Williams, 2008; Nicol & Swinney, 1989; Patterson et al., 2014; Xiang et al., 2009). Many such studies have shown that the online processing of reflexives and pronouns does not appear to be affected by NPs that are in structural positions in which they cannot act as an antecedent for these elements. In other words, the processing of reflexives and pronouns does not seem to be susceptible to attraction effects, which suggests that these processes are largely guided by relevant syntactic constraints.

These differences are important because they have been taken to indicate that distinct mechanisms are involved in the processing of subject–verb agreement and referential dependencies. More recent research, however, has called this distinction into question. Specifically, a study investigating the processing of reflexives has indicated that when there is a severe morphological mismatch between the reflexive and its antecedent – and in particular, when they differ by more than one morphological feature – grammatically unavailable antecedents can give rise to attraction effects (Parker & Phillips, 2017). These findings have been interpreted to suggest that subject–verb agreement and reflexive dependencies rely on the same processing mechanism and, therefore, as support for a unified system for the processing of grammatical dependencies. The present study aims to investigate this proposal further by

examining whether comparable attraction effects apply across referential dependency types. In particular, using two bi–directional self–paced reading task experiments, this study examines whether attraction effects during the online processing of pronouns are also modulated by the extent of the morphological mismatch between the pronoun and its antecedent.

1.2 Background

1.2.1 Attraction effects in subject-verb agreement

Several studies have indicated attraction effects during the comprehension of sentences involving subject–verb agreement (Clifton et al., 1999; Dillon et al., 2013; Pearlmutter et al., 1999; Van Dyke, 2007; Wagers et al., 2009). For example, Wagers et al. (2009) examined the processing sentences as in (1) in a self–paced reading task:

(1a) The **key** to the **cell** unsurprisingly ***was*** rusty from many years of disuse.[1]

(1b) *The **key** to the **cell** unsurprisingly ***were*** rusty from many years of disuse.

(1c) The **key** to the **cells** unsurprisingly ***was*** rusty from many years of disuse.

(1d) *The **key** to the **cells** unsurprisingly ***were*** rusty from many years of disuse.

The results indicated that although there was clear processing difficulty when the subject head noun (*key*) mismatched with the agreeing verb (*were*), this effect was influenced by the number features of an intervening attractor noun (*cell(s)*). In sentences in which both the subject head noun and the attractor noun mismatched with the verb, as in (1b), there were much longer reading times at and after the verb compared to the grammatical control condition (1a). However, this effect of ungrammaticality was sharply reduced in ungrammatical sentences like (1d)

[1] For the sake of continuity and ease of exposition, in examples related to attraction effects, the head of the NP that can participate in the dependency of interest -- either as the agreement controller or as a possible antecedent for a pronoun or reflexive -- is bolded. The head noun of the attractor NP then is bolded and underlined, while the dependent element is bolded and italicized.

relative to their grammatical controls (1c). That is, there was an attenuated effect of ungrammaticality in sentences in which the number features of the attractor noun matched with those of the verb. The results from Wagers et al.'s (2009) and other similar studies (Clifton et al., 1999; Dillon et al., 2013; Pearlmutter et al., 1999; Van Dyke, 2007) provide evidence that NPs in structural positions that cannot control agreement can influence the online processing of the relevant verb, especially if the NP in an agreement–controlling structural position mismatches with the verb in agreement features.

1.2.2 Cue-based retrieval model

To account for the attraction effects found in these studies, Wagers et al. (2009) proposed a cue-based retrieval model for dependency resolution during online sentence comprehension. Specifically, it was proposed that the agreeing verb triggers a search over the memory representation for the sentence in order to retrieve an element that satisfies the subject-verb agreement dependency. It was further proposed that this search functions as a process whereby relevant cues are used to query the memory representation for a matching element. In the case of subject-verb agreement, the relevant cues relate to both syntactic and morphological properties. That is, under this model, at the agreeing verb, a search is triggered for an NP (1) that occupies a structural position in which it can act as an agreement controller and (2) that matches the number features of the verb. Wagers et al. (2009) offer two ways in which this cue-based retrieval process can account for the attenuated processing difficulty that occurs for ungrammatical sentences with matching intervenors – i.e., for sentences like (1d) above. Under the first of these conceptions, this process is engaged whenever an agreeing verb is encountered. In the case of grammatical sentences (like [1a] and [1c] above), an NP that matches all of the relevant cues is

available and essentially out-competes any other partially matching element for retrieval. In the case of ungrammatical sentences, however, no element in the sentence offers a perfect match for the relevant retrieval cues. In such cases, an element that offers a partial match for the relevant cues may be retrieved. Alternatively, Wagers et al. (2009) note that this retrieval process could be engaged only as part of a recovery process once an ungrammatical agreeing verb has been detected. In other words, when a mismatch is detected between the verb and the sentential subject, reanalysis is activated, and cues are employed to find a partially matching NP. In either case, according to this model, the resolution of subject-verb agreement engages a memory retrieval process that is prone to error particularly in cases where there are partial matches to relevant retrieval cues.

1.2.3 Reflexive processing

An important question then is whether comparable cue-based retrieval processes apply to the processing of other linguistic dependencies. With regard to this question, it is important to note that a different pattern of results has been found for attraction effects during the processing of referential dependencies. For instance, Dillon et al. (2013) conducted a study in which they directly compared attraction effects between subject–verb dependencies and reflexive dependencies using an eye–tracking paradigm. Items as in (2) were used to test attraction effects in subject–verb dependencies:

(2a) The new **executive** who oversaw the middle **manager** apparently ***was*** dishonest about the company's profits.

(2b) *The new **executive** who oversaw the middle **manager** apparently ***were*** dishonest about the company's profits.

(2c) The new **executive** who oversaw the middle **managers** apparently ***was*** dishonest about the company's profits.

(2d) *The new **executive** who oversaw the middle **managers** apparently ***were*** dishonest about the company's profits.

Similar to the results of Wagers et al. (2009), they observed clear processing difficulty when the subject head noun (*executive*) mismatched with the agreeing verb (*were*). More specifically, the participants had much longer reading times at the verb *were* for the sentences like (2b) when compared to the control condition (2a). However, in sentences where the subject head noun mismatched the verb in number features, but the attractor matched the verb, as in (2d), there was an attenuated grammaticality effect when compared to its control condition (2c). That is, just as in Wagers et al. (2009), they found an attraction effect for ungrammatical sentences with matching attractors in the processing of subject-verb agreement.

In order to examine whether comparable attraction effects apply in the processing of reflexives, Dillon et al. (2013) tested sentences as in (3) in the same experiment. Similar to the subject–verb agreement items, these sentences had a subject head noun and an attractor noun that either matched or mismatched with an agreeing element – in this case, a reflexive – in number features.

(3a) The new **executive** who oversaw the middle **manager** apparently doubted ***himself*** on most major decisions.

(3b) *The new **executive** who oversaw the middle **manager** apparently doubted ***themselves*** on most major decisions.

(3c) The new **executive** who oversaw the middle **managers** apparently doubted ***himself*** on most major decisions.

(3d) *The new **executive** who oversaw the middle **managers** apparently doubted ***themselves*** on most major decisions.

In these sentences, only the subject NP (headed by *executive*) is in a position where it can act as the antecedent for the reflexive. This is often accounted for under Principle A of Binding Theory,

which dictates that an anaphor must be bound in its governing category (Chomsky, 1982). This means that an anaphor must refer to a c-commanding clausemate NP. In the examples above, only the main-clause subject NP is this structural position. Conversely, the NP in the more deeply embedded dependent clause, headed by the attractor *manager(s)*, does not c-command the reflexive and is therefore not in a position to act as its antecedent. In items such as (3b), the subject NP and dependent-clause NP both mismatched in morphological features with the reflexive, and participants had much slower reading times compared to the grammatical control as in (3a). A comparable reading time difference was observed at the reflexive for sentences such as (3d) – in which the subject NP does not match in morphological features with the reflexive, yet the attractor noun and reflexive do match in terms of plurality – when compared to its grammatical control sentences as in (3c), thus indicating no attraction effects. Therefore, the results of Dillon et al. (2014) were taken to indicate that the processing of a reflexive is not influenced by an NP in a structural position in which it cannot act as a licit antecedent and that syntactic cues are weighted more heavily than morphological cues during reflexive processing. This contrasts with the results seen for the parallel conditions for subject–verb agreement (2c & 2d), which did result in attraction effects for the subject head mismatch/attractor match condition. That is, during subject-verb agreement processing, the processing of the verb can be influenced by a noun that is not in a structural position that can control agreement, indicating that unlike reflexive processing, subject–verb agreement processing relies heavily on morphological cues, which can sometimes override syntactic cues.

1.2.4 Pronominal processing

Similar to the processing of reflexives, the processing of pronoun dependencies also seems to be largely unaffected by NPs in positions where they cannot be a grammatical antecedent. One study that shows evidence for this is a self–paced reading task conducted by Chow et al. (2014). In this study, they used experimental items such as those in (4) to determine whether the processing of pronouns is susceptible to attraction effects.

(4a) **Ethan** discovered that the **analyst** had mocked ***him*** mercilessly for singing karaoke after drinking...

(4b) ***Paige** discovered that the **receptionist** had mocked ***him*** mercilessly for singing karaoke after drinking...

(4c) **Ethan** discovered that the **receptionist** had mocked ***him*** mercilessly for singing karaoke after drinking...

(4d) ***Paige** discovered that the **analyst** had mocked ***him*** mercilessly for singing karaoke after drinking...

According to Principle B (Chomsky, 1982), a pronoun must be free (i.e., not bound) within its governing clause. This means that (generally speaking) a pronoun cannot refer to a c-commanding clausemate NP. In sentences such as (4), for instance, the subject NP of the dependent clause (*that the analyst/receptionist had mocked…*) cannot act as an antecedent for the pronoun. Rather, in these sentences, the only NP that can act as an antecedent for the pronoun is the main-clause subject NP (*Ethan/Paige*). Chow et al. (2014) manipulated the gender of the main-clause subject NP and dependent-clause NP to either match or mismatch with the pronoun, which was held constant. They found longer reading times in the region immediately following the pronoun in sentence type (4b) when compared to the grammatical control sentence type (4a). This same pattern of results was found in condition (4d) when compared to the control condition (4c). And in fact, they observed no attenuation of this effect when the attractor (*analyst*) matched

yet the subject noun (*Paige*) mismatched the pronoun (*him*) in condition (4d) compared to condition (4c). They argue that this pattern of results indicates that illicit antecedents do not interfere during the processing of pronouns, even if they match in morphological features. Taken with the results from Dillon et al. (2013) and others (e.g., Clifton et al., 1999; Cunnings & Sturt, 2014; Patterson et al., 2014; Xiang et al., 2009), these findings suggest that the processing of reflexives and pronouns is guided strongly by syntactic constraints. That is, during referential processing, only NPs with relevant syntactic cues (i.e., that are in structural positions in which they can act as licit antecedents) are retrieved as antecedents.

A few explanations have been proposed in order to account for the differences in attraction effects for subject-verb agreement and referential dependencies. One possibility is that subject-verb and referential dependencies rely on different mechanisms for processing. That is, subject-verb agreement dependencies may rely on cue-based retrieval, as proposed by Wagers, et al. (2009), while referential dependencies use a different processing mechanism altogether. However, it is also possible that both types of long-distance dependencies employ comparable cue-based retrieval processes, yet the syntactic cues act as a gating function for referential dependencies. More specifically, under this account, syntactic cues simply do not allow for a reflexive or pronoun to search for a structurally illicit antecedent. Lastly, subject-verb and referential dependencies may actually rely on the same cue-based retrieval mechanism, but syntactic and morphological cues may be weighted differently based on the dependency type. Based on the pattern of results in previous studies (e.g., Chow et al., 2014; Cunnings & Sturt, 2014; Dillon et al., 2013), referential dependencies may give much more weight to syntactic cues, which would account for the absence of attraction effects for this dependency type.

1.2.5 Attraction effects in reflexive processing

Support for the last of these proposals comes from a study by Parker and Phillips (2017). This study used eye tracking to test whether reflexive processing would be more susceptible to attraction effects if the reflexive and its structurally licit antecedent mismatched in two features, specifically number and gender. In other words, they tested whether agreement cues could override syntactic cues if a reflexive and its syntactically acceptable antecedent were an especially poor match in terms of agreement features. They hypothesized that if the strength of the reflexive–antecedent match affects processing, then there should be attraction effects when the reflexive and its antecedent were severely mismatched in agreement features. A sample of their items is shown in (5).

Target Match

(5a) The talented **actor** mentioned that the attractive **spokesman** praised ***himself*** for a great job.

(5b) The talented **actress** mentioned that the attractive **spokesman** praised ***himself*** for a great job.

Target 1–feature Mismatch

(5c) *The talented **actor** mentioned that the attractive **spokeswoman** praised ***himself*** for a great job.

(5d) *The talented **actress** mentioned that the attractive **spokeswoman** praised ***himself*** for a great job.

Target 2–feature Mismatch

(5e) *The talented **actor** mentioned that some of the **spokeswomen** praised ***himself*** for a great job.

(5f) *The talented **actress** mentioned that some of the **spokeswomen** praised ***himself*** for a great job.

Similar to previous studies, Parker and Phillips (2017) tested items as in (5c) and (5d) that had a one-feature mismatch between the reflexive and its antecedent (**spokeswoman**… ***himself***). For these sentence types, they observed comparable processing difficulty regardless of whether the

attractor matched with the pronoun, thus indicating no attraction effects. More specifically, when ungrammatical sentences such as (5c) and (5d) were compared to their grammatical counterparts (5a) and (5b), participants had significantly longer reading times at the reflexive, regardless of whether the attractor matched (**actor**) or mismatched (**actress**) with the reflexive. These results patterned similarly to what Dillon et al. (2013) previously found for reflexive processing and what Chow et al. (2014) observed in regards to pronoun processing, again indicating that syntactic cues seem to outweigh morphological cues during referential processing.

However, they found a different pattern of results for the two-feature mismatch conditions (**spokeswomen… *himself***), as in (5e) and (5f). For sentences such as (5f), in which the reflexive had no suitable antecedent either morphologically or syntactically (**actress**… **spokeswomen**… ***himself***), there were significantly longer reading times when compared to its grammatical counterpart (5b). However, for sentences like (5e) – in which the reflexive mismatched with its antecedent in gender and number yet matched with the attractor in all morphological features (**actor**… **spokeswomen**… ***himself***) – there was attenuated processing difficulty. That is, the difference in reading times between sentences such as (5a) and (5e) was significantly less than the difference in reading times between sentences such as (5b) and (5f). They interpreted these findings as reflexives being prone to attraction effects when the structurally available antecedent was an especially poor match for the reflexive and that in these cases of severe mismatch between the reflexive and its grammatical antecedent, retrieval can be influenced by grammatically irrelevant elements. This is in contrast to what was found for the one-feature mismatch conditions, for which no attraction effects were found, suggesting that syntactic cues outweighed morphological cues during processing if the reflexive and antecedent mismatched in only one morphological feature. Furthermore, Parker and Phillips (2017) also

interpreted these attraction effects in two-feature mismatch sentences as support for the hypothesis that the processing of both reflexives and subject–verb agreement is driven by the same retrieval mechanism, specifically a cue–based retrieval model.

1.2.6 Predictability as a factor for cue weighting

The attraction effects for reflexive dependencies in Parker and Phillips (2017) suggest that both reflexive and subject-verb agreement processes recruit morphological features as retrieval cues. However, the extent to which attraction effects are elicited for each dependency formation is highly dependent on the degree of mismatch between the agreeing elements. For subject-verb agreement, attraction effects are often found in one-feature mismatch conditions, while attraction effects for reflexive processing are only elicited when there is a stronger mismatch between the reflexive and its antecedent. As shown in Parker and Phillips' (2017) one-feature mismatch condition for reflexives (as well as in previous studies discussed above), syntactic cues seem to be weighted more heavily than morphological cues for referential dependencies. These syntactic cues then minimize attraction for structurally illicit antecedents, even if the reflexive and its antecedent do not perfectly match in morphological features. However, Parker and Phillips (2017) have shown that if the reflexive and its structurally acceptable antecedent are an especially poor match (i.e., they mismatch in two features), then the retrieval of the antecedent can be influenced by syntactically illicit elements. Although it is possible that these dependency formations both use the same cue–based retrieval mechanism, the question still remains of why these cues are weighted differently between these long–distance dependencies.

Parker and Phillips (2017) propose that this difference in cue weighting relates to the predictability of the dependency. In the case of subject–verb agreement, when a subject noun

phrase is encountered, a prediction is made as to what features will be assigned to an upcoming verb. Therefore, when the verb form violates that prediction, a repair mechanism is activated in order to retrieve a noun that better matches in features. This error-prone mechanism may then retrieve a noun that matches in morphological features but that is not in a structural position to control subject-verb agreement. Thus, these attraction effects suggest that subject-verb agreement processing is more reliant on morphological cues than syntactic ones. On the other hand, referential dependencies are not predictable in the same manner as agreement dependencies. When an NP is encountered during sentence processing, there are few, if any, indicators that the same NP will be referred to again with a reflexive or pronoun. Therefore, when a reflexive or pronoun is encountered, retrieval is inherently required to resolve its antecedent. Unlike in subject–verb agreement, this retrieval is motivated less by a prediction error but rather is a necessary part of referential processing, so syntactic cues remain prioritized for referential dependencies. If this model proposed by Parker and Phillips (2017) is correct, a comparable pattern of attraction effects should be obtained for pronouns – another unpredictable referential dependency.

Chapter 2

Experiment 1

2.1 Overview of the experiments

Until recently, the processing of referential dependencies seemed to contrast starkly with subject–verb agreement processing, with only the latter susceptible to attraction effects from structurally inaccessible elements. However, in light of Parker and Phillips' (2017) results, reflexive dependencies may be subject to attraction effects when there is a severe mismatch in morphological features between the agreeing elements. Therefore, the present study seeks to further investigate whether referential dependencies are susceptible to attraction effects in cases of severe feature mismatch by examining the processing of pronouns, as reflexive and pronoun processing have been shown to pattern similarly to one another. In other words, the present study aims to test whether a structurally illicit antecedent may be retrieved during processing if the pronoun and the grammatical antecedent do not match in either gender or number features. If so, this would suggest that during referential processing, morphological cues may override syntactic cues in favor of an antecedent that is a better match for the pronoun. However, if attraction effects are not found for pronominal processing, this would imply that under a cue-based retrieval mechanism, syntactic cues are used as a gating mechanism during the linking of pronouns and antecedents. Experiment 1 will test whether structurally illicit antecedents can influence the processing of pronouns when the pronoun and grammatical antecedent mismatch in one morphological feature, namely gender. Experiment 2, then, will test whether pronoun processing is susceptible to attraction effects when there is a more severe mismatch between the pronoun and grammatical antecedent, specifically in gender and number.

In order to investigate these issues, the present study will use bidirectional self–paced reading (BSPR) to test for processing differences among the sentences of interest. This task was developed by Paape and Vasishth (2021a) as a method comparable to eye tracking during reading and has been shown to reliably detect online processing difficulty in a range of sentence types (Paape & Vasishth, 2021a, 2021b; Witzel & Witzel, 2023). In standard self–paced reading (SPR) tasks, participants read each word/region of the sentence at their own pace, but it is not possible to reread previous sections of the text. In BSPR, however, it is possible to return to previous words. This aspect of the task is important for several reasons. First, in a study comparing SPR and BSPR (Paape & Vasishth, 2021b), participants reported that BSPR more closely approximated natural reading and that it was easier to comprehend sentences under this method. BSPR thus seems to provide a more ecologically valid method of investigating online sentence processing than standard SPR. This method also provides multidimensional reading data, in the sense that it allows for the examination of reading times when regions of interest are first encountered as well as processing time measures that involve regressive reading times on those regions. This is especially important in the present study in light of the fact that some of the attraction effects for reflexives in Parker and Phillips (2017) were observed primarily under eye–tracking measures that include regressive fixations. It is therefore important to use an online reading task that allows for comparable processing time measures in this study as well. It is also important to note a potential advantage of this method over eye tracking for the investigation of pronoun processing. Pronouns are of course shorter words and, as such, are likely to be skipped during normal reading and consequently during eye-tracking studies. In BSPR, however, it is not possible for participants to skip past the pronoun to subsequent words in the sentence. This

aspect of the task thus potentially allows for clearer indications of processing costs incurred at the pronoun than in an eye–tracking paradigm.

2.2 Experiment 1 design

Experiment 1 tests for attraction effects in the processing of pronoun–antecedent dependencies when the pronoun and its target antecedent mismatch in one feature, namely gender. Similar to Chow et al. (2014), this first experiment explores whether an illicit antecedent may be retrieved during pronoun processing if the target noun (i.e., the structurally licit antecedent) and its pronoun mismatch with regards to morphological features. For Experiment 1, four sentence types as outlined in (6) made up each experimental set.

(6a) *Grammatical – Attractor Mismatch*
The **grandfather** that visited the **granddaughter** took ***her*** to a festival over the weekend.

(6b) *Ungrammatical – Attractor Mismatch*
*The **grandfather** that visited the **grandson** took ***her*** to a festival over the weekend.

(6c) *Grammatical – Attractor Match*
The **grandfather** that visited the **grandson** took ***him*** to a festival over the weekend.

(6d) *Ungrammatical – Attractor Match*
*The **grandfather** that visited the **granddaughter** took ***him*** to a festival over the weekend.

For all sentence types, the attractor element (*grandfather*) is in a subject NP position. The object pronoun (*her/him*) is c-commanded by the subject NP and therefore cannot refer to the attractor; instead, the only syntactically available antecedent for this pronoun is the NP in the embedded relative clause (*granddaughter/grandson*). In the *Attractor Mismatch* sentence types such as (6a) and (6b), the pronoun, *her*, always mismatches in gender with the attractor noun, *grandfather*. In the *Grammatical – Attractor Mismatch* sentences as in (6a), the pronoun matches in gender with

its antecedent, *granddaughter*, yet in the *Ungrammatical – Attractor Mismatch*, the pronoun mismatches with the antecedent, *grandson*. Therefore, in sentences such as (6b), participants are expected to show processing difficulty at and immediately after the pronoun when compared to condition (6a), as there is no potential antecedent that matches in morphological features with the pronoun.

In the *Attractor Match* sentences as in (6c) and (6d), the pronoun, *him*, always matches in gender with the attractor noun, *grandfather*. In the *Grammatical – Attractor Match* sentences as in (6c), the pronoun matches in gender with its antecedent, *grandson*; however, the pronoun and its antecedent mismatch in gender for the *Ungrammatical – Attractor Mismatch* sentences as in (6d). For this latter condition, processing difficulty is also expected at the pronoun when compared to the control condition (6c), suggesting that these referential dependencies are highly constrained by syntactic cues, with no evidence of attraction effects as shown in studies previously discussed.

Although this experimental design is comparable to that of Chow et al. (2014), who also tested a one-feature mismatch for attraction effects in pronoun processing, it is important to note that the sentence structure used in this experiment is different. In Chow et al. (2014), the grammatical antecedent was always the main–clause subject while the attractor was a subject within an embedded clause. As mentioned previously, for the present study, the grammatical antecedent is always the object of an embedded clause, while the attractor is always the main–clause subject. This is important to note because if pronoun processing is guided strongly by syntactic constraints for the one–feature mismatch sentences, then grammatically inaccessible antecedents should not influence processing from any structural position. Furthermore, the linear order of the important elements in sentences like (6) is as follows: attractor – grammatical

antecedent – pronoun. This is the same linear order used in Parker and Phillips (2017) for reflexive processing, which allows for more direct comparisons between pronoun and reflexive processing. Furthermore, this experiment provides a baseline set of results that can be compared more directly to the two–feature mismatch results from Experiment 2.

It is important to note when discussing the following experiments that pronouns can refer to antecedents that are outside of the local sentence in previous or upcoming discourses. Therefore, sentences labeled *ungrammatical* in this study are technically semantically ambiguous instead of syntactically ungrammatical. However, previous studies such as Van Berkum et al. (2007) have investigated whether there is a preference to link pronouns with an intrasentential antecedent if the pronoun does not have a clear referent within the sentence, as in (7):

(7) Anna shot at Linda as *he* jumped over the fence.

Even though it can be assumed that *he* could refer to an antecedent outside of the local sentence (as *he* does not stereotypically match in morphological cues with *Anna* or *Linda*), Van Berkum et al. (2007) still found evidence of processing difficulty at the pronoun, indicating that participants preferred to link pronouns with an intrasentential antecedent before assuming a larger, missing discourse (see also Filik et al., 2008; Osterhout & Mobley, 1995). Therefore, taking these previous studies into consideration, the sentences in the current study are labeled *ungrammatical* for ease of discussion, consistency with previous studies' labels, and the strong preference to locate antecedents intrasententially before assuming a larger discourse.

Additionally, the present study uses a different experimental method than previous studies that have examined similar effects, namely that pronoun processing is strongly guided by syntactic constraints when the pronoun and its antecedent mismatch in one feature (e.g., Chow et al., 2014; Clifton et al., 1999; Cunnings & Sturt, 2014; Lee & Williams, 2008; Nicol & Swinney,

1989; Patterson et al., 2014; Xiang et al., 2009). Therefore, it is important to show that the bidirectional SPR method can capture the same effects found in other studies testing 1-feature mismatch conditions in pronoun processing. Taking these differences into account, Experiment 1 tests one–feature mismatches so that clearer comparisons can be made to findings in previous research and so that the bidirectional self–paced reading task can be confirmed as an effective method for measuring these effects.

2.2.1 Method

2.2.1.1 Participants

Sixty-five participants took part in Experiment 1. The data from these participants were excluded if participants performed with less than 80% accuracy on the comprehension task (8 participants) or if participants indicated that they were not native speakers of English (8 participants). The data from the remaining forty-nine participants were included in the analysis (34 female, 15 male; mean age = 20.12, *SD* = 3.17; mean accuracy rate = 10.55%, *SD* = 4.70). These participants indicated that they were native speakers of English with normal or corrected–to–normal vision. Participants were students from the University of Texas Arlington and received course credit for their participation.

2.2.1.2 Stimuli

Forty–eight sets of experimental items were created, as repeated in (8). (For a comprehensive list of the experimental items, see Appendix A.)

(8a) *Grammatical – Attractor Mismatch*
The **grandfather** that visited the **granddaughter** took ***her*** to a festival over the weekend.

(8b) *Ungrammatical – Attractor Mismatch*
*The **grandfather** that visited the **grandson** took ***her*** to a festival over the weekend.

(8c) *Grammatical – Attractor Match*
The **grandfather** that visited the **grandson** took ***him*** to a festival over the weekend.

(8d) *Ungrammatical – Attractor Match*
*The **grandfather** that visited the **granddaughter** took ***him*** to a festival over the weekend.

The attractors were always main clause subjects, and the grammatical antecedents were always nouns embedded in a subject–extracted relative clause. All nouns for both the attractors and antecedents were definitionally gendered to avoid any processing differences that may occur between definitionally and stereotypically gendered nouns (see Kreiner et al., 2008, for more discussion of these differences). Half of the nouns were female, and half were male. The relative clause was immediately followed by the main clause verb. The verb was always followed by a direct object pronoun (with an equal number of instances of *him* and *her* across items). The pronoun was immediately followed by a three-word spillover region that began with a closed-class word, and usually with a preposition. Since the pronoun *her* can also function as a possessive pronoun (e.g., *her success*), this type of continuation served to immediately disambiguate it as a direct object pronoun.

As illustrated in the sample sentences in (8) above, two levels of grammaticality (grammatical/ungrammatical) were crossed with two levels of attractor match (match/mismatch) to result in a 2x2 within–participants design. In the attractor mismatch conditions, the pronoun always mismatched in gender with the main subject clause (the attractor) and either matched or mismatched with the embedded noun (i.e., syntactically licit antecedent). In the attractor match

conditions, the pronoun always matched in gender with the main subject clause and either matched or mismatched with the embedded noun.

The 48 item sets were combined with 60 grammatical fillers of similar length, for a total of 108 sentences. Sixteen of the fillers had definitionally gendered nouns and sixteen had stereotypically gendered nouns as subjects; the rest of the fillers (28) did not use gendered nouns. Twenty-three of the fillers had subject–extracted relative clauses as in the target items, and twenty-three had object–extracted relative clauses. The remaining fourteen fillers had complement clauses. (For a comprehensive list of the filler sentences, see Appendix C). All of the target and filler sentences were followed by a comprehension question, which addressed different parts of the sentence to make sure that participants read the entire sentence. The questions did not probe for content related specifically to interpretation of the pronoun.

2.2.1.3 Procedure

Participants first completed an online language background questionnaire using QuestionPro. The bidirectional self–paced reading task was conducted remotely using the DMDX software (Forster & Forster, 2003). The items were presented in black letters (Courier New font, size 12) on a white background, in the center of the computer screen. At the beginning of each item, the participant saw a string of dashes on the screen and pressed the RIGHT CTRL button to see each word. The participant then saw the first word of the sentence and pressed the RIGHT CTRL key to see the next word. As the participant progressed through the sentence, they had the option to press the LEFT CTRL key to move to the previous word in the sentence or to press the SPACEBAR key to return to the beginning of the sentence. After they reached the end of the sentence, a comprehension question appeared with the two choices, “NO” or “YES.” The

participant selected “NO” by pressing the LEFT CTRL key or “YES” by pressing the RIGHT CTRL key. The participant received feedback on their response, and the next item began automatically. Half of the comprehension questions had “YES” as the correct answer, and the other half had “NO” as the correct answer. Half of the experimental items were grammatical, and the other half were ungrammatical. The items were presented in a different random order for each participant in 9 blocks of 12 items. Participants were encouraged to take a break after each block. The items were organized in counterbalanced lists such that each participant saw all 48 experimental items, but only one condition from each item set. At the beginning of the task, the participant was given 6 practice trials.

2.2.1.4 Data analysis

Statistical analyses were conducted for the critical and spillover regions. The critical region consisted of the pronoun (*him/her*), and the spillover region consisted of the three words following the pronoun, as in the following example:

(9) The grandfather who visited the granddaughter took | **him** | **to a festival** | over the weekend.

For each region of interest, three measures are reported: first–pass reading time, go–past time, and total reading time. First–pass reading time is the amount of time spent in a region before it is exited to either the right or left. Go–past time is the sum of all reading times after entering a region before leaving that region to the right; this measure includes regressive reading times. Total reading time is the cumulative time spent in the region before completing the sentence.

The data for the two regions (critical word, spillover region) were analyzed using linear mixed–effects models fitted with the lmer function from the lme4 package (Bates, Mächler,

Bolker, & Walker, 2015) in R (version 4.0.5; R Development Core Team, 2020). In these models, attractor type (match, mismatch) and grammaticality (grammatical, ungrammatical) are fixed effect predictors, which were sum-coded. The models included the maximal random effects structure (Barr, Levy, Scheepers, & Tily, 2013), and the bobyqa optimizer was used (Nash & Varadhan, 2011; Nash, 2014; Varadhan et al., 2020). In the cases in which the maximal model failed to converge (first-pass time for pronoun and spillover regions), the random effects structure was simplified by removing the random slope for the interaction that was associated with the smaller variance (see Table 2 for detailed model specifications). The *p*–values for these analyses were estimated using the Satterthwaite approximation implemented in the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017). Raw reading times were log transformed prior to analysis in order to meet the distributional assumptions of the statistical models. Estimated marginal means and standard errors for these log–transformed reading times were calculated based on the linear mixed–effects model reported for each region using the emmeans package.

2.3 Results

For the forty-nine participants whose data was included in the analyses, the mean overall error rate was 10.55% (*SD* = 4.74). The data for trials in which any single reading time was longer than 5000 milliseconds were also eliminated from the analyses (3.15% of the data for the measures below). Table 2.1 provides descriptive statistics (estimated marginal means and standard errors for log-transformed reading times) for each sentence type in each analysis region. Table 2.2 provides a summary of the results from the linear mixed effects regression model. Figure 2.1 provides a plot of the estimated marginal means of the log-transformed reading times

for each sentence type at the critical region. Figure 2.2 provides a plot of the estimated marginal means of the log-transformed reading times for each sentence type at the three-word spillover region.

At the critical region, there was a significant effect of grammaticality ($p < 0.001$) for the total time measure, indicating that participants experienced processing difficulty while reading the ungrammatical sentences compared to the grammatical sentences. In the spillover region, there were also longer reading times for ungrammatical sentences when compared to the control sentences, as evidenced by a significant effect of grammaticality across all measures (first-pass: $p < 0.001$; regression path: $p < 0.001$; total: $p < 0.001$), again indicating that participants experienced processing difficulty while reading ungrammatical sentences. However, there was no interaction between grammaticality and attractor type for any measure, which indicates that the effect of grammaticality was not modulated by whether the attractor noun matched or mismatched with the pronoun. This further indicates that no attraction effects were observed during pronoun processing when the pronoun and its antecedent mismatched in one feature.

Table 2.1. Estimated marginal means and standard errors (in parentheses) for the log-transformed reading times for each measure in each analysis region, by sentence condition. Millisecond equivalents for the estimated marginal means are provided in brackets.

	Region	
	pronoun *her/him*	spillover *to a festival*
First Pass Time		
grammatical / attractor mismatch	5.67 (.05) [289]	6.68 (.04) [796]
ungrammatical / attractor mismatch	5.69 (.05) [291]	6.76 (.05) [848]
grammatical / attractor match	5.67 (.04) [290]	6.67 (.04) [787]
ungrammatical / attractor match	5.70 (.04) [297]	6.74 (.04) [841]
Regression Path Time		
grammatical / attractor mismatch	5.68 (.05) [295]	6.73 (.04) [835]
ungrammatical / attractor mismatch	5.69 (.04) [300]	6.83 (.05) [916]
grammatical / attractor match	5.70 (.04) [299]	6.70 (.04) [817]
ungrammatical / attractor match	5.74 (.05) [309]	6.83 (.05) [914]
Total Time		
grammatical / attractor mismatch	5.80 (.05) [329]	6.80 (.05) [897]
ungrammatical / attractor mismatch	5.87 (.06) [350]	6.92 (.06) [997]
grammatical / attractor match	5.80 (.05) [330]	6.78 (.05) [883]
ungrammatical / attractor match	5.90 (.06) [359]	6.91 (.05) [988]

*The grandfather that visited the (granddaughter/grandson) took **(her/him) to a festival*** over the weekend.

Table 2.2. Mixed-effects regression estimates for the fixed effects of grammaticality, attractor match, and their interaction on the log-transformed reading times for each measure in each analysis region.

	Region							
	pronoun *her/him*				spillover *to a festival*			
First Pass Time†	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*
Intercept	5.68	0.04	133.55	<.001	6.71	0.04	164.73	<.001
Grammaticality	0.03	0.02	1.61	0.114	**0.08**	**0.02**	**4.67**	**<.001**
Attractor Match	-0.01	0.02	-0.41	0.681	0.01	0.01	0.90	0.372
Grammaticality x Attractor Match	-0.01	0.04	-0.41	0.683	-0.002	0.03	-0.07	0.947
Regression Path Time								
Intercept	5.71	0.04	135.48	<.001	6.77	0.04	171.40	<.001
Grammaticality	0.03	0.02	1.67	0.096	**0.11**	**0.03**	**4.45**	**<.001**
Attractor Match	-0.02	0.02	-0.71	0.479	0.02	0.02	0.76	0.454
Grammaticality x Attractor Match	-0.01	0.04	-0.31	0.759	-0.02	0.04	-0.45	0.658
Total Time								
Intercept	5.84	0.05	116.66	<.001	6.85	0.05	143.56	<.001
Grammaticality	**0.09**	**0.02**	**3.69**	**<.001**	**0.12**	**0.02**	**5.45**	**<.001**
Attractor Match	-0.01	0.02	-0.37	0.709	0.02	0.02	0.91	0.367
Grammaticality x Attractor Match	-0.03	0.05	-0.49	0.622	-0.003	0.04	-0.09	0.927

*The grandfather that visited the (granddaughter/grandson) took **(her/him) to a festival** over the weekend.*

† The statistical model for first pass time in the pronoun and spillover regions were coded as follows: `lmer (dv ~ grammaticality * attractor match + (1 + grammaticality * attractor match | subj) + (1 + grammaticality + attractor match | item)`; for all other regions/measures, the statistical model was coded as follows: `lmer (dv ~ grammaticality * attractor match + (1 + grammaticality * attractor match | subj) + (1 + grammaticality * attractor match | item)`.

Figure 2.1. Log-transformed reading times at the pronoun region of each sentence type in Experiment 1. Error bars show +/- 1 SE.

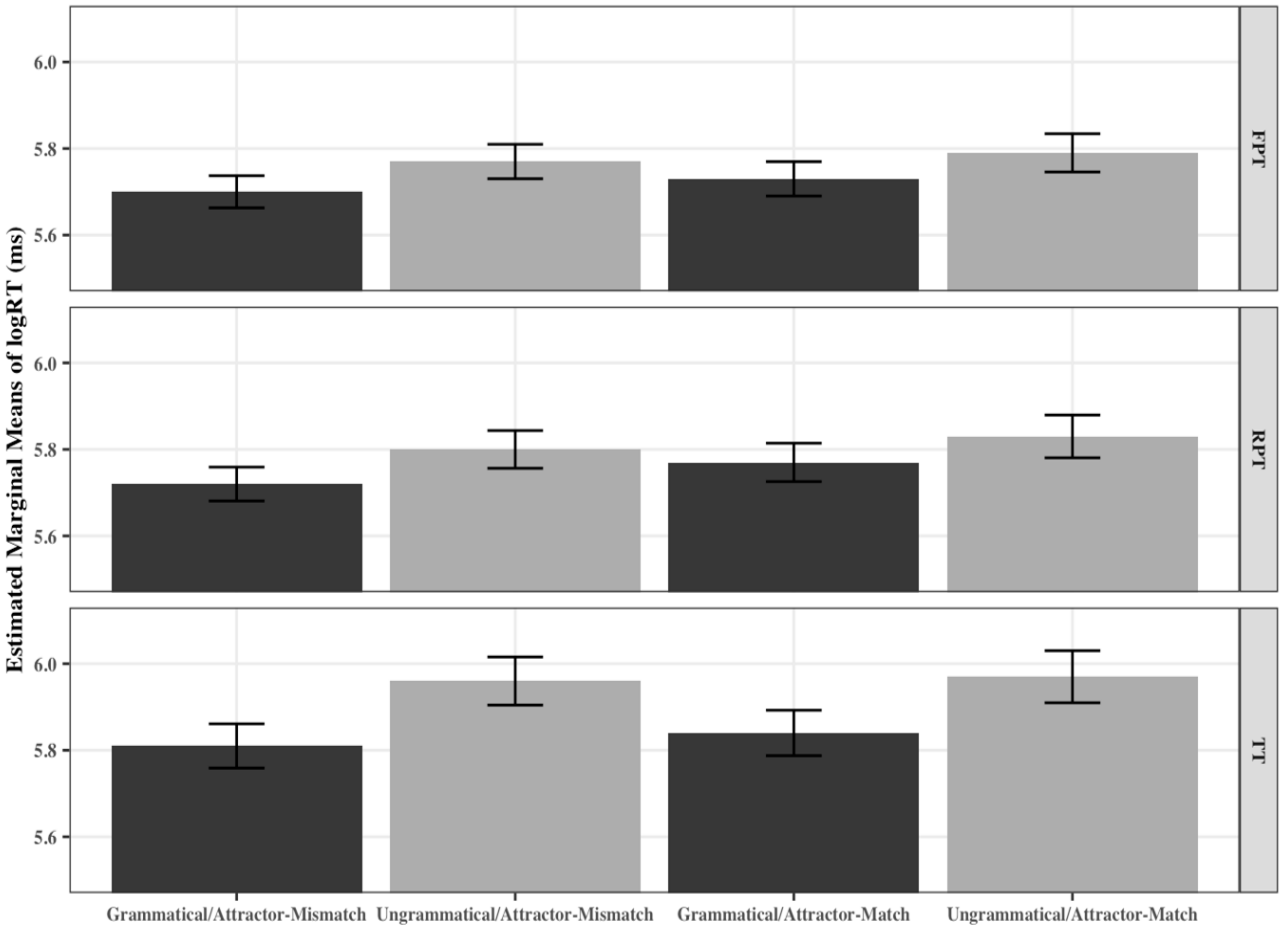
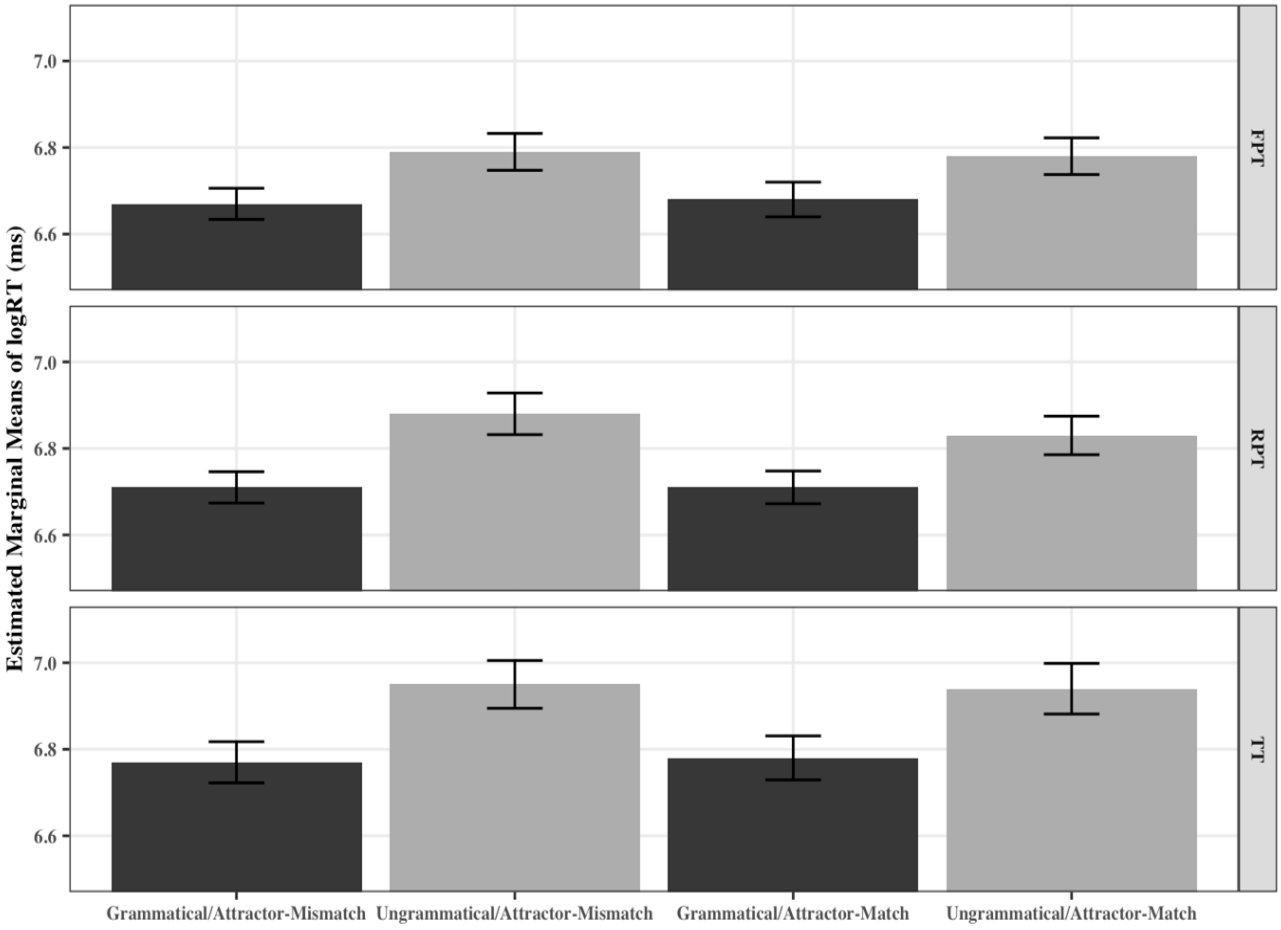


Figure 2.2. Log-transformed reading times at the spillover region of each sentence type in Experiment 1. Error bars show +/- 1 SE.



2.4 Discussion

These results are similar to previous studies that investigated one-feature mismatches between pronouns and antecedents (e.g., Chow et al., 2014). There were longer reading times as evidenced by significant grammaticality effects for both ungrammatical conditions compared to their grammatical control conditions; however, this was not modulated by attractor type. That is, participants did not show shorter reading times for the ungrammatical sentences with an attractor match, suggesting that processing was not influenced by a noun that matched in gender with the pronoun even when the grammatical antecedent mismatched with its pronoun in morphological

features. Under a cue-based retrieval model, this suggests that pronoun processing is largely guided by syntactic constraints and that these syntactic cues may act as a gating mechanism during antecedent retrieval. In other words, even though the morphological features do not match between the pronoun and its grammatical antecedent in the ungrammatical conditions, structurally illicit antecedents that are a better match morphologically will not be retrieved as a potential antecedent during processing. Additionally, this set of results shows that the bidirectional self-paced reading task is able to replicate results of previous studies that have used other methods such as standard self-paced reading or eye-tracking. Therefore, it can be assumed that this will be able to accurately measure whether there are attraction effects during pronoun processing for the two-feature mismatch conditions in Experiment 2.

Chapter 3

Experiment 2

3.1 Experiment 2 design

Experiment 2 investigates whether pronoun processing is susceptible to attraction effects when the grammatical antecedent and its pronoun mismatch in two features, specifically in gender and number. With the same two-feature mismatch paradigm used by Parker and Phillips (2017) to test reflexive processing, this experiment tests whether syntactic cues may be overridden by morphological cues in cases where the pronoun and its antecedent are egregiously mismatched. This will be tested using items as in (10):

(10a) *Grammatical – Attractor Mismatch*
The **grandfather** that visited the **granddaughter** took ***her*** to a festival over the weekend.

(10b) *Ungrammatical – Attractor Mismatch*
*The **grandfather** that visited the **grandsons** took ***her*** to a festival over the weekend.

(10c) *Grammatical – Attractor Match*
The **grandfather** that visited the **grandson** took ***him*** to a festival over the weekend.

(10d) *Ungrammatical – Attractor Match*
*The **grandfather** that visited the **granddaughters** took ***him*** to a festival over the weekend.

For all sentence types, the attractor element (*grandfather*) is in a subject NP position. The object pronoun (*her/him*) is c-commanded by the subject NP and therefore cannot refer to the attractor. The only syntactically available antecedent for this pronoun is the NP in the embedded relative clause (*granddaughter(s)/grandson(s)*). In the *Attractor Mismatch* sentence types such as (10a) and (10b), the pronoun, *her*, always mismatches in gender with the attractor noun, *grandfather*. In the *Grammatical – Attractor Mismatch* sentences as in (10a), the pronoun matches in gender and number with its antecedent, *granddaughter*, yet in the *Ungrammatical – Attractor Mismatch*,

the pronoun mismatches with the antecedent, *grandsons*, in both gender and number. Therefore, in sentences such as (10b), participants are expected to show processing difficulty at and immediately after the pronoun when compared to condition (10a), as no potential antecedent morphologically matches with the pronoun.

In the *Attractor Match* sentences as in (10c) and (10d), the pronoun, *him*, always matches in all morphological features with the attractor noun, *grandfather*. In the *Grammatical – Attractor Match* sentences as in (10c), the pronoun matches in gender and number with its antecedent, *grandson*; however, the pronoun and its antecedent mismatch in gender and number for the *Ungrammatical – Attractor Mismatch* sentences as in (10d). If structurally illicit antecedents can influence pronoun processing when there is a severe mismatch between the pronoun and grammatical antecedent, then processing difficulty will be attenuated for sentences such as (10d). That is, there should be less processing difficulty at the pronoun in (10d) because the noun *grandfather* will act as an attractor for the pronoun *him* since it matches in both features for gender and number while the grammatical antecedent mismatches in both features. However, if syntactic cues act as a gating mechanism during the processing of pronouns, then there will be no attenuation of processing difficulty and thus no attraction effects.

3.1.1 Method

3.1.1.1 Participants

Seventy participants took part in Experiment 2. The data from these participants were excluded if participants performed with less than 80% accuracy on the comprehension task (8 participants); if participants indicated that they were not native speakers of English (9 participants); or if participants indicated impaired vision (1 participant). The data from the

remaining fifty-two participants were included in the analysis (44 female, 8 male; mean age = 19.35, *SD* = 4.74; mean accuracy rate = 9.85%, *SD* = 4.82). These participants were native speakers of English with normal or corrected–to–normal vision. Participants were students from the University of Texas–Arlington and received course credit for their participation.

3.1.1.2 Stimuli

Forty–eight sets of experimental items were created, as repeated in (11). (For a comprehensive list of experimental items, see Appendix B.)

(11a) *Grammatical – Attractor Mismatch*
The **grandfather** that visited the **granddaughter** took ***her*** to a festival over the weekend.

(11b) *Ungrammatical – Attractor Mismatch*
*The **grandfather** that visited the **grandsons** took ***her*** to a festival over the weekend.

(11c) *Grammatical – Attractor Match*
The **grandfather** that visited the **grandson** took ***him*** to a festival over the weekend.

(11d) *Ungrammatical – Attractor Match*
*The **grandfather** that visited the **granddaughters** took ***him*** to a festival over the weekend.

As in Experiment 1, the attractors were always main clause subjects, and the targets were always embedded nouns. All the attractors and target nouns were definitionally gendered nouns. The relative clause was immediately followed by the main clause verb. The verb was always followed by a direct object pronoun (equal number of *him* and *her*). The pronoun was immediately followed by a three-word spillover region that always began with a closed-class word.

As illustrated in the sample sentences, two levels of target match (match/mismatch) were crossed with two levels of attractor match (match/mismatch) to result in a 2x2 within–

participants design. The factor attractor match was manipulated by varying the gender of the pronoun so that it matched or mismatched with the main clause subject. The factor target match was manipulated by varying the number and gender of the noun in the embedded clause.

The 48 item sets were combined with the same 60 fillers from Experiment 1 for a total of 108 sentences. It is important to note that 24 of the fillers were changed so that the grammatical direct object was *them*. This was done to balance out the ungrammatical experimental items in which *him/her* was used to refer to a plural antecedent. (For a comprehensive list of filler items, see Appendix C). All of the target and filler sentences were followed by a comprehension question, which addressed different parts of the sentence to make sure that participants read the entire sentence. The questions did not probe for content related specifically to the interpretation of the pronoun.

3.1.1.3 Procedure

The procedure for Experiment 2 was the same as Experiment 1.

3.1.1.4 Data analysis

Statistical analyses were conducted for the critical and spillover regions. The critical region consists of the pronoun (*him/her*), and the spillover region consists of the three words following the pronoun, as in the following example:

(12) The grandfather that visited the granddaughters took | **him** | **to a festival** | over the weekend.

For each region of interest, three measures are reported: first–pass reading time, go–past time, and total reading time. The data for the two regions (critical word, spillover region) were

analyzed using linear mixed–effects models fitted with the lmer function from the lme4 package (Bates, Mächler, Bolker, & Walker, 2015) in R (version 4.0.5; R Development Core Team, 2020). In these models, attractor type (match, mismatch) and grammaticality (grammatical, ungrammatical) are fixed effect predictors, which were contrast-coded. The models included the maximal random effects structure (Barr, Levy, Scheepers, & Tily, 2013), and the bobyqa optimizer was used (Nash & Varadhan, 2011; Nash, 2014; Varadhan et al., 2020). None of the maximal models failed to converge (see Table 4 for detailed model specifications). The *p*–values for these analyses were estimated using the Satterthwaite approximation implemented in the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017). Raw reading times were log transformed prior to analysis in order to meet the distributional assumptions of the statistical models. Estimated marginal means and standard errors for these log–transformed reading times were calculated based on the linear mixed–effects model reported for each region using the emmeans package.

3.2 Results

For the fifty-two participants whose data was included in the analyses, the mean overall error rate was 9.85% (*SD* = 4.87). The data for trials in which any single reading time was longer than 5000 milliseconds were also eliminated from the analyses (2.92% of the data for the measures below). Table 3.1 provides descriptive statistics (estimated marginal means and standard errors for log-transformed reading times) for each sentence type in each analysis region. Table 3.2 provides a summary of the results from the linear mixed effects regression model. Figure 3.1 provides a plot of the estimated marginal means of the log-transformed reading times for each sentence type at the critical region. Figure 3.2 provides a plot of the estimated marginal

means of the log-transformed reading times for each sentence type at the three-word spillover region.

At the critical region, there was a significant effect of grammaticality across all measures (first-pass: $p = 0.001$; go-past: $p = 0.006$; total: $p < 0.0001$), indicating processing difficulty for ungrammatical sentences compared to the grammatical sentences. In the spillover region, there was also a significant effect of grammaticality across all measures (first-pass: $p < 0.0001$; go-past: $p < 0.0001$; total: $p < 0.0001$), again indicating processing difficulty for ungrammatical sentences. Crucially, there was no interaction between grammaticality and attractor type for any measure, indicating that the effect of grammaticality was not modulated by whether the attractor noun matched with the pronoun. This lack of interaction therefore suggests that there are no attraction effects during pronoun processing even in cases in which the pronoun and antecedent mismatch in two features.

Table 3.1. Estimated marginal means and standard errors (in parentheses) for the log-transformed reading times for each measure in each analysis region, by sentence condition. Millisecond equivalents for the estimated marginal means are provided in brackets.

	Region	
	pronoun *her/him*	spillover *to a festival*
First Pass Time		
grammatical / attractor mismatch	5.70 (.04) [298]	6.67 (.04) [788]
ungrammatical / attractor mismatch	5.77 (.04) [321]	6.79 (.04) [886]
grammatical / attractor match	5.73 (.04) [308]	6.68 (.04) [790]
ungrammatical / attractor match	5.79 (.04) [327]	6.78 (.04) [879]
Regression Path Time		
grammatical / attractor mismatch	5.72 (.04) [305]	6.71 (.04) [818]
ungrammatical / attractor mismatch	5.80 (.04) [330]	6.88 (.05) [968]
grammatical / attractor match	5.77 (.04) [321]	6.71 (.04) [818]
ungrammatical / attractor match	5.83 (.05) [341]	6.83 (.04) [917]
Total Time		
grammatical / attractor mismatch	5.81 (.05) [332]	6.77 (.05) [864]
ungrammatical / attractor mismatch	5.96 (.06) [387]	6.95 (.06) [1034]
grammatical / attractor match	5.84 (.05) [342]	6.78 (.05) [874]
ungrammatical / attractor match	5.97 (.06) [390]	6.94 (.06) [1029]

The grandfather that visited the (granddaughter[s]/grandson[s]) took ***(her/him) to a festival*** over the weekend.

Table 3.2. Mixed-effects regression estimates for the fixed effects of grammaticality, attractor match, and their interaction on the log-transformed reading times for each measure in each analysis region.

	Region							
	pronoun				spillover			
	her/him				*to a festival*			
First Pass Time	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*
Intercept	5.75	0.04	157.29	<.001	6.57	0.04	179.87	<.001
Grammaticality	**0.07**	**0.02**	**3.34**	**0.001**	**0.11**	**0.02**	**5.58**	**<.001**
Attractor Match	-0.02	0.02	-1.32	0.190	0.001	0.02	0.08	0.934
Grammaticality x Attractor Match	0.02	0.04	0.40	0.692	0.01	0.03	0.45	0.652
Regression Path Time								
Intercept	5.78	0.04	147.53	<.001	6.78	0.04	182.15	<.001
Grammaticality	**0.07**	**0.02**	**2.87**	**0.006**	**0.14**	**0.03**	**5.24**	**<.001**
Attractor Match	-0.04	0.02	-1.82	0.072	0.03	0.02	1.25	0.216
Grammaticality x Attractor Match	0.02	0.05	0.40	0.694	0.05	0.04	1.46	0.149
Total Time								
Intercept	5.90	0.05	115.53	<.001	6.86	0.05	139.04	<.001
Grammaticality	**0.14**	**0.03**	**5.40**	**<.001**	**0.17**	**0.03**	**6.19**	**<.001**
Attractor Match	-0.02	0.02	-0.82	0.414	-0.004	0.02	-0.20	0.843
Grammaticality x Attractor Match	0.03	0.04	0.66	0.514	0.02	0.04	0.56	0.575

*The grandfather that visited the (granddaughter[s]/grandson[s]) took **(her/him) to a festival*** over the weekend.

The statistical model for all regions/measures was coded as follows: `lmer (dv ~ grammaticality * attractor match + (1 + grammaticality * attractor match | subj) + (1 + grammaticality * attractor match | item)`

Figure 3.1. Log-transformed reading times at the pronoun region of each sentence type in Experiment 2. Error bars show +/- 1 SE.

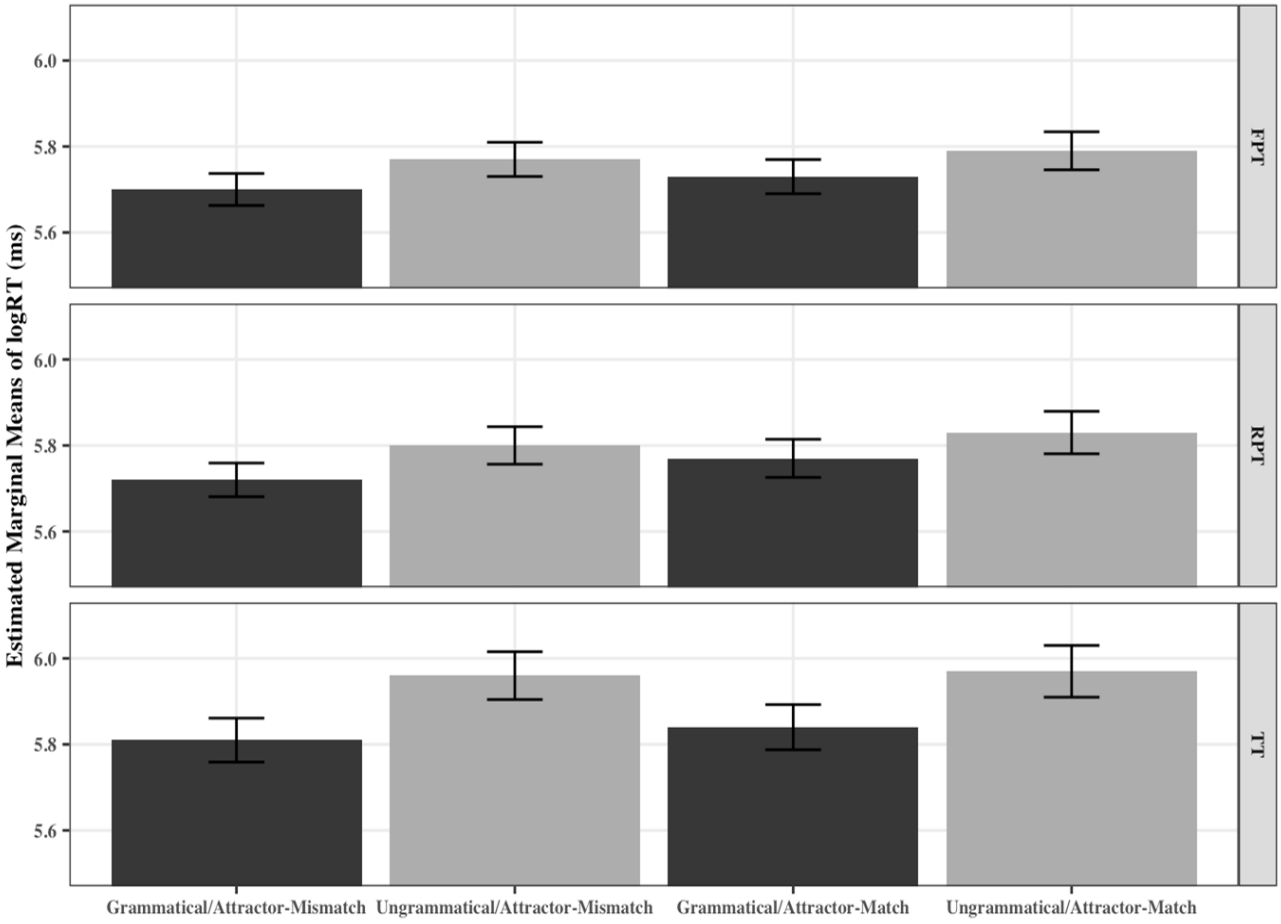
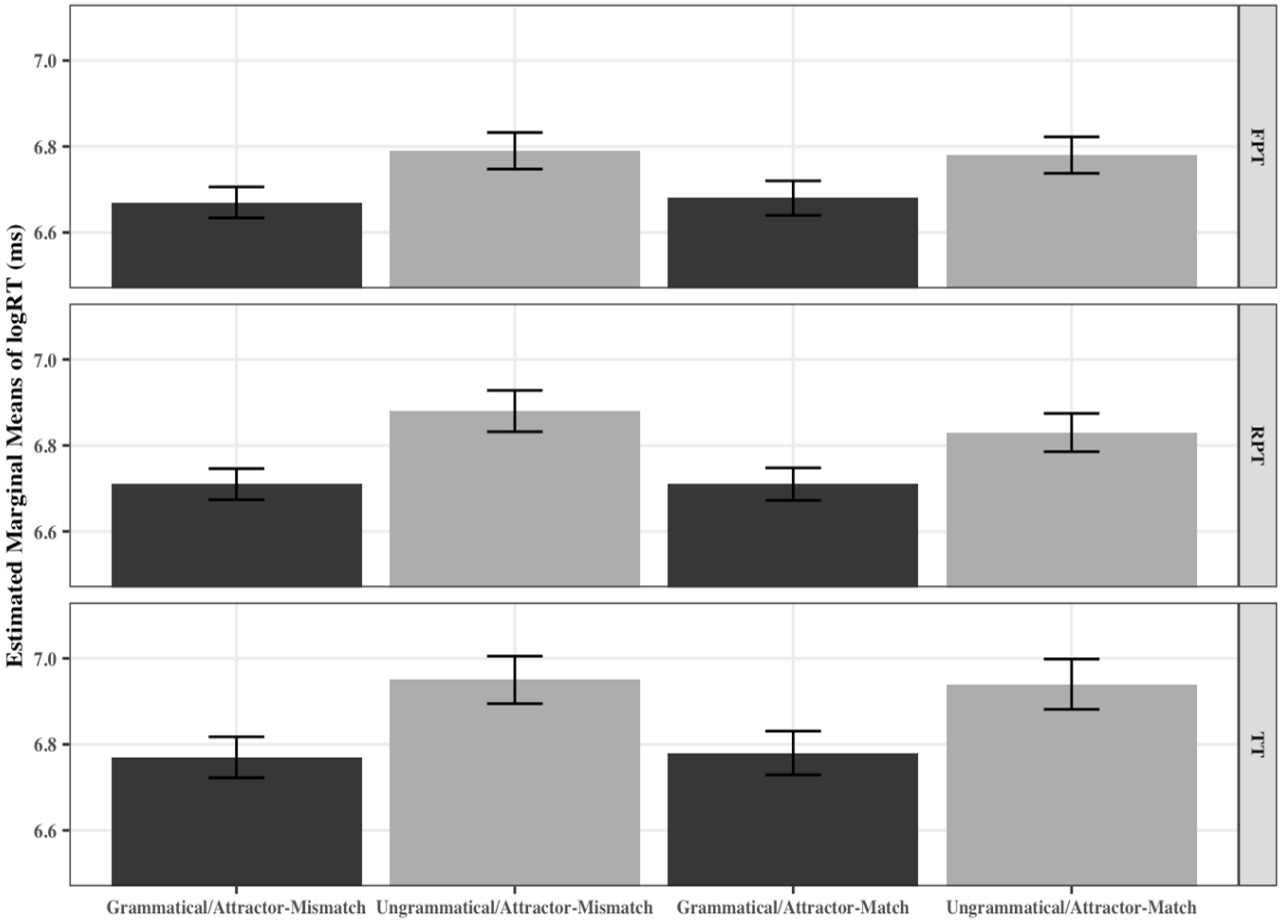


Figure 3.2. Log-transformed reading times at the spillover region of each sentence type in Experiment 2. Error bars show +/- 1 SE.



3.3 Combined analysis of Exp. 1 and Exp. 2

A combined statistical analysis of Experiment 1 and Experiment 2 was conducted to ensure that the differences across experiments did not affect the significant effects of grammaticality or lack of attraction effects in individual experiment analyses. The data were analyzed using linear mixed–effects models fitted with the lmer function from the lme4 package (Bates, Mächler, Bolker, & Walker, 2015) in R (version 4.3.2; R Development Core Team, 2020). In these models, experiment (Exp. 1, Exp. 2), attractor type (match, mismatch) and grammaticality (grammatical, ungrammatical) are fixed effect predictors, which were sum-

coded. In one case, the maximal model failed to converge – for first-pass time for the pronoun region. The random effects structure for this analysis was simplified by iteratively removing the random slope for the highest-order interaction that was associated with the smallest variance (see Table 3.3 for detailed model specifications).

As in the individual experiment analyses, there were significant effects of grammaticality for all measures (first-pass time; regression path time; and total time) in both regions of interest (pronoun and spillover). There was no two-way interaction between experiment and grammaticality nor between experiment and attractor match for any measure. Additionally, there was no significant three-way interaction among experiment, grammaticality, and attractor match for any measure. This indicates that although the two experiments were conducted using different items and administered to different participant pools, the differences between these two experiments did not affect the significant effects of grammaticality nor did they affect the lack of attraction effects in the individual analyses.

Table 3.3. Mixed-effects regression estimates for the fixed effects of experiment, grammaticality, attractor match, and their interaction on the log-transformed reading times for each measure in each analysis region.

	Region							
	pronoun *her/him*				spillover *to a festival*			
First Pass Time†	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*
Intercept	5.72	0.03	204.60	<0.001	6.72	0.03	243.54	<0.001
Experiment (EX)	0.07	0.06	1.24	0.216	0.02	0.06	0.33	0.74
Grammaticality (G)	0.05	**0.01**	**3.64**	**<0.001**	**0.09**	**0.01**	**7.25**	**<0.001**
Attractor Match (AM)	-0.02	0.01	-1.29	0.198	0.01	0.01	0.64	0.522
EX x G	0.04	0.03	1.50	0.136	0.03	0.03	1.33	0.186
EX x AM	-0.02	0.03	-0.68	0.500	-0.01	0.02	-0.51	0.613
G x AM	<0.01	0.02	0.01	0.995	0.01	0.02	0.26	0.792
EX x G x AM	0.03	0.05	0.63	0.532	0.02	0.04	0.37	0.71
Regression Path Time								
Intercept	5.75	0.03	200.14	<0.001	6.78	0.03	249.98	<0.001
Experiment (EX)	0.07	0.06	1.27	0.208	0.01	0.05	0.15	0.884
Grammaticality (G)	**0.05**	**0.02**	**3.36**	**<0.001**	**0.13**	**0.02**	**7.03**	**<0.001**
Attractor Match (AM)	-0.03	0.02	-1.86	0.065	0.03	0.01	1.44	0.153
EX x G	0.03	0.03	1.09	0.275	0.03	0.04	0.77	0.441
EX x AM	-0.02	0.03	-0.75	0.456	0.01	0.03	0.29	0.769
G x AM	<0.01	0.03	0.08	0.937	0.02	0.03	0.71	0.481
EX x G x AM	0.03	0.07	0.50	0.615	0.07	0.05	1.40	0.163
Total Time								
Intercept	5.87	0.04	163.84	<0.001	6.86	0.03	199.35	<0.001
Experiment (EX)	0.06	0.07	0.77	0.443	<0.01	0.07	0.07	0.948
Grammaticality (G)	**0.11**	**0.02**	**6.48**	**<0.001**	**0.15**	**0.02**	**8.39**	**<0.001**
Attractor Match (AM)	-0.01	0.07	-0.84	0.401	0.01	0.01	0.44	0.660
EX x G	0.05	0.04	1.53	0.129	0.05	0.04	1.33	0.187
EX x AM	-0.01	0.03	-0.29	0.775	-0.02	0.03	-0.74	0.462
G x AM	<0.01	0.03	0.03	0.974	0.01	0.03	0.32	0.752
EX x G x AM	0.05	0.07	0.78	0.437	0.03	0.05	0.52	0.603

† The statistical model for first pass time in the pronoun were coded as follows: lmer (dv ~ EX * G * AM + (1 + G + AM | subj) + (1 + G + AM | item); for all other regions/measures, the statistical model was coded as follows: lmer (dv ~ EX * G * AM + (1 + G * AM | subj) + (1 + G * AM | item).

3.4 Discussion

The pattern of results observed in this experiment – and across Experiments 1 and 2 – indicates that pronouns are not susceptible to attraction effects even when there is a severe mismatch between the pronoun and antecedent. This provides evidence that pronominal dependency processing weighs syntactic cues more heavily than morphological cues across the

board, contrasting with what has been observed for both reflexive and subject-verb agreement processing. Parker and Philips (2017) suggested that the heavier weighting of syntactic cues for referential dependencies was due to the unpredictability of these dependencies. That is, when a noun is encountered in an English sentence, it may be difficult to predict whether a reflexive or pronoun may be encountered later in the sentence. Therefore, it is necessary for syntactic cues to be strongly weighted during referential processing so that the pronoun and reflexive can be correctly linked to its antecedent. However, while it is true that referential dependencies rely more heavily on syntactic cues during processing than what has been observed during subject-verb agreement processing, predictability may not be the only factor in determining how these cue weights are assigned (see Chapter 4 for further discussion). Considering the lack of attraction effects for pronominal dependencies seen in Experiment 2 – which contrasts with the attraction effects for reflexives in Parker and Phillips (2017) – it seems as though syntactic cues are weighted more strongly for pronominal dependencies than for reflexive dependencies. In fact, structure cues may act as a gating mechanism during pronoun processing as no attraction effects were found even in the case of a severe agreement mismatch between the pronoun and its antecedent.

Chapter 4

General Discussion

4.1 Differences in cue weightings among long-distance dependencies

This dissertation investigated whether the processing of pronouns would be influenced by structurally illicit antecedents if there were varying degrees of mismatch in morphological features between the pronoun and the grammatical antecedent. Across both experiments, no attraction effects were observed regardless of the degree of mismatch. This suggests that during pronominal processing, syntactic cues act as a gating mechanism in order to prevent structurally illicit antecedents from being retrieved. This also further indicates that under a cue-based retrieval model of dependency processing, syntactic and morphological cue weightings are contingent on the type of long-distance dependency.

To account for the different cue weightings for distinct types of long-distance dependencies, Parker and Phillips (2017) argue that the predictability of the dependency may affect how heavily the syntactic cues are weighted. More specifically, they claim that SVA is a predictable dependency because upon encountering a subject noun phrase, one can predict that a verb will most likely occur later in the sentence, and additionally, a prediction can be made as to which morphological features will be assigned to the upcoming verb. Therefore, predictable dependencies (like SVA) will not weigh syntactic cues heavily, which then can give rise to attraction effects. Conversely, referential dependencies are categorized as unpredictable, as there are few indicators that a noun will be referred to again with a reflexive or pronoun in the same sentence. Thus, these dependency types will have much stronger syntactic cue weightings, and according to Parker and Phillips' (2017) account, should only show evidence of attraction effects in cases of extreme mismatch between the dependent elements.

However, the present study shows that while there does seem to be a difference in cue weightings between predictable and unpredictable dependencies, there are also differences in syntactic cue weightings among specific types of unpredictable dependencies. That is, while reflexives and pronouns are both categorized as unpredictable dependencies with strong syntactic cue weightings, these two dependency types exhibit different patterns of attraction effects. Specifically, even in cases where the pronoun and its antecedent were egregiously mismatched, there was no evidence of attraction effects during the processing of pronouns. This suggests an even stronger weighting of syntactic cues than seen in reflexive processing, for which a severe mismatch between the reflexive and antecedent has been shown to result in attraction effects (Parker & Phillips, 2017). Therefore, while predictability may be a factor in determining cue weighting, it does not completely capture the differences that have been observed with regards to different types of long-distance dependencies.

4.2 Intrasentential vs. extrasentential satisfaction

One factor that could further explain why SVA, reflexives, and pronoun processing use different cue weightings is the requirement for an intrasentential or extrasentential antecedent. The following distinction in Table 4.1 is proposed as an explanation for the different pattern of results among long-distance dependencies. This incorporates the proposal by Parker and Phillips (2017) that the predictability of the dependency may factor into the weighting of syntactic cues. However, this also takes into account that some dependencies – such as subject-verb agreement and reflexives – require their agreeing elements to be satisfied intrasententially while others – such as pronouns – can have dependent elements that are intra- or extrasentential.

Table 4.1. Indication of whether dependency processing is susceptible to attraction effects based on its predictability and intrasentential satisfaction requirement. (✓ indicates that the dependency has the qualities indicated in the column; x indicates that it does not.)

	Predictable	Intrasentential Satisfaction Required	Attraction Effects
SVA	✓	✓	✓
Reflexives	x	✓	✓*
Pronouns	x	x	x

*only for extreme mismatches

Under this model, as shown in the table above[2], the combination of predictability and intrasentential satisfaction requirements give rise to a tripartite distinction among these long-distance dependencies. SVA is highly susceptible to attraction effects because of the predictable nature of these dependencies (i.e., when a noun in a subject position is encountered, a verb can be expected) and also because there is a need to satisfy this dependency intrasententially. The predictability and intrasentential requirement of this dependency allow for attraction effects to arise because when the grammatically linked elements mismatch in morphological features, the error-prone processing mechanism may search for an element that does match in corresponding features. In other words, if a verb does not match in morphological features with its structurally licit noun, the processor must still link the verb to a noun in order to fulfill the subject-verb dependency. This also holds true for reflexive processing: the reflexive must be linked to an antecedent within the same sentence. However, unlike SVA dependencies, reflexives are unpredictable (i.e., when a noun is encountered, one cannot always predict that a reflexive will be linked to it later in the sentence). Therefore, syntactic cues will be relatively stronger for reflexives, and attraction effects are only observed if the syntactically licit antecedent severely

[2] A fourth logically possible combination of these factors presented in the table – a long-distance dependency element that is predictable but that does not require intrasentential satisfaction – likely does not exist.

mismatches in morphological features with the reflexive, since the processor must still find an element intrasententially to link to the reflexive.

Pronouns, though, are not predictable nor do they require intrasentential antecedents, and no attraction effects were observed for this type of dependency. Therefore, this suggests that the combination of unpredictability and ability to link to extrasentential antecedents may lead to heavily weighted syntactic cues. Pronoun processing may be less susceptible to attraction effects because if there is no suitable antecedent within the sentence (either syntactically or morphologically), then an antecedent can be assumed to exist outside of the sentence in a larger, unknown discourse. In both Experiments 1 and 2, participants showed evidence of processing difficulty when there was no suitable intrasentential antecedent for the pronoun. However, the lack of attraction effects indicates that there was no attempt to retrieve a noun outside of the licit structure. This suggests, then, that since there is a possibility of an extrasentential antecedent, the syntactic cues for pronominal processing act as a gating mechanism for morphological cues and do not allow structurally illicit antecedents to be retrieved, even when the grammatical antecedent and pronoun severely mismatch in terms of morphological features.

4.3 Future Work

4.3.1 Influence of linear structure

While no attraction effects were found in either experiment regardless of the degree of mismatch between the pronoun and antecedent, the linear structure of the items may have contributed to the lack of attraction effects. In other words, sentences with a different structure than those used in this study may give rise to attraction effects during pronoun processing when an antecedent is an especially poor match in morphological features for the pronoun. For the

items in Experiments 1 and 2, the pronoun is linearly closer to its grammatical antecedent than to the attractor noun. This was done in order to match the same linear order as used in Parker and Phillips (2017), so that close comparisons could be made. However, it may be the case that linear ordering plays a key role in the processing of pronominal dependencies, suggesting that if the attractor were linearly closer to the pronoun, there would be evidence of attraction effects. Some studies posit that attraction effects are found in subject-verb agreement processing because the attracting element is easier to retrieve from working memory because the attracting noun has occurred more recently than the head noun relative to verb processing (e.g., Badecker & Kuminiak, 2007; Bock & Cutting, 1992; Solomon & Pearlmutter, 2004). Therefore, one future direction of this study is to test two-feature mismatch conditions for sentences such as those seen in Chow et al. (2014) in which the attractor noun would be linearly closer to the pronoun and thus possibly more accessible in working memory. Further investigations that manipulate linear order will help lend evidence to whether syntactic cues act as a gating mechanism during pronominal processing regardless of the linear order of the constituents.

4.3.2. Second Language Acquisition

Another area of research with regards to the real-time processing of pronominal dependencies is in second language acquisition. Previous studies have argued that for non–native English speakers, the processing of reflexives and pronouns is not highly constrained by structure (i.e., the Shallow Structure Hypothesis; Clahsen & Felser, 2006; Felser, 2019; Felser & Cunnings, 2012; Patterson et al., 2014). Instead, it has been suggested that non–native speakers are more influenced by discourse–prominent potential antecedents. However, many studies have used items in which the only grammatically available referent is in a discourse-prominent

position. For example, Patterson et al., (2014) investigated pronominal processing for non-native English speakers using sentences such as (13) and (14). For both sentence types, the participants were likely to choose the subject noun as the antecedent for the pronoun. They interpreted these findings as evidence that for sentences like (13), non-native speakers were not employing syntactic Principle B during online processing but were primarily linking dependent elements based on whether the antecedent was in a discourse prominent position.

(13) The **boy** remembered that **Matthew** had bought ***him*** a new computer game.

(14) **Harry** heard **William** pull the curtain around ***him*** in the quiet hospital ward.

However, the fact that the only grammatical antecedent for the pronoun is also in a discourse prominent position in sentences such as (13) creates a confound as this cannot clearly distinguish whether non-native speakers are relying on syntax or discourse prominence during the processing of these sentences. Therefore, the items used for Experiments 1 and 2 would be especially interesting for investigating whether non-native, as the attractors are always in a discourse–prominent position, yet they are not grammatical antecedents. This would then allow the decoupling of discourse-prominent subjects and syntactically available antecedents to fully investigate whether non-native speakers are employing syntactic principles during real-time processing in the same manner as native speakers. If it is the case discourse prominence plays a primary role in referential dependency processing, it would be predicted that non–native English speakers would be more susceptible to attraction effects for both one–feature and two–feature mismatch conditions during online pronoun processing.

4.4 Conclusion

This dissertation investigated the real-time processing of pronouns compared with other types of long-distance dependency processing under a common cue-based retrieval model. More specifically, it explored whether pronoun processing would be susceptible to attraction effects if the pronoun and its antecedent mismatched in morphological features. Experiment 1 used a one-feature mismatch paradigm in which the pronoun and its antecedent mismatched in gender, and the results showed having an attractor element that matched in features with the pronoun did not give rise to attraction effects. Similarly, Experiment 2 used a two-feature mismatch paradigm in which the pronoun and its antecedent mismatched in number and gender, and again, no attraction effects were observed.

These results contrast with what has been observed for the processing of other types of long-distance dependencies. During subject-verb agreement processing, the processing of the verb can be influenced by noun phrases that are not in a structural position to control agreement. During the processing of reflexives, though, antecedent retrieval is only influenced by grammatically unavailable noun phrases if there is an egregious mismatch between the reflexive and grammatical antecedent (e.g., both gender and number). However, given the results of Experiment 1 and 2, pronoun processing does not seem to be influenced by structurally illicit antecedents, regardless of the degree of mismatch between the pronoun and grammatical antecedent. Therefore, within a cue-based retrieval model, syntactic and morphological cue weightings seem to be contingent on the type of long-distance dependency. Thus, during pronominal processing, syntactic cues are weighted more heavily than for other types of dependencies and act as a gating mechanism in order to prevent structurally illicit noun phrases from being retrieved as antecedents.

APPENDIX A. LIST OF ITEMS FOR EXPERIMENT 1

All items are presented in the following order:

(a) main clause mismatch / embedded clause match – grammatical
(b) main clause mismatch / embedded clause mismatch – ungrammatical
(c) main clause match / embedded clause match – grammatical
(d) main clause match / embedded clause mismatch – ungrammatical
(e) comprehension question and answer

(1)
The congresswoman that hired the waiter praised him for the success of the event.
The congresswoman that hired the waitress praised him for the success of the event.
The congresswoman that hired the waitress praised her for the success of the event.
The congresswoman that hired the waiter praised her for the success of the event.
YES – Did the congresswoman hire the waiter? / Did the congresswoman hire the waitress?

(2)
The councilman that talked to the spokeswoman congratulated her on the success of the fundraiser.
The councilman that talked to the spokesman congratulated her on the success of the fundraiser.
The councilman that talked to the spokesman congratulated him on the success of the fundraiser.
The councilman that talked to the spokeswoman congratulated him on the success of the fundraiser.
YES – Was the fundraiser successful?

(3)
The woman that managed the actor criticized him for the failure of the movie.
The woman that managed the actress criticized him for the failure of the movie.
The woman that managed the actress criticized her for the failure of the movie.
The woman that managed the actor criticized her for the failure of the movie.
NO – Was the movie successful?

(4)
The monk that pitied the woman hid her from the agents of the secret police.
The monk that pitied the man hid her from the agents of the secret police.
The monk that pitied the man hid him from the agents of the secret police.
The monk that pitied the woman hid him from the agents of the secret police.
NO – Was the monk cruel to the woman? / Was the monk cruel to the man?

(5)
The saleswoman that spoke to the policeman deceived him about the extent of the illegal activity.
The saleswoman that spoke to the policewoman deceived him about the extent of the illegal activity.

The saleswoman that spoke to the policewoman deceived her about the extent of the illegal activity.
The saleswoman that spoke to the policeman deceived her about the extent of the illegal activity.
YES – Did the saleswoman speak to the policeman? / Did the saleswoman speak to the policewoman?

(6)
The schoolboy that annoyed the waitress embarrassed her at the restaurant in front of the customers.
The schoolboy that annoyed the waiter embarrassed her at the restaurant in front of the customers.
The schoolboy that annoyed the waiter embarrassed him at the restaurant in front of the customers.
The schoolboy that annoyed the waitress embarrassed him at the restaurant in front of the customers.
NO – Did the waitress like the schoolboy? / Did the waiter like the schoolboy?

(7)
The stewardess that scolded the man blamed him for the accident during the emergency landing.
The stewardess that scolded the woman blamed him for the accident during the emergency landing.
The stewardess that scolded the woman blamed her for the accident during the emergency landing.
The stewardess that scolded the man blamed her for the accident during the emergency landing.
YES – Did an accident occur during the emergency landing?

(8)
The father that met the bridesmaid familiarized her with every detail of the wedding plans.
The father that met the groomsman familiarized her with every detail of the wedding plans.
The father that met the groomsman familiarized him with every detail of the wedding plans.
The father that met the bridesmaid familiarized him with every detail of the wedding plans.
NO – Did the mother know every detail of the wedding plans?

(9)
The actress that hired the businessman introduced him to the director of the new spy film.
The actress that hired the businesswoman introduced him to the director of the new spy film.
The actress that hired the businesswoman introduced her to the director of the new spy film.
The actress that hired the businessman introduced her to the director of the new spy film.
YES – Did the actress know the director of the spy film?

(10)
The older brother that partied with the bachelorette mocked her for singing karaoke at the bar.
The older brother that partied with the bachelor mocked her for singing karaoke at the bar.
The older brother that partied with the bachelor mocked him for singing karaoke at the bar.
The older brother that partied with the bachelorette mocked him for singing karaoke at the bar.

NO – Did the younger brother party with the bachelorette? / Did the younger brother party with the bachelor?

(11)
The older sister that mentored the boy scout prepared him for the trip to the wilderness.
The older sister that mentored the girl scout prepared him for the trip to the wilderness.
The older sister that mentored the girl scout prepared her for the trip to the wilderness.
The older sister that mentored the boy scout prepared her for the trip to the wilderness.
YES – Did the older sister mentor the boy scout? / Did the older sister mentor the girl scout?

(12)
The king that shunned the witch blamed her when the curse was unleashed on the castle.
The king that shunned the wizard blamed her when the curse was unleashed on the castle.
The king that shunned the wizard blamed him when the curse was unleashed on the castle.
The king that shunned the witch blamed him when the curse was unleashed on the castle.
NO – Was a curse unleashed on the village?

(13)
The councilman that admired the girl scout nominated her for the award for community service.
The councilman that admired the boy scout nominated her for the award for community service.
The councilman that admired the boy scout nominated him for the award for community service.
The councilman that admired the girl scout nominated him for the award for community service.
NO – Did the councilman dislike the girl scout? / Did the councilman dislike the boy scout?

(14)
The spokeswoman that represented the congressman protected him despite the pressure to expose corrupt politicians.
The spokeswoman that represented the congresswoman protected him despite the pressure to expose corrupt politicians.
The spokeswoman that represented the congresswoman protected her despite the pressure to expose corrupt politicians.
The spokeswoman that represented the congressman protected her despite the pressure to expose corrupt politicians.
YES – Was there pressure to expose corrupt politicians?

(15)
The emperor that praised the witch congratulated her on having saved so many lives.
The emperor that praised the wizard congratulated her on having saved so many lives.
The emperor that praised the wizard congratulated him on having saved so many lives.
The emperor that praised the witch congratulated him on having saved so many lives.
NO – Did the emperor despise the witch? / Did the emperor despise the wizard?

(16)
The bride that consulted with the groomsman considered him to be important to the wedding's success.

The bride that consulted with the bridesmaid considered him to be important to the wedding's success.
The bride that consulted with the bridesmaid considered her to be important to the wedding's success.
The bride that consulted with the groomsman considered her to be important to the wedding's success.
YES – Did the bride consult the groomsman? / Did the bride consult the bridesmaid?

(17)
The duke that distrusted the nun criticized her during private meetings with church officials.
The duke that distrusted the priest criticized her during private meetings with church officials.
The duke that distrusted the priest criticized him during private meetings with church officials.
The duke that distrusted the nun criticized him during private meetings with church officials.
NO – Did the duke meet with government officials?

(18)
The princess that sang to the king entertained him with lively songs at the feast.
The princess that sang to the queen entertained him with lively songs at the feast.
The princess that sang to the queen entertained her with lively songs at the feast.
The princess that sang to the king entertained her with lively songs at the feast.
YES – Did the princess sing to the king? / Did the princess sing to the queen?

(19)
The wizard that cursed the princess poisoned her on the night of the full moon.
The wizard that cursed the prince poisoned her on the night of the full moon.
The wizard that cursed the prince poisoned him on the night of the full moon.
The wizard that cursed the princess poisoned him on the night of the full moon.
NO – Did the witch curse the princess? / Did the witch curse the prince?

(20)
The bachelorette that spoke to the waiter emailed him with more details about the party.
The bachelorette that spoke to the waitress emailed him with more details about the party.
The bachelorette that spoke to the waitress emailed her with more details about the party.
The bachelorette that spoke to the waiter emailed her with more details about the party.
YES – Did the bachelorette provide details about the party?

(21)
The grandfather that visited the granddaughter took her to a festival over the weekend.
The grandfather that visited the grandson took her to a festival over the weekend.
The grandfather that visited the grandson took him to a festival over the weekend.
The grandfather that visited the granddaughter took him to a festival over the weekend.
NO – Did the grandfather attend a concert over the weekend?

(22)
The waitress that served the old man thanked him for being patient during the busy lunch hour.

The waitress that served the old woman thanked him for being patient during the busy lunch hour.
The waitress that served the old woman thanked her for being patient during the busy lunch hour.
The waitress that served the old man thanked her for being patient during the busy lunch hour.
YES – Did the waitress work during lunch hour?

(23)
The gentleman that disagreed with the duchess confronted her after being removed from the king's council.
The gentleman that disagreed with the duke confronted her after being removed from the king's council.
The gentleman that disagreed with the duke confronted him after being removed from the king's council.
The gentleman that disagreed with the duchess confronted him after being removed from the king's council.
NO – Was the gentleman asked to stay on the king's council?

(24)
The girl that disrespected the priest mocked him during the ritual for the forest gods.
The girl that disrespected the priestess mocked him during the ritual for the forest gods.
The girl that disrespected the priestess mocked her during the ritual for the forest gods.
The girl that disrespected the priest mocked her during the ritual for the forest gods.
YES – Did the girl disrespect the priest? / Did the girl disrespect the priestess?

(25)
The wizard that cursed the young woman changed her into a frog in front of everyone.
The wizard that cursed the young man changed her into a frog in front of everyone.
The wizard that cursed the young man changed him into a frog in front of everyone.
The wizard that cursed the young woman changed him into a frog in front of everyone.
YES – Did the wizard curse the young woman? / Did the wizard curse the young man?

(26)
The aunt that spoiled the nephew bought him a large popcorn and candy at the movies.
The aunt that spoiled the niece bought him a large popcorn and candy at the movies.
The aunt that spoiled the niece bought her a large popcorn and candy at the movies.
The aunt that spoiled the nephew bought her a large popcorn and candy at the movies.
YES – Did the aunt buy popcorn and candy?

(27)
The policeman that investigated the congresswoman identified her as a suspect in the fraud case.
The policeman that investigated the congressman identified her as a suspect in the fraud case.
The policeman that investigated the congressman identified him as a suspect in the fraud case.
The policeman that investigated the congresswoman identified him as a suspect in the fraud case.
NO – Did the policeman investigate a murder?

(28)
The woman that met the boy scout paid him for the items purchased during the fundraiser.
The woman that met the girl scout paid him for the items purchased during the fundraiser.
The woman that met the girl scout paid her for the items purchased during the fundraiser.
The woman that met the boy scout paid her for the items purchased during the fundraiser.
NO – Did the woman forget to pay for the items?

(29)
The monk that respected the princess defended her despite the criticism from the press.
The monk that respected the prince defended her despite the criticism from the press.
The monk that respected the prince defended him despite the criticism from the press.
The monk that respected the princess defended him despite the criticism from the press.
NO – Did the monk disapprove of the princess? / Did the monk disapprove of the prince?

(30)
The sorceress that disapproved of the king threatened him after the announcement of the unjust law.
The sorceress that disapproved of the queen threatened him after the announcement of the unjust law.
The sorceress that disapproved of the queen threatened her after the announcement of the unjust law.
The sorceress that disapproved of the king threatened her after the announcement of the unjust law.
YES – Was the law unfair?

(31)
The king that trusted the duchess ordered her to visit areas of the kingdom suffering from famine.
The king that trusted the duke ordered her to visit areas of the kingdom suffering from famine.
The king that trusted the duke ordered him to visit areas of the kingdom suffering from famine.
The king that trusted the duchess ordered him to visit areas of the kingdom suffering from famine.
NO – Was the kingdom suffering from a drought?

(32)
The grandmother that criticized the little boy asked him to help out around the house.
The grandmother that criticized the little girl asked him to help out around the house.
The grandmother that criticized the little girl asked her to help out around the house.
The grandmother that criticized the little boy asked her to help out around the house.
YES – Did the grandmother criticize the little boy? / Did the grandmother criticize the little girl?

(33)
The father that supported the actress watched her in several performances of the show.
The father that supported the actor watched her in several performances of the show.
The father that supported the actor watched him in several performances of the show.

The father that supported the actress watched him in several performances of the show.
NO – Did the father disapprove of the actress? / Did the father disapprove of the actor?

(34)
The mother that visited the son asked him for a tour around the university campus.
The mother that visited the daughter asked him for a tour around the university campus.
The mother that visited the daughter asked her for a tour around the university campus.
The mother that visited the son asked her for a tour around the university campus.
YES – Did the mother want a tour of the campus?

(35)
The schoolboy that bullied the little girl pushed her onto the ground and walked away.
The schoolboy that bullied the little boy pushed her onto the ground and walked away.
The schoolboy that bullied the little boy pushed him onto the ground and walked away.
The schoolboy that bullied the little girl pushed him onto the ground and walked away.
NO – Was the schoolboy kind to the little girl? / Was the schoolboy kind to the little boy?

(36)
The policewoman that questioned the father told him to report everything about the incident.
The policewoman that questioned the mother told him to report everything about the incident.
The policewoman that questioned the mother told her to report everything about the incident.
The policewoman that questioned the father told her to report everything about the incident.
YES – Did the policewoman question the father? / Did the policewoman question the mother?

(37)
The priest that counseled the duchess advised her to study law at the university.
The priest that counseled the duke advised her to study law at the university.
The priest that counseled the duke advised him to study law at the university.
The priest that counseled the duchess advised him to study law at the university.
NO – Did the priest recommend studying finance at the university?

(38)
The stewardess that confronted the businessman asked him to exit immediately from the plane.
The stewardess that confronted the businesswoman asked him to exit immediately from the plane.
The stewardess that confronted the businesswoman asked her to exit immediately from the plane.
The stewardess that confronted the businessman asked her to exit immediately from the plane.
YES – Did the stewardess confront the businessman? / Did the stewardess confront the businesswoman?

(39)
The grandfather that cared for the granddaughter taught her how to ride a bicycle one afternoon.
The grandfather that cared for the grandson taught her how to ride a bicycle one afternoon.
The grandfather that cared for the grandson taught him how to ride a bicycle one afternoon.
The grandfather that cared for the granddaughter taught him how to ride a bicycle one afternoon.

NO – Did the grandmother take care of the granddaughter? / Did the grandmother take care of the grandson?

(40)
The woman that spoke to the councilman assured him that the campaign would be successful.
The woman that spoke to the councilwoman assured him that the campaign would be successful.
The woman that spoke to the councilwoman assured her that the campaign would be successful.
The woman that spoke to the councilman assured her that the campaign would be successful.
YES – Did the woman think that the campaign would be successful?

(41)
The boy scout that spoke with the old woman asked her to recommend places to visit in the area.
The boy scout that spoke with the old man asked her to recommend places to visit in the area.
The boy scout that spoke with the old man asked him to recommend places to visit in the area.
The boy scout that spoke with the old woman asked him to recommend places to visit in the area.
NO – Did the boy scout ask about the history of the area?

(42)
The nun that annoyed the schoolboy scolded him for behaving badly every day during class.
The nun that annoyed the schoolgirl scolded him for behaving badly every day during class.
The nun that annoyed the schoolgirl scolded her for behaving badly every day during class.
The nun that annoyed the schoolboy scolded her for behaving badly every day during class.
YES – Did the nun annoy the schoolboy? / Did the nun annoy the schoolgirl?

(43)
The emperor that met with the queen informed her of the plans to crush the rebellion.
The emperor that met with the king informed her of the plans to crush the rebellion.
The emperor that met with the king informed him of the plans to crush the rebellion.
The emperor that met with the queen informed him of the plans to crush the rebellion.
NO – Did the general meet with the queen? / Did the general meet with the king?

(44)
The mom that punished the son prevented him from attending parties over the weekend.
The mom that punished the daughter prevented him from attending parties over the weekend.
The mom that punished the daughter prevented her from attending parties over the weekend.
The mom that punished the son prevented her from attending parties over the weekend.
YES – Did the mom punish the son? / Did the mom punish the daughter?

(45)
The king that argued with the lady threatened her during a meeting with all the royalty.
The king that argued with the lord threatened her during a meeting with all the royalty.
The king that argued with the lord threatened him during a meeting with all the royalty.
The king that argued with the lady threatened him during a meeting with all the royalty.
NO – Did the prince argue with the lady? / Did the prince argue with the lord?

(46)
The niece that respected the uncle trusted him to keep secrets about the family business.
The niece that respected the aunt trusted him to keep secrets about the family business.
The niece that respected the aunt trusted her to keep secrets about the family business.
The niece that respected the uncle trusted her to keep secrets about the family business.
YES – Did the niece know secrets about the family business?

(47)
The man that irritated the maid confronted her after not receiving a drink at the party.
The man that irritated the butler confronted her after not receiving a drink at the party.
The man that irritated the butler confronted him after not receiving a drink at the party.
The man that irritated the maid confronted him after not receiving a drink at the party.
NO – Did the man receive a drink at the party?

(48)
The grandmother that consoled the grandson made him a large meal after the terrible day.
The grandmother that consoled the granddaughter made him a large meal after the terrible day.
The grandmother that consoled the granddaughter made her a large meal after the terrible day.
The grandmother that consoled the grandson made her a large meal after the terrible day.
YES – Did the grandmother make a large meal?

APPENDIX B. LIST OF ITEMS FOR EXPERIMENT 2

All items are presented in the following order:

(a) main clause mismatch / embedded clause match – grammatical
(b) main clause mismatch / embedded clause mismatch – ungrammatical
(c) main clause match / embedded clause match – grammatical
(d) main clause match / embedded clause mismatch – ungrammatical

(1)
The congresswoman that hired the waiter praised him for the success of the event.
YES -Did the congresswoman hire the waiter?
The congresswoman that hired the waitresses praised him for the success of the event.
YES -Did the congresswoman hire the waitresses?
The congresswoman that hired the waitress praised her for the success of the event.
YES -Did the congresswoman hire the waitress?
The congresswoman that hired the waiters praised her for the success of the event.
YES -Did the congresswoman hire the waiters?

(2)
The councilman that talked to the spokeswoman congratulated her on the success of the fundraiser.
The councilman that talked to the spokesmen congratulated her on the success of the fundraiser.
The councilman that talked to the spokesman congratulated him on the success of the fundraiser.
The councilman that talked to the spokeswomen congratulated him on the success of the fundraiser.
YES – Was the fundraiser successful?

(3)
The woman that managed the actor criticized him for the failure of the movie.
The woman that managed the actresses criticized him for the failure of the movie.
The woman that managed the actress criticized her for the failure of the movie.
The woman that managed the actors criticized her for the failure of the movie.
NO – Was the movie successful?

(4)
The monk that pitied the woman hid her from the agents of the secret police.
NO -Was the monk cruel to the woman?
The monk that pitied the men hid her from the agents of the secret police.
NO -Was the monk cruel to the men?
The monk that pitied the man hid him from the agents of the secret police.
NO -Was the monk cruel to the man?
The monk that pitied the women hid him from the agents of the secret police.
NO -Was the monk cruel to the women?

(5)
The saleswoman that spoke to the policeman deceived him about the extent of the illegal activity.
YES -Did the saleswoman speak to the policeman?
The saleswoman that spoke to the policewomen deceived him about the extent of the illegal activity.
YES -Did the saleswoman speak to the policewomen?
The saleswoman that spoke to the policewoman deceived her about the extent of the illegal activity.
YES -Did the saleswoman speak to the policewoman?
The saleswoman that spoke to the policemen deceived her about the extent of the illegal activity.
YES -Did the saleswoman speak to the policemen?

(6)
The schoolboy that annoyed the waitress embarrassed her at the restaurant in front of the customers.
NO -Did the waitress like the schoolboy?
The schoolboy that annoyed the waiters embarrassed her at the restaurant in front of the customers.
NO -Did the waiters like the schoolboy?
The schoolboy that annoyed the waiter embarrassed him at the restaurant in front of the customers.
NO -Did the waiter like the schoolboy?
The schoolboy that annoyed the waitresses embarrassed him at the restaurant in front of the customers.
NO -Did the waitresses like the schoolboy?

(7)
The stewardess that scolded the man blamed him for the accident during the emergency landing.
The stewardess that scolded the women blamed him for the accident during the emergency landing.
The stewardess that scolded the woman blamed her for the accident during the emergency landing.
The stewardess that scolded the men blamed her for the accident during the emergency landing.
YES – Did an accident occur during the emergency landing?

(8)
The father that met the bridesmaid familiarized her with every detail of the wedding plans.
The father that met the groomsmen familiarized her with every detail of the wedding plans.
The father that met the groomsman familiarized him with every detail of the wedding plans.
The father that met the bridesmaids familiarized him with every detail of the wedding plans.
NO – Did the mother know every detail of the wedding plans?

(9)
The actress that hired the businessman introduced him to the director of the new spy film.
The actress that hired the businesswomen introduced him to the director of the new spy film.

The actress that hired the businesswoman introduced her to the director of the new spy film.
The actress that hired the businessmen introduced her to the director of the new spy film.
YES – Did the actress know the director of the spy film?

(10)
The older brother that partied with the bachelorette mocked her for singing karaoke at the bar.
NO -Did the younger brother party with the bachelorette?
The older brother that partied with the bachelors mocked her for singing karaoke at the bar.
NO -Did the younger brother party with the bachelors?
The older brother that partied with the bachelor mocked him for singing karaoke at the bar.
NO -Did the younger brother party with the bachelor?
The older brother that partied with the bachelorettes mocked him for singing karaoke at the bar.
NO -Did the younger brother party with the bachelorettes?

(11)
The older sister that mentored the boy scout prepared him for the trip to the wilderness.
YES -Did the older sister mentor the boy scout?
The older sister that mentored the girl scouts prepared him for the trip to the wilderness.
YES -Did the older sister mentor the girl scouts?
The older sister that mentored the girl scout prepared her for the trip to the wilderness.
YES -Did the older sister mentor the girl scout?
The older sister that mentored the boy scouts prepared her for the trip to the wilderness.
YES -Did the older sister mentor the boy scouts?

(12)
The king that shunned the witch blamed her when the curse was unleashed on the castle.
The king that shunned the wizards blamed her when the curse was unleashed on the castle.
The king that shunned the wizard blamed him when the curse was unleashed on the castle.
The king that shunned the witches blamed him when the curse was unleashed on the castle.
NO – Was the curse unleashed on the village?

(13)
The councilman that admired the girl scout nominated her for the award for community service.
NO -Did the councilman dislike the girl scout?
The councilman that admired the boy scouts nominated her for the award for community service.
NO -Did the councilman dislike the boy scouts?
The councilman that admired the boy scout nominated him for the award for community service.
NO -Did the councilman dislike the boy scout?
The councilman that admired the girl scouts nominated him for the award for community service.
NO -Did the councilman dislike the girl scouts?

(14)
The spokeswoman that represented the congressman protected him despite the pressure to expose corrupt politicians.

The spokeswoman that represented the congresswomen protected him despite the pressure to expose corrupt politicians.
The spokeswoman that represented the congresswoman protected her despite the pressure to expose corrupt politicians.
The spokeswoman that represented the congressmen protected her despite the pressure to expose corrupt politicians.
YES – Was there pressure to expose corrupt politicians?

(15)
The emperor that praised the witch congratulated her on having saved so many lives.
NO -Did the emperor despise the witch?
The emperor that praised the wizards congratulated her on having saved so many lives.
NO -Did the emperor despise the wizards?
The emperor that praised the wizard congratulated him on having saved so many lives.
NO -Did the emperor despise the wizard?
The emperor that praised the witches congratulated him on having saved so many lives.
NO -Did the emperor despise the witches?

(16)
The bride that consulted with the groomsman considered him to be important to the wedding's success.
YES -Did the bride consult the groomsman?
The bride that consulted with the bridesmaids considered him to be important to the wedding's success.
YES -Did the bride consult the bridesmaids?
The bride that consulted with the bridesmaid considered her to be important to the wedding's success.
YES -Did the bride consult the bridesmaid?
The bride that consulted with the groomsmen considered her to be important to the wedding's success.
YES -Did the bride consult the groomsmen?

(17)
The duke that distrusted the nun criticized her during private meetings with church officials.
The duke that distrusted the priests criticized her during private meetings with church officials.
The duke that distrusted the priest criticized him during private meetings with church officials.
The duke that distrusted the nuns criticized him during private meetings with church officials.
NO – Did the duke meet with government officials?

(18)
The princess that sang to the king entertained him with lively songs at the feast.
YES -Did the princess sing to the king?
The princess that sang to the queens entertained him with lively songs at the feast.
YES -Did the princess sing to the queens?
The princess that sang to the queen entertained her with lively songs at the feast.
YES -Did the princess sing to the queen?

The princess that sang to the kings entertained her with lively songs at the feast.
YES -Did the princess sing to the kings?

(19)
The wizard that cursed the princess poisoned her on the night of the full moon.
NO -Did the witch curse the princess?
The wizard that cursed the princes poisoned her on the night of the full moon.
NO -Did the witch curse the princes?
The wizard that cursed the prince poisoned him on the night of the full moon.
NO -Did the witch curse the prince?
The wizard that cursed the princesses poisoned him on the night of the full moon.
NO -Did the witch curse the princesses?

(20)
The bachelorette that spoke to the waiter emailed him with more details about the party.
The bachelorette that spoke to the waitresses emailed him with more details about the party.
The bachelorette that spoke to the waitress emailed her with more details about the party.
The bachelorette that spoke to the waiters emailed her with more details about the party.
YES – Did the bachelorette provide details about the party?

(21)
The grandfather that visited the granddaughter took her to a festival over the weekend.
The grandfather that visited the grandsons took her to a festival over the weekend.
The grandfather that visited the grandson took him to a festival over the weekend.
The grandfather that visited the granddaughters took him to a festival over the weekend.
NO – Did the grandfather attend a concert over the weekend?

(22)
The waitress that served the old man thanked him for being patient during the busy lunch hour.
The waitress that served the old women thanked him for being patient during the busy lunch hour.
The waitress that served the old woman thanked her for being patient during the busy lunch hour.
The waitress that served the old men thanked her for being patient during the busy lunch hour.
YES – Did the waitress work during lunch hour?

(23)
The gentleman that disagreed with the duchess confronted her after being removed from the king's council.
The gentleman that disagreed with the dukes confronted her after being removed from the king's council.
The gentleman that disagreed with the duke confronted him after being removed from the king's council.
The gentleman that disagreed with the duchesses confronted him after being removed from the king's council.
NO – Was the gentleman asked to stay on the king's council?

(24)
The girl that disrespected the priest mocked him during the ritual for the forest gods.
YES -Did the girl disrespect the priest?
The girl that disrespected the priestesses mocked him during the ritual for the forest gods.
YES -Did the girl disrespect the priestesses?
The girl that disrespected the priestess mocked her during the ritual for the forest gods.
YES -Did the girl disrespect the priestess?
The girl that disrespected the priests mocked her during the ritual for the forest gods.
YES -Did the girl disrespect the priests?

(25)
The wizard that cursed the young woman changed her into a frog in front of everyone.
YES -Did the wizard curse the woman?
The wizard that cursed the young men changed her into a frog in front of everyone.
YES -Did the wizard curse the men?
The wizard that cursed the young man changed him into a frog in front of everyone.
YES -Did the wizard curse the man?
The wizard that cursed the young women changed him into a frog in front of everyone.
YES -Did the wizard curse the women?

(26)
The aunt that spoiled the nephew bought him a large popcorn and candy at the movies.
The aunt that spoiled the nieces bought him a large popcorn and candy at the movies.
The aunt that spoiled the niece bought her a large popcorn and candy at the movies.
The aunt that spoiled the nephews bought her a large popcorn and candy at the movies.
YES – Did the aunt buy popcorn and candy?

(27)
The policeman that investigated the congresswoman identified her as a suspect in the fraud case.
The policeman that investigated the congressmen identified her as a suspect in the fraud case.
The policeman that investigated the congressman identified him as a suspect in the fraud case.
The policeman that investigated the congresswomen identified him as a suspect in the fraud case.
NO – Did the policeman investigate a murder?

(28)
The woman that met the boy scout paid him for the items purchased at the fundraiser.
The woman that met the girl scouts paid him for the items purchased at the fundraiser.
The woman that met the girl scout paid her for the items purchased at the fundraiser.
The woman that met the boy scouts paid her for the items purchased at the fundraiser.
NO – Did the woman forget to pay for the items?

(29)
The monk that respected the princess defended her despite the criticism from the press.
NO -Did the monk disapprove of the princess?
The monk that respected the princes defended her despite the criticism from the press.
NO -Did the monk disapprove of the princes?

The monk that respected the prince defended him despite the criticism from the press.
NO -Did the monk disapprove of the prince?
The monk that respected the princesses defended him despite the criticism from the press.
NO -Did the monk disapprove of the princesses?

(30)
The sorceress that disapproved of the king threatened him after the announcement of the unjust law.
The sorceress that disapproved of the queens threatened him after the announcement of the unjust law.
The sorceress that disapproved of the queen threatened her after the announcement of the unjust law.
The sorceress that disapproved of the kings threatened her after the announcement of the unjust law.
YES – Was the law unfair?

(31)
The king that trusted the duchess ordered her to visit areas of the kingdom suffering from famine.
The king that trusted the dukes ordered her to visit areas of the kingdom suffering from famine.
The king that trusted the duke ordered him to visit areas of the kingdom suffering from famine.
The king that trusted the duchesses ordered him to visit areas of the kingdom suffering from famine.
NO – Was the kingdom suffering from a drought?

(32)
The grandmother that criticized the little boy asked him to help out around the house.
YES -Did the grandmother criticize the little boy?
The grandmother that criticized the little girls asked him to help out around the house.
YES -Did the grandmother criticize the little girls?
The grandmother that criticized the little girl asked her to help out around the house.
YES -Did the grandmother criticize the little girl?
The grandmother that criticized the little boys asked her to help out around the house.
YES -Did the grandmother criticize the little boys?

(33)
The father that supported the actress watched her in several performances of the show.
NO -Did the father disapprove of the actress?
The father that supported the actors watched her in several performances of the show.
NO -Did the father disapprove of the actors?
The father that supported the actor watched him in several performances of the show.
NO -Did the father disapprove of the actor?
The father that supported the actresses watched him in several performances of the show.
NO -Did the father disapprove of the actresses?

(34)
The mother that visited the son asked him for a tour around the university campus.
The mother that visited the daughters asked him for a tour around the university campus.
The mother that visited the daughter asked her for a tour around the university campus.
The mother that visited the sons asked her for a tour around the university campus.
YES – Did the mother want a tour of the campus?

(35)
The schoolboy that bullied the little girl pushed her onto the ground and walked away.
NO -Was the schoolboy kind to the little girl?
The schoolboy that bullied the little boys pushed her onto the ground and walked away.
NO -Was the schoolboy kind to the little boys?
The schoolboy that bullied the little boy pushed him onto the ground and walked away.
NO -Was the schoolboy kind to the little boy?
The schoolboy that bullied the little girls pushed him onto the ground and walked away.
NO -Was the schoolboy kind to the little girls?

(36)
The policewoman that questioned the father told him to report everything about the incident.
YES -Did the policewoman question the father?
The policewoman that questioned the mothers told him to report everything about the incident.
YES -Did the policewoman question the mothers?
The policewoman that questioned the mother told her to report everything about the incident.
YES -Did the policewoman question the mother?
The policewoman that questioned the fathers told her to report everything about the incident.
YES -Did the policewoman question the fathers?

(37)
The priest that counseled the duchess advised her to study law at the university.
The priest that counseled the dukes advised her to study law at the university.
The priest that counseled the duke advised him to study law at the university.
The priest that counseled the duchesses advised him to study law at the university.
NO – Did the priest recommend studying finance at the university?

(38)
The stewardess that confronted the businessman asked him to exit immediately from the plane.
YES -Did the stewardess confront the businessman?
The stewardess that confronted the businesswomen asked him to exit immediately from the plane.
YES -Did the stewardess confront the businesswomen?
The stewardess that confronted the businesswoman asked her to exit immediately from the plane.
YES -Did the stewardess confront the businesswoman?
The stewardess that confronted the businessmen asked her to exit immediately from the plane.
YES -Did the stewardess confront the businessmen?

(39)
The grandfather that cared for the granddaughter taught her how to ride a bicycle one afternoon.
NO -Did the grandmother take care of the granddaughter?
The grandfather that cared for the grandsons taught her how to ride a bicycle one afternoon.
NO -Did the grandmother take care of the grandsons?
The grandfather that cared for the grandson taught him how to ride a bicycle one afternoon.
NO -Did the grandmother take care of the grandson?
The grandfather that cared for the granddaughters taught him how to ride a bicycle one afternoon.
NO -Did the grandmother take care of the granddaughters?

(40)
The woman that spoke to the councilman assured him that the campaign would be successful.
The woman that spoke to the councilwomen assured him that the campaign would be successful.
The woman that spoke to the councilwoman assured her that the campaign would be successful.
The woman that spoke to the councilmen assured her that the campaign would be successful.
YES – Did the woman think that the campaign would be successful?

(41)
The boy scout that spoke with the old woman asked her to recommend places to visit in the area.
The boy scout that spoke with the old men asked her to recommend places to visit in the area.
The boy scout that spoke with the old man asked him to recommend places to visit in the area.
The boy scout that spoke with the old women asked him to recommend places to visit in the area.
NO – Did the boy scout ask about the history of the area?

(42)
The nun that annoyed the schoolboy scolded him for behaving badly every day during class.
YES -Did the nun annoy the schoolboy?
The nun that annoyed the schoolgirls scolded him for behaving badly every day during class.
YES -Did the nun annoy the schoolgirls?
The nun that annoyed the schoolgirl scolded her for behaving badly every day during class.
YES -Did the nun annoy the schoolgirl?
The nun that annoyed the schoolboys scolded her for behaving badly every day during class.
YES -Did the nun annoy the schoolboys?

(43)
The emperor that met with the queen informed her of the plans to crush the rebellion.
NO -Did the general meet with the queen?
The emperor that met with the kings informed her of the plans to crush the rebellion.
NO -Did the general meet with the kings?
The emperor that met with the king informed him of the plans to crush the rebellion.
NO -Did the general meet with the king?
The emperor that met with the queens informed him of the plans to crush the rebellion.
NO -Did the general meet with the queens?

(44)
The mom that punished the son prevented him from attending parties over the weekend.
YES -Did the mom punish the son?
The mom that punished the daughters prevented him from attending parties over the weekend.
YES -Did the mom punish the daughters?
The mom that punished the daughter prevented her from attending parties over the weekend.
YES -Did the mom punish the daughter?
The mom that punished the sons prevented her from attending parties over the weekend.
YES -Did the mom punish the sons?

(45)
The king that argued with the lady threatened her during a meeting with all the royalty.
NO -Did the prince argue with the lady?
The king that argued with the lords threatened her during a meeting with all the royalty.
NO -Did the prince argue with the lords?
The king that argued with the lord threatened him during a meeting with all the royalty.
NO -Did the prince argue with the lord?
The king that argued with the ladies threatened him during a meeting with all the royalty.
NO -Did the prince argue with the ladies?

(46)
The niece that respected the uncle trusted him to keep secrets about the family business.
The niece that respected the aunts trusted him to keep secrets about the family business.
The niece that respected the aunt trusted her to keep secrets about the family business.
The niece that respected the uncles trusted her to keep secrets about the family business.
YES – Did the niece know secrets about the family business?

(47)
The man that irritated the maid confronted her after not receiving a drink at the party.
The man that irritated the butlers confronted her after not receiving a drink at the party.
The man that irritated the butler confronted him after not receiving a drink at the party.
The man that irritated the maids confronted him after not receiving a drink at the party.
NO – Did the man receive a drink at the party?

(48)
The grandmother that consoled the grandson made him a large meal after the terrible day.
The grandmother that consoled the granddaughters made him a large meal after the terrible day.
The grandmother that consoled the granddaughter made her a large meal after the terrible day.
The grandmother that consoled the grandsons made her a large meal after the terrible day.
YES – Did the grandmother make a large meal?

Appendix C

PRACTICE ITEMS

(1) The tourist that angrily insulted the merchant tossed the money onto the counter.
YES – Did the tourist insult the merchant?

(2) The fireman that rescued the policemen visited them in the hospital afterwards.
NO – Did the fireman rescue the policewomen?

(3) The secretary that worked for the businessman asked him for advice about finances.
NO – Did the secretary ask for marriage advice?

(4) The singer that advised the actress recommended hiring a new agent.
NO – Did the writer recommend hiring a new agent?

(5) The soccer player that accidentally kicked the teammate apologized repeatedly after the game.
YES – Did the soccer player apologize after the game?

(6) The mother that adored the daughter bought her several presents for her birthday.
YES – Did the mother buy presents for the daughter?

FILLER ITEMS

(1) The poet that published a new book worked closely with the editor.
NO – Did the poet work with the cover artist?

(2) The lecturer that taught in the mathematics department skipped the graduation ceremony.
NO – Did the lecturer teach biology?

(3) The activist that admired the union workers edited the article about the strike for better wages.
YES – Did the activist edit an article about the strike?

(4) The painter that created dramatic portraits designed the artwork for a special exhibition.
NO – Did the sculptor design the artwork?

(5) The student that received a scholarship from the university was very pleased with the amount of money.
YES – Did the student receive a scholarship?

(6) The sculpture that was studied by the historian was relatively unknown.
NO – Was the sculpture studied by an archeologist?

(7) The essay that was graded by the professor was very lengthy and hard to understand.
YES – Was the essay very long?

(8) The fireman that rescued the cat from the tree was well–liked by the town's citizens.
YES – Did the citizens like the fireman?

(9) The butler that admired the housekeeper carefully set the table for dinner.
NO – Did the butler dislike the housekeeper?

(10) The woman that tripped on the sidewalk was badly injured and was rushed to the hospital.
YES – Did the woman go to the hospital?

(11) The soldier that was very drunk smashed a bottle against the bar during the fight with his friend.
NO – Was the soldier sober at the bar?

(12) The carpenter that advised the electrician finished building the house on time.
YES – Did the carpenter finish the house on time?

(13) The teacher that taught first grade often stayed late to prepare for the next day's lessons.
NO – Did the teacher often leave work early?

(14) The cheerleader that went to summer camp broke her ankle when doing a triple somersault.
YES – Did the cheerleader go to summer camp?

(15) The painting that the library commissioned was hung in the entryway.
YES – Was the painting hung in the entryway?

(16) The computer that the technician fixed was in good condition after the malware was removed.
YES – Did the technician fix the computer?

(17) The comedian that the media criticized canceled the upcoming shows for the next two months.
NO – Did the media criticize the actor?

(18) The historian that the university praised attended several conferences about the eighteenth century.
YES – Did the historian attend conferences about the eighteenth century?

(19) The coffee that the professor drank was imported from a small town in Brazil.
NO – Was the coffee imported from Chile?

(20) The restaurant that the family loved went out of business after twenty years.
NO – Did the family dislike the restaurant?

(21) The guitar that the musician often used was damaged before the show by a careless roadie.
YES – Did a roadie damage the guitar?

(22) The maid that the employer respected was given a raise because of her good work ethic.
NO – Was the maid demoted at her job?

(23) The king that the country hated passed several unjust laws that the citizens disliked.
NO – Did the country love their king?

(24) The cameraman that the director admired filmed footage for the documentary.
YES – Did the cameraman shoot footage for the documentary?

(25) The waiter that the manager disliked was fired last weekend for being consistently late.
NO – Was the waiter always on time?

(26) The secretary that the manager hired loved the new job because of its flexibility.
YES – Did the manager hire the secretary?

(27) The architect that the company promoted moved to a large city where there were more work opportunities.
YES – Did the company promote the architect?

(28) The football player that the college recruited trained every day to be ready to play on the team.
NO – Did the basketball player train every day?

(29) The groundskeeper knew that his brother hunted on the weekend with his friend while on vacation.
NO – Did the groundskeeper's brother ski on vacation?

(30) The manager was pleased that the janitor vacuumed the reception area at the hotel every evening.
YES – Did the janitor vacuum at the hotel?

(31) The musician said that the dancer practiced in the studio before the recital.
NO – Did the dancer practice at the theater?

(32) The pianist mentioned that the violinist rehearsed every day with the conductor in the music hall.
NO – Did the violinist rehearse with the pianist?

(33) The butler reported that the maid swept behind the stove during the meeting with the homeowner.
YES – Did the maid sweep behind the stove?

(34) The boy noticed that the farmer mowed the field with his son over the summer.
YES – Did the farmer mow the field?

(35) The secretary noted that the writer drank at the pub with the director to pitch his script.
NO – Did the writer drink with the editor?

(36) The cheerleader remembered that the band played several popular songs during the football game.
YES – Did the band play popular songs?

(37) The tourist that visited the monuments photographed them from several different angles.
YES – Did the tourist take pictures of the monuments?

(38) The architect that designed the skyscrapers toured them after construction was completed.
NO – Did the architect design the houses?

(39) The chef that ordered the sirloin steaks grilled them to perfection at the party.
YES – Did the chef grill steak?

(40) The trainer that envied the gymnasts trained them every day at the gym.
NO – Did the trainer work with the wrestlers?

(41) The mother that loved the roses in the garden watered them early in the morning.
YES – Did the mother love the roses?

(42) The father that rode with the teenagers told them to wait in the car while he bought gas.
NO – Did the aunt ride with the teenagers?

(43) The maid that gathered the dirty shirts washed them along with the towels.
YES – Did the maid wash the shirts?

(44) The hairdresser that owned several salons visited all of them during a general inspection.
NO – Did the manicurist own the salons?

(45) The general that met with the soldiers ordered them to stay at the military base.
YES – Did the general meet with the soldiers?

(46) The writer that several editors recommended thanked them after getting hired full–time.
NO – Was the designer hired full–time?

(47) The singer that the fans cheered for gave them autographed photos after the show.
YES – Did the fans cheer for the singer?

(48) The engineer that the managers interviewed thanked them for their interest and time.
NO – Did the managers interview the interior designer?

(49) The dentist that the patients liked advised them to floss every night.
YES – Did the patients like the dentist?

(50) The actress that the charities contacted supported them with large donations each month.
YES – Did the charities contact the actress?

(51) The businessman that the couple consulted called them often with advice.
NO – Did the lawyer consult the couple?

(52) The librarian that the children adored organized a summer reading program for them every year.
YES – Did the librarian organize a reading program?

(53) The judge that the lawyers met scolded them for disrespectful behavior in the courtroom.
NO – Were the lawyers praised for their behavior?

(54) The coach that the students admired greeted them at the main entrance every day.
YES – Did the coach greet the students?

(55) The editors said that the author ate at the diner with them to discuss the new book.
YES – Did the author eat at the diner?

(56) The guitarists recounted that the drummer kept time with them very well during the concert.
YES – Did the drummer keep time well?

(57) The women recalled that the guide climbed down the ravine with them on the hike.
NO – Did the guide lead the women down the river?

(58) The nephews remembered that the uncle bought them several books for Christmas.
YES – Did the uncle buy books for the nephews?

(59) The pirates said that the thief stole supplies from them when the ship was docked.
NO – Did the thief steal treasure from the pirates?

(60) The teachers revealed that the principal smoked in the cafeteria with them last night.
NO – Did the principal smoke in the gymnasium?

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