Reflexive attraction in comprehension is selective

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Abstract

Many studies have shown that attraction effects are consistently found for linguistic dependencies like subject-verb agreement, e.g., *The key to the cabinets are on the table. However, not all dependencies are equally susceptible to attraction. A parade case involves reflexive-antecedent dependencies, which rarely show attraction effects. The contrast between agreement and reflexives with respect to attraction has motivated various proposals regarding the memory architecture for the parser, including the use of qualitatively different access mechanisms or the selective use of morphological features as retrieval cues for different dependencies. In this paper, we show how to systematically induce attraction effects for reflexives in three eye-tracking experiments. Furthermore, we show based on computational simulations that it is possible to derive both the presence and absence of reflexive attraction from the same retrieval mechanism, based on the ACT-R architecture. We then propose an account of why agreement and reflexives are differentially susceptible to attraction, based on the predictability of the dependency.
**Introduction**

The task of building a sentence structure requires mechanisms for encoding a structured representation in memory and accessing specific elements of that representation to guide further elaboration. The effects of grammatically irrelevant items on real-time sentence comprehension have proven to be a useful tool for understanding these mechanisms. For instance, in order to determine whether the reflexive anaphor *themselves* in (1) is appropriately licensed, memory access mechanisms must recover the encoding of the subject noun *executive*, while avoiding interference from grammatically irrelevant items that match the agreement features of the reflexive, such as the embedded plural noun *managers*.

(1) *The executive who oversaw the managers doubted themselves on most decisions.*

Previous research has shown that grammatically irrelevant items rarely interfere during reflexive licensing (e.g., Clifton, Frazier, & Deevy, 1999; Cunnings & Sturt, 2014; Dillon, Mishler, Sloggett, & Phillips, 2013; Nicol & Swinney, 1989; Sturt, 2003; Xiang Dillon, & Phillips, 2009; but cf. Cunnings & Felser, 2013; Patil, Vasishth, & Lewis, 2016). However, retrieval processes do not always avoid grammatically irrelevant items. For instance, Dillon and colleagues found that retrieval for subject-verb agreement licensing in closely matched sentences like (2) is susceptible to interference (‘attraction’) from the irrelevant plural noun *managers*, giving rise to an ‘illusion of acceptability’ (Dillon et al., 2013; see also Clifton et al., 1999; Patson & Husband, 2015; Pearlmutter, Garnsey, & Bock, 1999; Phillips, Wagers, & Lau, 2011; Tanner, Nicol, & Brehm, 2014; Tucker, Idrissi, & Almedia, 2015; Wagers, Lau, & Phillips, 2009).

(2) *The executive who oversaw the managers were dishonest.*

The contrast between agreement and reflexive licensing with respect to attraction is striking, since retrieval in both cases targets the same structural position, i.e., the subject of the current clause. The reasons for this contrast remain unresolved, and we attempt to address this puzzle in the current study.

*Interference effects in comprehension*
Research on memory access in sentence comprehension has identified two distinct types of interference. The first type is referred to as ‘inhibitory interference’, and manifests as increased processing difficulty during dependency formation. For example, Gordon and colleagues tested sentences like those in (3) using self-paced reading and observed processing difficulty reflected in longer reading times at the verb praised in (3a) relative to (3b) (Gordon, Hendrick, & Johnson, 2001). They interpreted this effect as a case of inhibitory interference, where the similarity between the two subject noun phrases (NPs) the banker and the barber, e.g., both are definite noun phrases, made it relatively difficult for comprehenders to retrieve the target subject the barber during subject-verb binding. Similar effects have been observed across a number of other studies (e.g., Fedorenko, Babyonyshev, & Gibson, 2004; Gordon, Hendrick, & Johnson, 2004, 2006; Van Dyke & Lewis, 2003; Van Dyke, 2006; Van Dyke, 2007).

(3)  a. The banker that the barber praised climbed the mountain.
    b. The banker that Ben praised climbed the mountain.

The second type of interference is known as ‘attraction’ (also called ‘intrusion’ or ‘facilitatory interference’), and manifests as eased processing and increased acceptability during dependency formation, relative to sentences that should be equally acceptable or unacceptable. Comprehenders frequently experience attraction during subject-verb agreement licensing. For instance, Wagers and colleagues used self-paced reading and speeded-acceptability judgments to examine the processing of grammatical and ungrammatical dependencies of the form in (4).

(4)  a. The key to the cabinet(s) unsurprisingly was rusty …
    b. *The key to the cabinet(s) unsurprisingly were rusty …

Wagers and colleagues found that in grammatical sentences like (4a), the number marking on the plural distractor cabinet(s) did not impact acceptability judgments or reading times after the verb. However, in ungrammatical sentences like (4b), the presence of the plural distractor cabinets, which matched the number of the verb were, increased rates of acceptance and facilitated reading times after the verb, relative to an ungrammatical condition with the singular cabinet.
Wagers and colleagues argued that the facilitation observed in sentences like (4b) was due to incorrect retrieval of the plural distractor, e.g., *cabinets*, on some portion of trials, due to a match with the plural retrieval cue at the verb. They argued that the contrast between grammatical and ungrammatical sentences with respect to attraction is expected if subject-verb agreement is resolved using a cue-based retrieval mechanism in a content-addressable memory architecture.

Attraction effects are not limited to subject-verb agreement. Attraction effects have also been reported for negative polarity item (NPI) licensing and null subject licensing (e.g., Drenhaus, Saddy, & Frisch, 2005; Parker, Lago, & Phillips, 2015; Vasishth, Brüssow, & Lewis, 2008; Xiang et al., 2009). Across most of these studies, the facilitation effects were interpreted as the behavioral signature of retrieving an incorrect item in memory.\(^1\)

Inhibitory interference and attraction have different behavioral signatures and license different conclusions about memory access in sentence comprehension. Inhibitory interference occurs in multiple match contexts, where the target and distractor both match some of the retrieval cues. Inhibitory interference could reflect a number of different underlying mechanisms, such as feature-overwriting during encoding (Nairne, 1998, 1990) or the use of degraded cues in retrieval (Anderson, 1974). By contrast, attraction arises when the target and distractor are distinct in feature content, but neither is a perfect match to the retrieval cues. In cases of attraction, retrieval of a partially matched distractor can ease processing of an unlicensed dependency by preventing a total retrieval failure. Unlike inhibitory interference, attraction has been interpreted as clear evidence for the retrieval of irrelevant items during dependency formation (see Dillon 2014, for discussion).

*Contrasting attraction profiles*

Attraction effects are consistently found for subject-verb agreement, but not for reflexive licensing. The contrast between agreement and reflexives with respect to attraction is evident in a recent study by Dillon et al. (2013). Dillon and colleagues used eye-tracking while reading to compare subject-verb agreement and reflexive licensing in closely matched sentences like (5), where the auxiliary verb in (5a) and the reflexive in (5b) must agree in number with the same subject, i.e., *the new executive*.

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\(^1\) Xiang et al. (2009) argued that the facilitation effect observed for NPI licensing does not reflect misretrieval, but rather over-application of the pragmatic licensing mechanisms that are responsible for normal NPI licensing.
The new executive who oversaw the middle manager(s) apparently was *were dishonest about the company’s profits.

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

Dillon and colleagues found that the processing of the ungrammatical plural verb *were in (5a) was susceptible to attraction from the plural distractor *managers, but that the processing of the ungrammatical plural reflexive *themselves in (5b) was not. In the reflexive conditions, comprehenders were sensitive only to the number (mis)match between the reflexive and the target subject the new executive.

The lack of attraction effects for reflexives is consistent across experimental measures and structural configurations. It has been replicated using eye-tracking while reading (Cunnings & Sturt, 2014) and event-related potentials (ERPs) (Xiang et al., 2009). In an early study on reflexive processing, Sturt (2003) found no attraction effects in contexts involving gender agreement. In two eye-tracking experiments, Sturt manipulated the (stereotypical) gender match between two potential licensors and the reflexive in configurations where the distractor appeared before the target subject (Experiment 1) or after (Experiment 2). Across both configurations and most measures, comprehenders showed sensitivity only to the gender (mis)match of the target subject. A small number of studies are reported to have shown interference in reflexive processing (e.g., Cunnings & Felser, 2013; Patil et al., 2016). But the effects reported in those studies are smaller and less consistent than the effects reported for agreement, and some are inhibitory interference effects, which may have a different source.

The contrasting attraction profiles for agreement and reflexives have important consequences for theories of cue-based memory retrieval. A major question for cue-based parsing models concerns how grammatical constraints relate to retrieval cues. In English, agreement and reflexive-antecedent dependencies both require morphological feature concord between elements in the dependency, so the use of morphological features as retrieval cues is motivated. If there is a

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2 The only exception to this pattern was observed in second-pass reading times, where the presence of a gender-matched distractor led to faster reading times at the reflexive, but only in grammatical conditions. However, the direction of the effect was reversed in Experiment 2.
transparent mapping from grammatical constraints to retrieval cues, then agreement and reflexives should deploy morphological features as retrieval cues in the same fashion. However, the contrasting retrieval profiles for reflexives and agreement imply that morphological features play different roles in retrieval for the two dependencies and that there is not a uniform mapping from grammatical constraints to retrieval cues.

One possibility suggested by Dillon and colleagues is that agreement and reflexives use distinct sets of retrieval cues to access a licensor (Dillon et al., 2013). For example, reflexive licensing might engage the same retrieval mechanism as agreement, but might deploy only structural retrieval cues, implementing morphological constraints only as a post-retrieval check. Another option suggested by Cunnings and Sturt is that retrieval for reflexive licensing deploys both structural and morphological cues during retrieval, but preferentially weights structural cues over morphological cues (Cunnings & Sturt, 2014). A third option is that agreement and reflexives could engage qualitatively different retrieval mechanisms: whereas agreement might engage a cue-based mechanism that deploys a combination of structural and non-structural cues, reflexives might engage a serial structure-guided search that exploits local structural relations to distinguish relevant from irrelevant licensors (see Dillon, in press).

Existing accounts differ in how they use morphological cues in retrieval, but they agree that structural information is prioritized over morphological information during retrieval for reflexive licensing, but not for agreement licensing. This conclusion is non-trivial, as it casts doubt upon the general assumption that all linguistic dependencies are uniformly resolved using a single, error-prone retrieval mechanism that deploys a combination of structural and non-structural retrieval cues to target specific items in content-addressable memory, as suggested in previous research (e.g., Martin & McElree, 2008; McElree, 2000; McElree, Foraker, & Dyer, 2003; Lewis & Vasishth, 2005; Lewis, Vasishth, & Van Dyke, 2006; Van Dyke & McElree, 2011; for a review, see McElree 2006). If the retrieval cues used to resolve different linguistic dependencies are not straightforwardly predictable from the well-formedness constraints on those dependencies, then it raises the question of how learners might converge on the retrieval strategies to deploy for each dependency.

Revisiting previous conclusions about attraction
There are two reasons to revisit previous conclusions about the contrasting attraction profiles for reflexives and agreement. The first reason is based on recent findings showing that a related class of anaphoric dependencies is susceptible to attraction. Parker and colleagues recently found that emphatic reflexives in adjunct control sentences like (6) are susceptible to attraction, but only selectively (Parker et al., 2015). In (6), the reflexive *himself* must take the higher subject {*the doctor / discovery*} as its antecedent.

(6) *The {doctor / discovery} that the researcher described was certified after debunking the myth himself.*

Results from Experiment 2 of the study showed a clear attraction effect at the reflexive when the target subject mismatched the reflexive in gender and animacy, e.g., *discovery*. However, in Experiment 3, the attraction effect disappeared when the reflexive and target subject mismatched only in gender, e.g., *nurse … himself*, replicating previous findings (e.g., Cunnings & Sturt, 2014; Sturt, 2003; Dillon et al., 2013).

Parker and colleagues suggested that this contrast might reflect the degree of feature match between the target subject and the reflexive, i.e., 2-feature mismatch in Experiment 2 vs. 1-feature mismatch in Experiment 3. However, the authors did not explicitly test this hypothesis, and it is unclear how representative these cases are of reflexive licensing more generally. It is important to determine whether the attraction effects reported by Parker and colleagues generalize to a broader set of structural environments and a wider range of anaphoric elements, including direct object reflexives like those tested in previous studies (e.g., Cunnings & Sturt, 2014; Sturt, 2003; Dillon et al., 2013).

The second reason to revisit previous conclusions about attraction effects is inspired by computational simulations. Building on the findings reported in Parker et al. (2015), we investigated how the degree of feature match between the reflexive and target subject might impact reflexive licensing using a computational model of memory access based on the cue-based retrieval model (‘ACT-R’; Lewis & Vasishth, 2005). We systematically varied the degree of feature match between the target subject and the non-structural retrieval cues at the reflexive (perfect match, 1-feature mismatch, 2-feature mismatch, and 3-feature mismatch) using the sentences from Sturt (2003), e.g., {She/he} remembered that the surgeon had pricked herself and The surgeon who
treated \{Jennifer/Johnathan\} had pricked herself (the details of the model are provided in the Supplementary Materials).

Figure 1 presents the percentage of the trials when the distractor, rather than the target subject, was retrieved for reflexive licensing in the model simulations. For current purposes, we adopted the common assumption that greater rates of distractor retrieval monotonically correspond to a stronger attraction effect (e.g., Dillon et al., 2013; Kush & Phillips; 2014; Vasishth et al., 2008). The model predicts a sharp increase in attraction as the number of features that match between the target subject and the reflexive is reduced. This effect is driven by the non-linear “fan” function of the model (Equation 3 in the Supplementary Materials), which reduces the strength of association between a cue and the target as a function of the number of items associated with that cue (Anderson, 1974, Anderson & Reder, 1999).

**Figure 1.** Percentage of incorrect retrievals for reflexive licensing as a function of probe-to-target similarity as predicted by the ACT-R model (stimuli based on Sturt, 2003).

These results imply that previous tests for reflexive attraction may not have used strong enough reflexive-antecedent mismatches to reliably elicit an effect. Previous studies tested contexts in
which the illicit reflexive-antecedent dependency involved only a single feature mismatch, e.g., gender (Cunnings & Sturt, 2014; Sturt, 2003) or number (Dillon et al., 2013). Based on the computational simulations and previous studies (e.g., Parker et al., 2015), we predict that reflexives should be more susceptible to attraction when the reflexive and target subject mismatch in multiple features.

*The present study*

The present study tests the prediction that reflexives should be more susceptible to attraction when the reflexive and the correct target subject mismatch in multiple features. Across three eye-tracking while reading experiments, we compared contexts where the target subject and a direct object reflexive mismatched in one feature, e.g., gender or number, and in two features, e.g., animacy + gender (Experiment 1), animacy + number (Experiment 2), and gender + number (Experiment 3). We also tested additional conditions involving agreement in Experiment 2 in order to compare the strength of attraction effects with agreement and anaphora.

**Experiment 1**

Experiment 1 was designed to test whether direct object reflexives would show attraction effects (i.e., facilitatory interference) in contexts with a stronger reflexive-antecedent feature mismatch than used in most previous studies. We compared contexts where the reflexive and the correct target subject mismatched in gender (1-feature mismatch) and gender and animacy (2-feature mismatch). We chose this feature combination because it has been shown to yield attraction for a related class of anaphors (e.g., Parker et al., 2015).

If attraction effects for reflexives depend on the degree of feature match between the reflexive and target subject, we should observe stronger attraction at the reflexive in the 2-feature mismatch context than in the 1-feature mismatch context. Alternatively, if reflexive licensing exclusively uses structural cues for retrieving an antecedent, as previously claimed (e.g., Dillon et al., 2013), we should not observe attraction, regardless of the degree of mismatch between the reflexive and the target subject.

*Participants*
Thirty members of the University of Maryland community participated in Experiment 1. Participants were either compensated $10 or received credit in an introductory linguistics course. The eye-tracking experiment, including setup and calibration, lasted approximately 45 minutes.

**Stimuli**

We crossed three levels of target match (match/1-feature mismatch/2-feature mismatch) with two levels of distractor match (match/mismatch) to result in a $3 \times 2$ within-participants design. The factor target match was manipulated by varying the degree of match between the target subject and the reflexive, such that they fully matched (match), mismatched in gender only (1-feature mismatch), or mismatched in animacy and gender (2-feature mismatch). The factor distractor match was manipulated by varying the gender of the distractor.

Thirty-six item sets of the form shown in Table 1 were constructed. The structure of the items followed that reported in Experiment 1 in Sturt (2003). Across all conditions, the distractor appeared in the subject position of the main clause, and the target appeared in the subject position of an embedded complement clause that contained the reflexive in direct object position. The stimuli used a mix of stereotypical gender, e.g., nurse, and definitional gender, e.g., father from previous studies (e.g., Dillon et al., 2013; Parker et al., 2015; Sturt, 2003). Previous work has shown that stereotypical gender and definitional gender behave similarly with respect to retrieval effects (Kreiner, Sturt, & Garrod, 2008). The main clause verb was immediately followed by the embedded clause. The embedded verb was always a non-agreeing past tense verb. The lack of agreement reduced the likelihood that subject-verb agreement would provide independent cues for subject retrieval. The verb was followed immediately by a direct object reflexive. The reflexive was followed by a 3-7 word spillover region.

The 36 item sets were combined with 72 grammatical fillers of similar length and complexity, for a total of 108 sentences. Half of the target items and half of the fillers were followed by a comprehension question, which addressed various parts of the target or filler sentence to prevent participants from developing superficial reading strategies that would allow them to answer the question without reading the entire sentence. The entire set of stimuli can be found in the Supplemental Materials.

**Table 1.** Sample set of items for Experiment 1. Pre-critical, critical, and spillover regions included in the analysis are indicated by slashes.
Target Match
The strict librarian said that the studious schoolgirl reminded herself about the overdue book.

Distractor mismatch
The strict father said that the studious schoolgirl reminded herself about the overdue book.

Distractor match
The strict librarian said that the studious schoolboy reminded herself about the overdue book.

Distractor mismatch
The strict father said that the studious schoolboy reminded herself about the overdue book.

Distractor match
The strict librarian said that the brief memo reminded herself about the overdue book.

Distractor mismatch
The strict father said that the brief memo reminded herself about the overdue book.

Procedure
The 36 item sets were distributed across 6 lists in a Latin Square design, and 6 participants were assigned to each list. Each list was randomized along with the filler sentences. Sentences were presented in 12-point Courier font. All sentences in the experiment fit one line on the visual display. Eye movements were recorded using an EyeLink 1000 tower-mount eye-tracker, which sampled at 1000 Hz. Participants had binocular vision during recording, but only the right eye was tracked. The tower was 32 inches from the visual display giving participants approximately 5 characters per degree of visual angle.

Prior to the experiment, participants were familiarized with the eye-tracking setup and were given four practice trials. While seated at the tower-mount, participants’ heads were immobilized using a chin rest and a forehead restraint that was adjusted by height for comfort. Before the experiment, and whenever necessary throughout the experiment, the experimenter calibrated the eye-tracker using a 9-point display procedure to ensure accurate recording of eye-movements. Participants began each trial by fixating on a marker at the beginning of the sentence, which triggered the display of the entire sentence. Participants ended the presentation sentences by pressing a button on a hand-held controller, which triggered the presentation of a comprehension
question on trials that had a comprehension question or transitioned to the next trial on trials that did not. Participants were allowed to take breaks as often as necessary throughout the experiment. The experimenter recalibrated the eye-tracker following each break.

Data analysis
Sentences were divided into five regions following Sturt (2003), as indicated in Table 1. We report means and statistical analyses from the pre-critical, critical, and spillover regions. The pre-critical region consisted of the words between the complementizer that and the reflexive (exclusive). The reflexive region consisted of the reflexive anaphor herself. The spillover region consisted of the two words following the reflexive.

For each region of interest, we report four measures: first-pass reading time, right-bound (go-past) reading time, regression path duration, and second pass reading time. First pass reading time is the sum of all fixations in a region before it is exited, either to the left or right. Right-bound reading time is the sum of all fixations in a region before it is exited to the right. Regression path duration is the sum of fixations in a region and all the regions to the left, starting when the region was entered until it was exited to the right. Second pass reading time is the sum of fixations in a region after the first pass.

Statistical analyses were carried out for each measure and region of interest using linear mixed effects models provided by the lme4 package (Bates, Maechler, Bolker, & Walker, 2014) in the R software environment (R Development Core Team, 2014). We first ran a model to test for a main effect of target match (‘grammaticality’), a main effect of distractor match, and the interaction between the two main effects. Treatment coding was applied using the level match of the factor target match as the baseline, and the level mismatch of the factor distractor match as the baseline. These baselines were chosen as they correspond to conditions where there is no effect of grammaticality and no attraction effect. To maximize the chances of observing an attraction effect, we also performed pairwise comparisons within the ungrammatical 1-feature mismatch and 2-feature mismatch conditions separately. All models were fit with a full variance-covariance matrix, i.e., a maximal random effects structure with random intercepts by participants and items and random slopes for all fixed effects and their interaction (Baayen, Davidson, & Bates, 2008; Barr, Levy, Scheepers, & Tily, 2013). If the model failed to converge or the variance-covariance matrix was degenerate (e.g., correlations were close to ±1), random slopes for items or participants were
removed. A fixed effect was considered significant if its absolute \( t \)-value was greater than 2, which indicates that its 95% confidence interval did not include 0 (Gelman & Hill, 2007). In order to reduce non-normality, statistical analyses were carried out over log-transformed reading times (Box & Cox, 1964).

**Results**

Table 2 provides the mean raw reading times by measure and region. Table 3 provides a summary of the statistical analyses. Figure 2 provides a plot of the mean raw reading times by measure at the critical reflexive region.

No significant effects or interactions were observed in first-pass reading times or right-bound reading times in the pre-critical, critical, or spillover regions. A main effect of grammaticality was observed in second-pass reading times at the critical reflexive region for both the 1- and 2-feature mismatch conditions. This effect was driven by longer reading times in the ungrammatical mismatch conditions relative to the grammatical match conditions. The effect also reached significance in the pre-critical region for the 1-feature mismatch condition, indicating that the processing disruption associated with the target feature mismatch influenced re-reading of both the reflexive region and the previous region.

Importantly, for the 1-feature mismatch conditions, there was no interaction of grammaticality with distractor match nor an effect of attraction in any region or measure, replicating previous findings (e.g., Dillon et al., 2013; Sturt, 2003). However, for the 2-feature mismatch conditions, there was a significant interaction of grammaticality with distractor match, driven by attraction in second-pass reading times at the reflexive region. This effect manifested as faster reading times for ungrammatical sentences with a distractor relative to ungrammatical sentences with no distractor. Regression path durations in this region also showed a significant effect of attraction in raw reading times \((t > 2)\). However, this effect did not reach significance with the log-transformed values, suggesting that the difference is driven by a few outlier points, which were normalized by the log-transformation.

**Table 2.** Table of means in Experiment 1. Standard error by participants is shown in parentheses.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Pre-critical</th>
<th>Critical</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First-pass reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target match, distractor match</td>
<td>1052 (47)</td>
<td>215 (12)</td>
<td>227 (17)</td>
</tr>
</tbody>
</table>
Target match, distractor mismatch
Target 1-feature mismatch, distractor match
Target 1-feature mismatch, distractor mismatch
Target 2-feature mismatch, distractor match
Target 1-feature mismatch, distractor mismatch

**Right-bound reading time**
Target match, distractor match
Target match, distractor mismatch
Target 1-feature mismatch, distractor match
Target 1-feature mismatch, distractor mismatch
Target 2-feature mismatch, distractor match
Target 2-feature mismatch, distractor mismatch

**Regression path duration**
Target match, distractor match
Target match, distractor mismatch
Target 1-feature mismatch, distractor match
Target 1-feature mismatch, distractor mismatch
Target 2-feature mismatch, distractor match
Target 2-feature mismatch, distractor mismatch

**Second-pass reading time**
Target match, distractor match
Target match, distractor mismatch
Target 1-feature mismatch, distractor match
Target 1-feature mismatch, distractor mismatch
Target 2-feature mismatch, distractor match
Target 2-feature mismatch, distractor mismatch

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Table 3. Summary of statistical analyses by region and measure in Experiment 1. Significant coefficients (|t| > 2) are in bold.

<table>
<thead>
<tr>
<th></th>
<th>Pre-critical</th>
<th>Regions</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>SE</td>
<td>t</td>
</tr>
<tr>
<td><strong>First pass reading time</strong></td>
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<tr>
<td>1-feature grammaticity</td>
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<td>0.08</td>
<td>-0.11</td>
</tr>
<tr>
<td>2-feature grammaticity</td>
<td>-0.12</td>
<td>0.08</td>
<td>-1.49</td>
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<td>2-feature attraction</td>
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<td>0.07</td>
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**Right-bound reading time**
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<th>SE</th>
<th>t</th>
<th>β</th>
<th>SE</th>
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<th>β</th>
<th>SE</th>
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<td>-0.32</td>
<td>0.25</td>
<td>0.34</td>
<td>0.73</td>
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<tr>
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<td>-0.42</td>
<td>0.11</td>
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### Regressions path duration

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<tr>
<th></th>
<th>1-feature grammaticality</th>
<th>2-feature grammaticality</th>
<th>Distractor match</th>
<th>1-feature grammaticality \times distractor match</th>
<th>2-feature grammaticality \times distractor match</th>
<th>1-feature attraction</th>
<th>2-feature attraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-feature grammaticality</td>
<td>-0.05 0.06 -0.86</td>
<td>0.33 0.21 1.54</td>
<td>0.17 0.25 0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td>-0.07 0.06 -1.09</td>
<td>0.40 0.22 1.83</td>
<td>-0.22 0.25 -0.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distractor match</td>
<td>-0.04 0.06 -0.59</td>
<td>0.00 0.21 0.03</td>
<td>-0.18 0.25 -0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality \times distractor match</td>
<td>0.11 0.09 1.14</td>
<td>-0.13 0.31 -0.43</td>
<td>0.24 0.35 0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature grammaticality \times distractor match</td>
<td>0.01 0.09 0.10</td>
<td>-0.12 0.31 0.41</td>
<td>0.26 0.36 0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>-0.04 0.08 -0.50</td>
<td>0.00 0.22 0.04</td>
<td>-0.20 0.25 -0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature attraction</td>
<td>-0.01 0.06 -0.24</td>
<td>-0.11 0.21 -0.54</td>
<td>0.08 0.30 0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Second-pass reading time

<table>
<thead>
<tr>
<th></th>
<th>1-feature grammaticality</th>
<th>2-feature grammaticality</th>
<th>Distractor match</th>
<th>1-feature grammaticality \times distractor match</th>
<th>2-feature grammaticality \times distractor match</th>
<th>1-feature attraction</th>
<th>2-feature attraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-feature grammaticality</td>
<td>0.59 0.29 2.04</td>
<td>1.05 0.29 3.51</td>
<td>0.43 0.26 1.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td>-0.11 0.27 -0.41</td>
<td>0.89 0.31 2.84</td>
<td>0.47 0.26 1.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distractor match</td>
<td>-0.29 0.31 -0.92</td>
<td>-0.01 0.30 -0.04</td>
<td>-0.05 0.26 -0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality \times distractor match</td>
<td>0.11 0.40 0.28</td>
<td>-0.02 0.43 -0.05</td>
<td>0.35 0.37 0.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature grammaticality \times distractor match</td>
<td>-0.37 0.48 0.77</td>
<td>-0.92 0.42 -2.16</td>
<td>0.05 0.38 0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>-0.29 0.31 -0.92</td>
<td>-0.00 0.24 -0.02</td>
<td>-0.05 0.31 -0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-feature attraction</td>
<td>-0.65 0.37 -1.75</td>
<td>-0.93 0.27 -3.41</td>
<td>0.03 0.33 0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.** Mean raw reading times by measure at the critical reflexive region in Experiment 1. Error bars indicate standard error of the mean.

---

### Discussion

Arguments leading to target word (first-pass reading time) and segments following the reflexive constructions (second-pass reading time) have shown that

- Target match, distractor match: 0.59 0.29 2.04
- Target match, distractor mismatch: 1.05 0.29 3.51
- 1-feature mismatch, distractor match: -0.11 0.27 -0.41
- 1-feature mismatch, distractor mismatch: 0.89 0.31 2.84
- 2-feature mismatch, distractor match: -0.29 0.31 -0.92
- 2-feature mismatch, distractor mismatch: -0.37 0.48 0.77
- 1-feature attraction: -0.29 0.31 -0.92
- 2-feature attraction: -0.65 0.37 -1.75

---

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Experiment 1 tested the prediction that reflexives should be more susceptible to attraction in contexts with a stronger reflexive-antecedent feature mismatch. When the reflexive mismatched the target in gender, e.g., schoolgirl … herself, no attraction effects were observed, replicating previous findings (e.g., Cunnings & Sturt, 2014; Sturt, 2003, Dillon et al., 2013). By contrast, when the reflexive mismatched the target subject in both gender and animacy, e.g., memo … herself, we observed a clear attraction effect.

These results demonstrate that reflexives are indeed susceptible to attraction, but only selectively: by making a minimal change to the degree of feature match between the target subject and reflexive, we were able to systematically induce reflexive attraction effects. However, since such effects are rarely observed for reflexives, it is important to verify that they generalize across licensing configurations and feature combinations. We address this issue in Experiment 2.

**Experiment 2**

Experiment 2 had two goals. The first goal was to test whether reflexive attraction would extend to other feature combinations and licensing configurations. To this end, we tested contexts where the reflexive and target subject mismatched in number and animacy, as opposed to gender and animacy. We manipulated number alongside animacy because previous research has shown that reflexives resist attraction in the presence of a number mismatch with the target (e.g., Dillon et al., 2013). We also reversed the relative linear positions of the target and distractor following Sturt (2003), which allowed us to test whether reflexive attraction would be robust across licensing configurations. The second goal was to obtain a within-subjects comparison of attraction effects for reflexives and agreement. To achieve this, we replaced the target vs. 1-feature mismatch comparison with maximally similar conditions involving subject verb agreement. As such, Experiment 2 was not designed to compare 1- vs. 2-feature mismatches for reflexives.

**Participants**

Thirty members of the University of Maryland community participated in Experiment 2. Participants were either compensated $10 or received credit in an introductory linguistics course. The eye-tracking experiment, including setup and calibration, lasted approximately 45 minutes.

**Stimuli**
We manipulated target match (match/1-feature mismatch/2-feature mismatch) and distractor match (match/mismatch). However, unlike in Experiment 1, the target match and 1-feature mismatch conditions involved subject-verb agreement. Across all items, the target subject was always singular and inanimate. In the target match conditions, the agreeing verb was singular, e.g., was, and matched the number of the target subject. In the 1-feature mismatch conditions, the agreeing verb was plural, e.g., were, and mismatched the target subject only in number. In the 2-feature mismatch conditions, the reflexive was plural, e.g., themselves, and mismatched the target subject in both number and animacy.

The linear positions of the target subject and distractor were reversed relative to Experiment 1, following Sturt (2003; Experiment 2). In all conditions, the target subject was modified by an object relative clause that contained the distractor in subject position. The relative clause never overtly expressed agreement in order to prevent attraction before the critical region. In the agreement conditions, the main clause verb phrase consisted of the critical agreeing auxiliary verb (was or were) immediately followed by the main verb. In the reflexive conditions, the main clause verb was always a non-agreeing past tense verb followed immediately by a direct object reflexive.

Thirty-six item sets of the form shown in Table 4 were constructed. The 36 item sets were mixed with 72 grammatical fillers of similar length and complexity, for a total of 108 sentences. Half of the target items and half of the fillers were followed by a comprehension question.

Table 4. Sample set of items for Experiment 2. Pre-critical, critical, and spillover regions included in the analysis are indicated by slashes.

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Target Match</th>
<th>Distractor match</th>
<th>Distractor mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The soothing tea that/ the nervous student drank/ was imported/ from India./</td>
<td>The soothing tea that/ the nervous students drank/ was imported/ from India./</td>
</tr>
<tr>
<td>1-feature mismatch</td>
<td></td>
<td>Distractor match</td>
<td>Distractor mismatch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The soothing tea that/ the nervous students drank/ were imported/ from India./</td>
<td>The soothing tea that/ the nervous student drank/ were imported/ from India./</td>
</tr>
</tbody>
</table>
**Data analysis**

Data analysis proceeded as in Experiment 1. However, we did not analyze the effect of grammaticality (target match) for the reflexive 2-feature mismatch conditions. This effect is not interpretable since it involves comparing grammatical and ungrammatical sentences at different critical words for different dependencies (verb vs. reflexive). Regioning for the agreement conditions followed the same regioning used for the agreement conditions in Dillon et al. (2013).

**Results**

Table 5 provides the mean raw reading times by measure and region. Table 6 provides a summary of the statistical analyses. Figure 3 provides a plot of the mean raw reading times by measure at the critical reflexive region.

No significant effects or interactions were observed in first-pass, right-bound reading times, or regression path duration in the pre-critical region. Agreement conditions showed a significant effect of grammaticality across all measures at the critical region, which was driven by longer reading times in the 1-feature mismatch conditions relative to the match conditions. This effect also reached significance in second-pass reading times in the pre-critical region, suggesting that the processing disruption in the target mismatch conditions influenced re-reading of the previous region. Crucially, there was a significant interaction of grammaticality with distractor match in second pass reading times at the critical region. This effect was driven by attraction in the ungrammatical mismatch conditions. Reflexive conditions showed a significant effect of attraction in first-pass, right-bound, and second-pass reading times at the critical region and spillover region.

**Table 5.** Table of means in Experiment 2. Standard error by participants is shown in parentheses.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Pre-critical</th>
<th>Critical</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-pass reading time</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6. Summary of statistical analyses by region and measure in Experiment 2. Significant coefficients (|t| > 2) are in bold.

<table>
<thead>
<tr>
<th>Region/Measure</th>
<th>Pre-critical</th>
<th>Critical</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\hat{\beta}$</td>
<td>SE</td>
<td>t</td>
</tr>
<tr>
<td><strong>First pass reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target match, distractor match</td>
<td>-0.05</td>
<td>0.06</td>
<td>-0.92</td>
</tr>
<tr>
<td>Target match, distractor mismatch</td>
<td>0.02</td>
<td>0.06</td>
<td>0.43</td>
</tr>
<tr>
<td>Agreement grammaticality</td>
<td>-0.00</td>
<td>0.09</td>
<td>-0.02</td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.02</td>
<td>0.09</td>
<td>0.26</td>
</tr>
<tr>
<td>Agreement grammaticality $\times$ distractor match</td>
<td>0.00</td>
<td>0.07</td>
<td>0.12</td>
</tr>
<tr>
<td>Agreement attraction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflexive attraction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Right-bound reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreement grammaticality</td>
<td>0.00</td>
<td>0.04</td>
<td>0.11</td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.05</td>
<td>0.04</td>
<td>1.22</td>
</tr>
<tr>
<td>Agreement grammaticality $\times$ distractor match</td>
<td>-0.03</td>
<td>0.06</td>
<td>-0.51</td>
</tr>
<tr>
<td>Agreement attraction</td>
<td>0.01</td>
<td>0.05</td>
<td>0.30</td>
</tr>
<tr>
<td>Reflexive attraction</td>
<td>-0.01</td>
<td>0.03</td>
<td>-0.28</td>
</tr>
<tr>
<td><strong>Regression path duration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreement grammaticality</td>
<td>0.01</td>
<td>0.04</td>
<td>0.36</td>
</tr>
</tbody>
</table>
**Figure 3.** Mean raw reading times by measure at the critical region in Experiment 2. Error bars indicate standard error of the mean.

**Discussion**
Experiment 2 was designed to achieve two goals. The first goal was to test whether reflexive attraction would extend to other feature combinations and licensing configurations. The second goal was to obtain a within-subjects comparison of attraction effects for reflexives and agreement. The key finding from Experiment 2 is that attraction effects for reflexives are as strong as those observed for agreement, and that reflexive attraction does in fact extend to other feature combinations and licensing configurations.

There are two concerns about the results of Experiment 2. First, agreement attraction and reflexive attraction showed different timing profiles: reflexives showed attraction across both early and late measures, e.g., first-pass and second-pass reading times, but agreement showed attraction only in late measures, e.g., second-pass reading times. However, it is unclear what to make of this contrast, since reflexive attraction was observed only in late measures in Experiment 1. We return to this issue in the General Discussion.

The second concern is that reflexive attraction might be driven by animacy, rather than by the more general property of reflexive-antecedent match. So far, both demonstrations of the reflexive attraction effect in Experiments 1 and 2 have used animacy in combination with other features. These findings are consistent with the view that animacy information has a privileged role in encoding and accessing linguistic items in memory (e.g., Nairne et al., 2013; Van Arsdall et al., 2013). If reflexive attraction is truly a consequence of the degree of reflexive-antecedent feature match as hypothesized, then we should observe a similar modulation of the effect using a feature combination that does not rely on animacy. We test this possibility in Experiment 3.

**Experiment 3**

Experiment 3 was designed to test whether reflexive attraction is driven by animacy or the more general property of reflexive-antecedent match. To achieve this, we held constant the animacy match between the potential licensors and the reflexive, and tested whether a feature combination involving gender and number would trigger the same modulation of the attraction effect seen in Experiment 1. If reflexive attraction is driven by animacy, we expect to see no difference between 1- and 2-feature mismatch contexts. However, if reflective attraction reflects the degree of reflexive-antecedent match, then we expect to observe the same modulation of attraction effects seen in Experiment 1.
Participants

Twenty-four members of the University of Maryland community participated in Experiment 3. Participants were either compensated $10 or received credit in an introductory linguistics course. The eye-tracking experiment, including setup and calibration, lasted approximately 45 minutes.

Stimuli

Thirty-six item sets of the form shown in Table 7 were constructed. The experimental stimuli and fillers followed the same design as in Experiment 1, with the exception that in the 2-feature mismatch context, the target subject and reflexive mismatched in gender and number.

Table 7. Sample set of items for Experiment 3. Pre-critical, critical, and spillover regions included in the analysis are indicated by slashes.

<table>
<thead>
<tr>
<th>Target Match</th>
<th>Distractor match</th>
<th>Distractor mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The talented actress mentioned that/ the attractive spokesman praised/ himself/ for a/ great job.</td>
<td>The talented actress mentioned that/ the attractive spokeswoman praised/ himself/ for a/ great job.</td>
</tr>
<tr>
<td>Target 1-feature mismatch</td>
<td>Distractor match</td>
<td>Distractor mismatch</td>
</tr>
<tr>
<td></td>
<td>The talented actor mentioned that/ the attractive spokesman praised/ himself/ for a/ great job.</td>
<td>The talented actress mentioned that/ the attractive spokeswoman praised/ himself/ for a/ great job.</td>
</tr>
<tr>
<td>Target 2-feature mismatch</td>
<td>Distractor match</td>
<td>Distractor mismatch</td>
</tr>
<tr>
<td></td>
<td>The talented actor mentioned that/ the attractive spokeswomen praised/ himself/ for a/ great job.</td>
<td>The talented actress mentioned that/ the attractive spokeswomen praised/ himself/ for a/ great job.</td>
</tr>
</tbody>
</table>

Data analysis

Data analysis proceeded as in Experiment 1.

Results
Table 8 provides the mean raw reading times by measure and region. Table 9 provides a summary of the statistical analyses. Figure 4 provides a plot of the mean raw reading times by measure at the critical reflexive region.

No significant effects or interactions were observed in the pre-critical region in first-pass reading times, right-bound reading times, or regression path durations. A main effect of grammaticality was observed in second-pass reading times at the critical region for both the 1- and 2-feature mismatch conditions. This effect was carried by longer reading times in the mismatch conditions relative to the match conditions. The effect of grammaticality for the 2-feature comparison also reached significance in the pre-critical region. A significant effect of attraction was observed across all measures at the critical region for the 2-feature mismatch conditions. There was a significant interaction of grammaticality with distractor match in the 2-feature mismatch conditions in regression path durations and second-pass reading times at the critical region. This effect was driven by attraction in the ungrammatical mismatch conditions. The interaction also reached significance in the pre-critical region. Crucially, for the 1-feature mismatch conditions, there was no interaction of grammaticality with distractor match or an effect of attraction in any region or measure, replicating previous findings (e.g., Cunnings & Sturt, 2014; Sturt, 2003; Dillon et al., 2013).

Table 8. Table of means in Experiment 3. Standard error by participants is shown in parentheses.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Pre-critical</th>
<th>Critical</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First-pass reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target match, distractor match</td>
<td>947 (50)</td>
<td>197 (11)</td>
<td>166 (13)</td>
</tr>
<tr>
<td>Target match, distractor mismatch</td>
<td>928 (43)</td>
<td>223 (12)</td>
<td>155 (15)</td>
</tr>
<tr>
<td>Target 1-feature mismatch, distractor match</td>
<td>805 (34)</td>
<td>225 (13)</td>
<td>166 (23)</td>
</tr>
<tr>
<td>Target 1-feature mismatch, distractor mismatch</td>
<td>903 (40)</td>
<td>223 (12)</td>
<td>165 (16)</td>
</tr>
<tr>
<td>Target 2-feature mismatch, distractor match</td>
<td>913 (36)</td>
<td>185 (12)</td>
<td>156 (14)</td>
</tr>
<tr>
<td>Target 2-feature mismatch, distractor mismatch</td>
<td>882 (37)</td>
<td>290 (18)</td>
<td>129 (14)</td>
</tr>
<tr>
<td><strong>Right-bound reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target match, distractor match</td>
<td>1162 (54)</td>
<td>200 (11)</td>
<td>196 (17)</td>
</tr>
<tr>
<td>Target match, distractor mismatch</td>
<td>1108 (41)</td>
<td>228 (12)</td>
<td>185 (23)</td>
</tr>
<tr>
<td>Target 1-feature mismatch, distractor match</td>
<td>1025 (36)</td>
<td>245 (14)</td>
<td>215 (31)</td>
</tr>
<tr>
<td>Target 1-feature mismatch, distractor mismatch</td>
<td>1088 (39)</td>
<td>234 (13)</td>
<td>195 (20)</td>
</tr>
<tr>
<td>Target 2-feature mismatch, distractor match</td>
<td>1117 (39)</td>
<td>191 (13)</td>
<td>191 (20)</td>
</tr>
<tr>
<td>Target 2-feature mismatch, distractor mismatch</td>
<td>1062 (40)</td>
<td>329 (21)</td>
<td>178 (23)</td>
</tr>
<tr>
<td><strong>Regression path duration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target match, distractor match</td>
<td>1295 (79)</td>
<td>221 (16)</td>
<td>312 (43)</td>
</tr>
</tbody>
</table>
Table 9. Summary of statistical analyses by region and measure in Experiment 3. Significant coefficients ($|t| > 2$) are in bold.

<table>
<thead>
<tr>
<th>Region</th>
<th>Pre-critical</th>
<th>Critical</th>
<th>Spillover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>SE</td>
<td>t</td>
</tr>
<tr>
<td><strong>First pass reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality</td>
<td>-0.01</td>
<td>0.06</td>
<td>-0.21</td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td>-0.02</td>
<td>0.06</td>
<td>-0.30</td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.00</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>1-feature grammaticality × distractor match</td>
<td>-0.11</td>
<td>0.09</td>
<td>-1.17</td>
</tr>
<tr>
<td>2-feature grammaticality × distractor match</td>
<td>0.03</td>
<td>0.09</td>
<td>0.35</td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>-0.10</td>
<td>0.06</td>
<td>-1.60</td>
</tr>
<tr>
<td>2-feature attraction</td>
<td>0.03</td>
<td>0.06</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>Right-bound reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality</td>
<td>-0.02</td>
<td>0.03</td>
<td>-0.54</td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td>-0.04</td>
<td>0.04</td>
<td>-1.20</td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.01</td>
<td>0.03</td>
<td>0.39</td>
</tr>
<tr>
<td>1-feature grammaticality × distractor match</td>
<td>-0.06</td>
<td>0.05</td>
<td>-1.16</td>
</tr>
<tr>
<td>2-feature grammaticality × distractor match</td>
<td>0.04</td>
<td>0.05</td>
<td>0.80</td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>-0.05</td>
<td>0.04</td>
<td>-1.20</td>
</tr>
<tr>
<td>2-feature attraction</td>
<td>0.05</td>
<td>0.04</td>
<td>1.43</td>
</tr>
<tr>
<td><strong>Regression path duration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality</td>
<td>-0.01</td>
<td>0.04</td>
<td>-0.24</td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td>-0.02</td>
<td>0.04</td>
<td>-0.51</td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.03</td>
<td>0.04</td>
<td>0.66</td>
</tr>
<tr>
<td>1-feature grammaticality × distractor match</td>
<td>-0.04</td>
<td>0.06</td>
<td>-0.73</td>
</tr>
<tr>
<td>2-feature grammaticality × distractor match</td>
<td>-0.00</td>
<td>0.06</td>
<td>-0.05</td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>-0.01</td>
<td>0.05</td>
<td>-0.31</td>
</tr>
<tr>
<td>2-feature attraction</td>
<td>0.02</td>
<td>0.04</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Second-pass reading time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-feature grammaticality</td>
<td>0.52</td>
<td>0.31</td>
<td>1.66</td>
</tr>
<tr>
<td>2-feature grammaticality</td>
<td><strong>1.15</strong></td>
<td><strong>0.31</strong></td>
<td><strong>3.60</strong></td>
</tr>
<tr>
<td>Distractor match</td>
<td>0.20</td>
<td>0.31</td>
<td>0.64</td>
</tr>
<tr>
<td>1-feature grammaticality × distractor match</td>
<td>-0.44</td>
<td>0.44</td>
<td>-0.99</td>
</tr>
<tr>
<td>2-feature grammaticality × distractor match</td>
<td><strong>-0.97</strong></td>
<td><strong>0.45</strong></td>
<td><strong>-2.17</strong></td>
</tr>
<tr>
<td>1-feature attraction</td>
<td>0.22</td>
<td>0.38</td>
<td>0.58</td>
</tr>
<tr>
<td>2-feature attraction</td>
<td><strong>-0.79</strong></td>
<td><strong>0.31</strong></td>
<td><strong>-2.52</strong></td>
</tr>
</tbody>
</table>
**Discussion**

Experiment 3 was designed to test whether reflexive attraction is driven by animacy features or more generally by the degree of reflexive-antecedent match. To achieve this, we held constant the animacy match between the potential licensors and reflexive, and deployed a feature combination involving gender and number. Results showed the same modulation of the attraction effect seen in Experiment 1: when the reflexive mismatched the target subject in just one feature, there was no attraction, but when it mismatched in two features, clear attraction effects were found. These findings demonstrate that the presence or absence of reflexive attraction does not rely on animacy.
features in retrieval, favoring an account based on the degree of reflexive-antecedent feature match. We develop this proposal further in the General Discussion.

**General Discussion**

*Summary of findings*

In this paper, we tested the prediction that reflexives should be more susceptible to attraction when the reflexive and target subject mismatch in multiple features. This prediction was motivated by previous empirical contrasts (e.g., Parker et al., 2015) and computational simulations. Across three eye-tracking experiments, we compared contexts where the target subject and a direct object reflexive mismatched in one feature, e.g., gender or number, and in two features, e.g., animacy + gender (Experiment 1), animacy + number (Experiment 2), and gender + number (Experiment 3). Results showed that reflexives are indeed susceptible to attraction, but only selectively. We found that when the reflexive mismatched the true subject in just one feature, we consistently observed no attraction, but when it mismatched in more features, strong attraction effects were found. These results suggest the following generalization: when the target subject is an especially poor match to the retrieval cues at the reflexive, which can be quantified by the number of matching features, e.g., 1- vs. 2-features, comprehenders notice irrelevant items.

*Survey of empirical contrasts*

Previous studies have shown that attraction effects are consistently found for agreement, but not for reflexives (see Dillon, 2014, for a review). We replicated these findings, and showed that reflexives are in fact susceptible to attraction by making a minimal change to the number of feature mismatches between the target subject and reflexive. To illustrate how our results diverge from previous studies, Figure 6 compares the findings from Experiments 1-3 of the current study to the effects reported in previous studies, e.g., Sturt (2003; labeled ‘S’), Cunnings and Sturt (2014; labeled ‘C&S’), and Dillon et al. (2013; labeled ‘D et al.’). The results from our 1-feature mismatch conditions are closely aligned with the results of previous studies that manipulated only one feature, showing a lack of attraction. By contrast, the results from our 2-feature mismatch

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3 Figure 6 reports late eye-tracking measures, e.g., second-pass, total time, since these measures consistently show attraction for both agreement and reflexives.
conditions diverge sharply from those studies, revealing attraction effects for reflexives that are as strong as those observed for agreement, if not stronger.

**Figure 6.** Comparison of the interference effects across Experiments 1-3 (labeled as P&P) with the effects reported in Sturt (2003; labeled as ‘S’), Cunnings & Sturt (2014; labeled as C&S), and Dillon et al. (2013; labeled as ‘D et al.’).

![Figure 6 Diagram](image)

The current results have several consequences for theories of memory access in sentence comprehension. Most importantly, our findings are consistent with the claim that there is a direct relation between grammatical constraints and their implementation as retrieval cues. Previous empirical contrasts (e.g., Dillon et al., 2013) motivated the claim that morphological cues play a different role in retrieval for agreement and reflexive licensing, despite similar agreement constraints on the two dependencies. However, the finding that reflexives and agreement are both susceptible to attraction implies they recruit morphological agreement features as retrieval cues in the same fashion, as expected if there is a uniform mapping from grammatical constraints to retrieval cues. Of course, this does not explain why agreement attraction effects are routinely found in 1-feature mismatch contexts, whereas a stronger mismatch is required to reliably elicit reflexive attraction effects. We return to this issue below.
We argue that the current results are best captured in a cue-based parsing architecture where agreement and reflexives deploy the same memory access mechanism. Specifically, we suggest that agreement and reflexives both engage a cue-based retrieval mechanism that uses a combination of structural and non-structural (e.g., morphological) cues to access a licensor in content-addressable memory. Importantly, this account is consistent with the general assumption that all linguistic dependencies are uniformly resolved using a direct-access, cue-based retrieval mechanism, as suggested in previous research (e.g., McElree, 2000; McElree et al., 2003; Lewis & Vasishth, 2005).

Why do agreement and reflexives differ?
We suggested that agreement and reflexives deploy the same memory access mechanism and that there is a uniform mapping from grammatical constraints to retrieval cues. On this view, both agreement and reflexives should show identical attraction profiles. However, it is clear that they are differentially susceptible to attraction: environments that exhibit strong agreement attraction effects, e.g., 1-feature mismatch contexts, do not exhibit reflexive attraction. To explain this difference, we first propose an account for why reflexive attraction is selective, and then suggest a way to capture the contrasting attraction profiles for agreement and reflexives.

We suggest that the selectivity of reflexive attraction may reflect a weighted cue-combinatorics scheme in which structural cues are weighted more strongly than morphological cues. Weighting structural cues over morphological cues maximizes the probability of retrieving the structurally appropriate target and minimizes attraction from structurally inappropriate items, even when the target is not a perfect match, e.g., 1-feature mismatch. However, the finding that reflexives are susceptible to attraction with stronger reflexive-antecedent mismatches, e.g., 2-feature mismatch, implies that the weighting for structural cues is not so strong that they serve a gating function, so that only the target is considered.

To make this account explicit, we simulated cue weighting for reflexive licensing. Using the same computational model described in the Introduction, we systematically manipulated the weight assigned to structural cues relative to non-structural cues. Figure 5 provides a plot of the predicted retrieval error rates across a range of different values. When structural cues are weighted equally to non-structural cues, widespread attraction effects are predicted for both the 1- and 2-feature mismatch conditions. By contrast, when the weighting for structural cues is at its strongest,
no attraction effects are predicted for either the 1- or 2-feature mismatch conditions. Interestingly, we find that at intermediate values, the model accurately predicts the absence of an attraction effect in the 1-feature mismatch condition and the presence of an attraction effect in the 2-feature mismatch condition. These results demonstrate that it is possible to capture both the presence and absence of reflexive attraction from the same retrieval mechanism by preferentially weighting structural cues over morphological cues.

**Figure 5.** Predicted retrieval error rates for 1-feature (solid) and 2-feature (dashed) mismatch conditions as a function of structural cue weighting.

One question that arises is how the parser determines when it should prioritize syntactic cues over morphological cues. The finding that agreement shows strong attraction effects, even in a 1-feature mismatch context, implies that structural cues are not weighted more strongly for agreement.

We suggest that the priority for structural cues is determined by whether retrieval is triggered by error correction or by normal dependency resolution. In the case of subject-verb agreement, retrieval might not always be required, since the subject noun can predict the number of the verb. However, when the verb form does not have the expected number feature, i.e., in ungrammatical sentences, cue-based retrieval might be triggered as a form of error correction to check the number of the subject (see Wagers et al., 2009, for discussion). On this view, the prediction error could lead the parser to be uncertain about the accuracy of its existing structural encoding and hence less
reliant on syntactic cues during retrieval. In the case of reflexive licensing, by contrast, reflexive anaphors cannot be anticipated as reliably as subject-verb agreement, and are less likely to violate expectations in a way that would impact priority for structural cues. Retrieval is required as part of normal resolution, and syntactic cues should remain prioritized over morphological cues.

This account makes a prediction about the timing of attraction effects: grammaticality effects should precede attraction effects for agreement, but the effects should be simultaneous for reflexives. This prediction matches the pattern of results from Experiments 2 and 3. For agreement, we observed a main effect of grammaticality in early measures, e.g., first-pass reading times, which may reflect detection of the number prediction error, triggering the error-driven retrieval processes that were observed as attraction in later measures. Reflexives, by contrast showed attraction from the earliest stages of processing, e.g., first-pass reading times, since they must engage retrieval from the start as part of normal resolution. The exception to this pattern was Experiment 1, where all effects for reflexives were observed in later measures.

The different timing profiles for attraction reported in the current study, taken together with previous empirical contrasts (e.g., Parker et al., 2015), suggest that retrieval prioritizes structural cues over non-structural cues, and that susceptibility to attraction might be based on the predictability of the dependency. This account provides one explanation of why agreement and reflexives could differ with respect to attraction. However, more work is needed to assess the generality of these claims. A first step would be to compare a broader range of predictable and unpredictable dependencies that engage memory retrieval, such as ellipsis and filler-gap dependencies. We leave the task of testing these dependencies to future research.

Lastly, we should also point out an additional unresolved concern. We found that it is possible to model the distribution of attraction effects for reflexives and agreement using the same retrieval architecture and the same retrieval cues, but by varying the weighting of different cues, and we have offered a rationale for why those weightings might differ. However, we have not offered any way of guaranteeing that comprehenders should choose the specific weightings that capture the observed experimental contrasts. Further research is necessary to determine how learners might converge on the correct weighting scheme.

Conclusion
In this paper, we tested the prediction that reflexive attraction reflects the degree of reflexive-antecedent feature match. Across three eye-tracking experiments, we showed that it is possible to systematically control where attraction effects do and do not occur for reflexive licensing. Furthermore, we showed based on computational simulations that it is possible to derive both the presence and absence of reflexive attraction from the same retrieval mechanism using a cue-combinatorics scheme that preferentially weights structural cues over morphological cues. Finally, we proposed an account of why agreement and reflexives differ with respect to attraction, based on the predictability of the dependency. Ultimately, these results provide further support for the claim that there is a direct relation between grammatical constraints and their implementation as retrieval cues (see Phillips et al., 2011, and Dillon, et al., 2013, for discussion) and that all linguistic dependencies are uniformly resolved using an error-prone retrieval mechanism (e.g., McElree, 2000; McElree et al., 2003; Lewis & Vasishth, 2005).

Acknowledgments
We would like to thank Brian Dillon, Norbert Hornstein, Dave Kush, and Sol Lago for helpful discussions. This work was supported in part by NSF-IGERT grant DGE-0801465 to the University of Maryland and by NSF grant BCS-0848554 to Colin Phillips.

References
Bates, D., Maechler, M., & Bolker, B. (2014). lme4: Linear mixed-effects models using S4 classes. Retrieved from http://CRAN.R-project.org/package=lme4


Supplementary material to accompany Parker & Phillips “Reflexive attraction in comprehension is selective”.

1. Description of the model

Our simulations were conducted using a variant of the ACT-R model of sentence processing (Adaptive Character of Thought—Rational; Anderson, 1990) based on the equations described in Lewis and Vasishth (2005) and Vasishth, Brüssow, Lewis, and Drenhaus (2008). The code for our model was originally developed by Badecker and Lewis (2007).

In the model, linguistic items are encoded as “chunks” in a content-addressable memory (Kohonen, 1980), and hierarchical structure arises as a consequence of a pointer mechanisms inspired by the attribute-value matrices from Head-driven Phrase Structure Grammar (HPSG; Pollard & Sag, 1994). Linguistic dependencies, such as subject-verb agreement and reflexive-antecedent dependencies, are formed using a general retrieval mechanism that probes all items in memory, in parallel, using a set of retrieval cues that target specific features of individual memory chunks. Memory chunks are differentially activated based on their match to the retrieval cues, and the success of retrieving a chunk is proportional to the chunk’s overall activation at the time of retrieval. Attraction effects are explained in this model as misretrieval of irrelevant chunks that partially match the retrieval cues (Dillon, Mishler, Slogget, & Phillips, 2013; Vasishth et al., 2008; Wagers, Lau, & Phillips, 2009).

The activation of a chunk $i$ ($A_i$) is defined as follows.¹

$$ A_i = B_i + \sum_{j=1}^{m} W_j S_{ij} - \sum_{k=1}^{p} P M_{ki} + \epsilon $$

The first term of Equation 1 describes the baseline activation of chunk $i$, which is calculated according to Equation 2. Equation 2 describes the usage history of chunk $i$ as the summation of all $n$ successful retrievals of $i$, where $t_j$ is the time since the $j$th successful retrieval of $i$ to the power of the negated decay parameter $d$. The output is passed through a logarithmic transformation to

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¹ Readers familiar with ACT-R may notice the non-standard presentation of Equation 1: the sign on the partial match component has been flipped to indicate its penalizing nature.
approximate the log odds that the chunk will be needed given its usage history. After a chunk has
been retrieved, the chunk receives an activation boost, followed by decay.

\[ B_i = \ln \left( \sum_{j=1}^{n} t_j^{-d} \right) \] (2)

The second term of Equation 1 reflects the degree of match between chunk \( i \) and the
retrieval cues. \( W \) is the weight associated with each retrieval cue \( j \), which defaults to the total
amount of goal activation \( G \) available divided by the number of cues (i.e., \( G/j \)). Weights are
assumed to be equal across all cues. This term was varied in simulations described in the General
Discussion. The degree of match between chunk \( i \) and the retrieval cues is the sum of the
(weighted) associative boost for each retrieval cue \( S_j \) that matches a feature value of chunk \( i \). The
associative boost that a cue contributes to a chunk that it matches is reduced as a function of the
fan of that cue, i.e., the number of chunks in memory that match the cue (Anderson, 1974),
according to Equation 3.

\[ S_{ji} = S - \ln (\text{fan}_j) \] (3)

The third term of Equation 1 reflects the penalty for a partial match between the cues of
the retrieval probe and the feature values of chunk \( i \). Partial matching makes it possible to retrieve
a chunk that matches only some of the cues, creating the opportunity for retrieval interference
(Anderson, Bothell, Byrne, Douglass, Lebiere, & Qin, 2004; Anderson & Matessa, 1997). Partial
matching is calculated as the matching summation over the \( k \) feature values of the retrieval cues.
\( P \) is a match scale, and \( M_{ki} \) reflects the similarity between the retrieval cue value \( k \) and the value of
the corresponding feature of chunk \( i \), expressed by maximum similarity and maximum difference.

Lastly, random noise is added to the activation level of chunk \( i \), generated from a logistic
distribution with a mean of 0, controlled by the noise parameter \( s \), which is related to the variance
of the distribution, according to Equations 4 and 5.

\[ \epsilon \sim \text{logistic}(0, \sigma^2) \] (4)
\[
\sigma^2 = \frac{\pi^2}{3}s^2
\]  

(5)

Activation \(A_i\) determines the probability of retrieving a chunk, according to Equation 6. The probability of retrieving chunk \(i\) is a logistic function of its activation with gain \(1/s\) and threshold \(\tau\). Chunks with higher activation are more likely to be retrieved.

\[
P(\text{recall}) = \frac{1}{1 + e^{(-A_i-\tau)/s}}
\]

(6)

Activation \(A_i\) also determines the retrieval latency \(T_i\) of a chunk, according to Equation 7. \(F\) is a scaling factor that sets predictions on an appropriate time scale. Chunks with a higher activation value have a faster retrieval latency.

\[
T_i = Fe_i^{-A_i}
\]

(7)

Previous implementations of the ACT-R model have included a wide range of processing modules, for lexical access, memory retrieval, and syntactic parsing (e.g., Lewis & Vasishth, 2005; Vasishth et al., 2008). However, our simulations focused solely on retrieval latencies, and abstracted away from the contribution of ancillary modules by stipulating the chunks in memory and retrievals required to parse the sentence. We adopted the standard assumption that longer retrieval latencies entail longer reading times.

For our simulations, we systematically varied the degree of feature match between the target subject and the non-structural retrieval cues at the reflexive (perfect match, 1-feature mismatch, 2-feature mismatch, and 3-feature mismatch) using the sentences from Sturt (2003), e.g., \{She/he\} remembered that the surgeon had pricked herself and The surgeon who treated {Jennifer/Johnathan} had pricked herself. For each condition, a schedule of constituent creation times and retrievals was estimated from the reading times reported in Sturt 2003. Retrievals associated with the processing of a given constituent, such as retrieval of a subject by a verb, or retrieval of a reflexive licensor, occurred 200 ms after the creation of the retrieval trigger.
References


2. Stimuli from Experiments 1-3

Format:

Column 1 = Condition
Column 2 = Item number
Column 3 = Sentence

Experiment 1:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 The famous actress thought that the female photographer depicted herself as a strict person.</td>
</tr>
<tr>
<td>2</td>
<td>1 The famous actor thought that the female photographer depicted herself as a strict person.</td>
</tr>
<tr>
<td>3</td>
<td>1 The famous actress thought that the film maker depicted herself as a strict person.</td>
</tr>
<tr>
<td>4</td>
<td>1 The famous actor thought that the film maker depicted herself as a strict person.</td>
</tr>
<tr>
<td>5</td>
<td>1 The famous actress thought that the film makers depicted herself as a strict person.</td>
</tr>
<tr>
<td>6</td>
<td>1 The famous actor thought that the film makers depicted herself as a strict person.</td>
</tr>
</tbody>
</table>
1 2 The influential congresswoman said that the kindergarten teacher inspired herself to be a better person.
2 2 The influential congressman said that the kindergarten teacher inspired herself to be a better person.
3 2 The influential congresswoman said that the factory worker inspired herself to be a better person.
4 2 The influential congressman said that the factory worker inspired herself to be a better person.
5 2 The influential congresswoman said that the factory workers inspired herself to be a better person.
6 2 The influential congressman said that the factory workers inspired herself to be a better person.
1 3 The trustworthy policeman said that the bank robber criticized himself for the noticeable error.
2 3 The trustworthy policewoman said that the bank robber criticized himself for the noticeable error.
3 3 The trustworthy policeman said that the female reporter criticized himself for the noticeable error.
4 3 The trustworthy policewoman said that the female reporter criticized himself for the noticeable error.
5 3 The trustworthy policeman said that the female reporters criticized himself for the noticeable error.
6 3 The trustworthy policewoman said that the female reporters criticized himself for the noticeable error.
1 4 The talented director claimed that the rude photographer described himself as a mean person.
2 4 The beautiful supermodel claimed that the rude photographer described himself as a mean person.
3 4 The talented director claimed that the female journalist described himself as a mean person.
4 4 The beautiful supermodel claimed that the female journalist described himself as a mean person.
5 4 The talented director claimed that the female journalists described himself as a mean person.
6 4 The beautiful supermodel claimed that the female journalists described himself as a mean person.
1 5 The democratic senator claimed that the influential spokesman distinguished himself as a honorable person.
2 5 The dutiful receptionist claimed that the influential spokesman distinguished himself as a honorable person.
3 5 The democratic senator claimed that the influential spokeswoman distinguished himself as a honorable person.
4 5 The dutiful receptionist claimed that the influential spokeswoman distinguished himself as a honorable person.
5 5 The democratic senator claimed that a few spokeswomen distinguished himself as a honorable person.
6 5 The dutiful receptionist claimed that a few spokeswomen distinguished himself as a honorable person.
1 6 The city councilwoman said that the female journalist characterized herself as a helpful person.
2 6 The city councilman said that the female journalist characterized herself as a helpful person.
3 6 The city councilwoman said that the male journalist characterized herself as a helpful person.
4 6 The city councilman said that the male journalist characterized herself as a helpful person.
The city councilwoman said that the male journalists characterized herself as a helpful person.
The city councilman said that the male journalists characterized herself as a helpful person.
The female witness claimed that the distracted mistress misrepresented herself in the murder trial.
The male witness claimed that the distracted mistress misrepresented herself in the murder trial.
The female witness claimed that the dishonest lawyer misrepresented herself in the murder trial.
The male witness claimed that the dishonest lawyer misrepresented herself in the murder trial.
The female witness claimed that the dishonest lawyers misrepresented herself in the murder trial.
The male witness claimed that the dishonest lawyers misrepresented herself in the murder trial.
The female witness claimed that the dishonest lawyer misrepresented herself in the murder trial.
The male witness claimed that the dishonest lawyer misrepresented herself in the murder trial.
The aspiring actress worried that the jealous beautician would portray herself as an ugly person.
The aspiring actor worried that the jealous beautician would portray herself as an ugly person.
The aspiring actress worried that the film director would portray herself as a dumb person.
The aspiring actor worried that the film director would portray herself as a dumb person.
The male witness claimed that the film directors would portray herself as a dumb person.
The female witness claimed that the film directors would portray herself as a dumb person.
The skilled businesswoman said that the new saleswoman described herself as a hard worker.
The skilled businessman said that the new saleswoman described herself as a hard worker.
The skilled businesswoman said that the regional manager described herself as a hard worker.
The skilled businessman said that the regional manager described herself as a hard worker.
The skilled businesswoman said that some regional managers described herself as a hard worker.
The skilled businessman said that some regional managers described herself as a hard worker.
The wealthy banker claimed that the stock broker cast himself in a negative light.
The diligent secretary claimed that the stock broker cast himself in a negative light.
The wealthy banker claimed that the female journalist cast himself in a negative light.
The diligent secretary claimed that the female journalist cast himself in a negative light.
The wealthy banker claimed that the female journalists cast himself in a negative light.
The diligent secretary claimed that the female journalists cast himself in a negative light.
The gorgeous model thought that the female photographer depicted herself as a strong person.
The handsome actor thought that the female photographer depicted herself as a strong person.
The gorgeous model thought that the male photographers depicted herself as a strong person.
The handsome actor thought that the male photographers depicted herself as a strong person.
The brave soldier thought that the political correspondent portrayed himself as a great leader.
The busy secretary thought that the political correspondent portrayed himself as a great leader.
The brave soldier thought that the female correspondent portrayed himself as a great leader.
The busy secretary thought that the female correspondent portrayed himself as a great leader.
The brave soldier thought that the female correspondents portrayed himself as a great leader.
The busy secretary thought that the female correspondents portrayed himself as a great leader.
The talented actor mentioned that the attractive spokesman praised himself for a great job.
The talented actress mentioned that the attractive spokesman praised himself for a great job.
The talented actor mentioned that the attractive spokeswoman praised himself for a great job.
4 13 The talented actress mentioned that the attractive spokeswoman praised himself for a great job.
5 13 The talented actor mentioned that some of the spokeswomen praised himself for a great job.
6 13 The talented actress mentioned that some of the spokeswomen praised himself for a great job.
1 14 The security guard said that the male witness identified himself as a potential suspect.
2 14 The friendly receptionist said that the male witness identified himself as a potential suspect.
3 14 The security guard said that the female witness identified himself as a potential suspect.
4 14 The friendly receptionist said that the female witness identified himself as a potential suspect.
5 14 The security guard said that the female witnesses identified himself as a potential suspect.
6 14 The friendly receptionist said that the female witnesses identified himself as a potential suspect.

1 15 The legendary rock star said that the band manager inspired himself to write a new song.
2 15 The legendary rock star said that the band manager inspired himself to write a new song.
3 15 The legendary rock star said that the female groupie inspired himself to write a new song.
4 15 The legendary rock star said that the female groupie inspired himself to write a new song.
5 15 The legendary rock star said that a few groupies inspired himself to write a new song.
6 15 The legendary rock star said that the female groupies inspired himself to write a new song.

1 16 The strict judge said that the jail warden convinced himself that the testimony was false.
2 16 The pretty newswoman said that the jail warden convinced himself that the testimony was false.
3 16 The strict judge said that the elderly woman convinced himself that the testimony was false.
4 16 The pretty newswoman said that the elderly woman convinced himself that the testimony was false.
5 16 The strict judge said that the elderly women convinced himself that the testimony was false.
6 16 The pretty newswoman said that the elderly women convinced himself that the testimony was false.

1 17 The radical feminist claimed that the armored policewoman prevented herself from joining the unsafe protest.
2 17 The radical protester claimed that the armored policewoman prevented herself from joining the unsafe protest.
3 17 The radical feminist claimed that the armored policeman prevented herself from joining the unsafe protest.
4 17 The radical protester claimed that the armored policeman prevented herself from joining the unsafe protest.
5 17 The radical feminist claimed that the armored policemen prevented herself from joining the unsafe protest.
6 17 The radical protester claimed that the armored policemen prevented herself from joining the unsafe protest.

1 18 The corrupt councilman said that the outspoken senator should appoint himself as the new county commissioner.
2 18 The corrupt councilwoman said that the outspoken senator should appoint himself as the new county commissioner.
3 18 The corrupt councilman said that the female senator should appoint himself as the new county commissioner.
4 18 The corrupt councilwoman said that the female senator should appoint himself as the new county commissioner.
The corrupt councilman said that the female senators should appoint himself as the new county commissioner.
The corrupt councilwoman said that the female senators should appoint himself as the new county commissioner.
The gullible librarian claimed that the mischievous schoolgirl tricked herself into believing that the story was true.
The gullible principal claimed that the mischievous schoolgirl tricked herself into believing that the story was true.
The gullible librarian claimed that the mischievous schoolboy tricked herself into believing that the story was true.
The gullible principal claimed that the mischievous schoolboy tricked herself into believing that the story was true.
The gullible librarian claimed that the mischievous schoolboys tricked herself into believing that the story was true.
The gullible principal claimed that the mischievous schoolboys tricked herself into believing that the story was true.

The innocent secretary said that the female lawyer defended herself in the court case.
The innocent manager said that the female lawyer defended herself in the court case.
The innocent secretary said that the persuasive lawyer defended herself in the court case.
The innocent manager said that the persuasive lawyer defended herself in the court case.
The innocent secretary said that the persuasive lawyers defended herself in the court case.
The innocent manager said that the persuasive lawyers defended herself in the court case.

The flustered nurse said that the female patient considered herself to be very attractive.
The flustered doctor said that the female patient considered herself to be very attractive.
The flustered nurse said that the male patient considered herself to be very attractive.
The flustered doctor said that the male patient considered herself to be very attractive.
The flustered nurse said that some of the chefs criticized herself for the horrible mistake.
The flustered doctor said that some of the chefs criticized herself for the horrible mistake.

The elderly woman said that the devout nun forgave herself for the secret affair.
The elderly man said that the devout nun forgave herself for the secret affair.
The elderly woman said that the devout priest forgave herself for the secret affair.
The elderly man said that the devout priest forgave herself for the secret affair.
The elderly woman said that the devout priests forgave herself for the secret affair.
The elderly man worried that the devout priests forgave herself for the secret affair.
1 24 The polite nanny worried that the dishonest maid would blame herself for the accident in the driveway.
2 24 The polite mailman worried that the dishonest maid would blame herself for the accident in the driveway.
3 24 The polite nanny worried that the dishonest gardener would blame herself for the accident in the driveway.
4 24 The polite mailman worried that the dishonest gardener would blame herself for the accident in the driveway.
5 24 The polite nanny worried that the dishonest gardeners would blame herself for the accident in the driveway.
6 24 The polite mailman worried that the dishonest gardeners would blame herself for the accident in the driveway.

1 25 The busy seamstress said that the flustered woman distracted herself from the important task.
2 25 The pool boy said that the noisy woman distracted herself from the important task.
3 25 The busy seamstress said that the noisy man distracted herself from the important task.
4 25 The pool boy said that the noisy man distracted herself from the important task.
5 25 The busy seamstress said that the noisy men distracted herself from the important task.
6 25 The pool boy said that the noisy men distracted herself from the important task.

1 26 The successful businessman said that the handsome reporter characterized himself as a greedy entrepreneur.
2 26 The successful businesswoman said that the handsome reporter characterized himself as a greedy entrepreneur.
3 26 The successful businessman said that the female reporter characterized himself as a greedy entrepreneur.
4 26 The successful businesswoman said that the female reporter characterized himself as a greedy entrepreneur.
5 26 The successful businessman said that the female reporters characterized himself as a greedy entrepreneur.
6 26 The successful businesswoman said that the female reporters characterized himself as a greedy entrepreneur.

1 27 The undercover policeman said that the cautious sergeant recorded himself talking about the secret plot.
2 27 The undercover policewoman said that the cautious sergeant recorded himself talking about the secret plot.
3 27 The undercover policeman said that the female spy recorded himself talking about the secret plot.
4 27 The undercover policewoman said that the female spy recorded himself talking about the secret plot.
5 27 The undercover policeman said that the female spies recorded himself talking about the secret plot.
6 27 The undercover policewoman said that the female spies recorded himself talking about the secret plot.

1 28 The sorority girl said the pretty cheerleader complimented herself on the new dress.
2 28 The frat boy said the pretty cheerleader complimented herself on the new dress.
3 28 The sorority girl said the football player complimented herself on the new dress.
4 28 The frat boy said the pretty football player complimented herself on the new dress.
5 28 The sorority girl said the football players complimented herself on the new dress.
6 28 The frat boy said the pretty football players complimented herself on the new dress.
1 29 The female hiker said that the girl scout taught herself how to build a fire.
2 29 The rugged hiker said that the girl scout taught herself how to build a fire.
3 29 The female hiker said that the boy scout taught herself how to build a fire.
4 29 The rugged hiker said that the boy scout taught herself how to build a fire.
5 29 The female hiker said that the boy scouts taught herself how to build a fire.
6 29 The rugged hiker said that the boy scouts taught herself how to build a fire.
1 30 The hip rapper said that the record producer photographed himself on the large stage.
2 30 The female publicist said that the record producer photographed himself on the large stage.
3 30 The hip rapper said that the female groupie photographed himself on the large stage.
4 30 The female publicist said that the female groupie photographed himself on the large stage.
5 30 The hip rapper said that the female groupies photographed himself on the large stage.
6 30 The female publicist said that the female groupies photographed himself on the large stage.
1 31 The brave policeman reported that the elderly man nominated himself for the prestigious award.
2 31 The brave policewoman reported that the elderly man nominated himself for the prestigious award.
3 31 The brave policeman reported that the elderly woman nominated himself for the prestigious award.
4 31 The brave policewoman reported that the elderly woman nominated himself for the prestigious award.
5 31 The brave policeman reported that several elderly women nominated himself for the prestigious award.
6 31 The brave policewoman reported that several elderly women nominated himself for the prestigious award.
1 32 The teenage girl said that the female coach motivated herself to win the championship.
2 32 The teenage boy said that the female coach motivated herself to win the championship.
3 32 The teenage girl said that the basketball coach motivated herself to win the championship.
4 32 The teenage boy said that the basketball coach motivated herself to win the championship.
5 32 The teenage girl said that the basketball coaches motivated herself to win the championship.
6 32 The teenage boy said that the basketball coaches motivated herself to win the championship.
1 33 The shy girl said that the mean librarian embarrassed herself in the school cafeteria.
2 33 The shy boy said that the mean librarian embarrassed herself in the school cafeteria.
3 33 The shy girl said that the mean bully embarrassed herself in the school cafeteria.
4 33 The shy boy said that the mean bully embarrassed herself in the school cafeteria.
5 33 The shy girl said that the mean bullies embarrassed herself in the school cafeteria.
6 33 The shy boy said that the mean bullies embarrassed herself in the school cafeteria.
1 34 The elderly man complained that the busy waiter didn't notice himself standing by the table.
2 34 The elderly woman complained that the busy waiter didn't notice himself standing by the table.
3 34 The elderly man complained that the busy waitress didn't notice himself standing by the table.
4 34 The elderly woman complained that the busy waitress didn't notice himself standing by the table.
5 34 The elderly man complained that the busy waitresses didn't notice himself standing by the table.
6 34 The elderly woman complained that the busy waitresses didn't notice himself standing by the table.

1 35 The friendly chef said that the kind butcher gave himself an extra large tip for the excellent meal.

2 35 The friendly waitress said that the kind butcher gave himself an extra large tip for the excellent meal.

3 35 The friendly chef said that the kind businesswoman gave himself an extra large tip for the excellent meal.

4 35 The friendly waitress said that the kind businesswoman gave himself an extra large tip for the excellent meal.

5 35 The friendly chef said that the few businesswomen gave himself an extra large tip for the excellent meal.

6 35 The friendly waitress said that the kind businesswomen gave himself an extra large tip for the excellent meal.

1 36 The female suspect said that the teenage girl revealed herself as the real criminal.

2 36 The male suspect said that the teenage girl revealed herself as the real criminal.

3 36 The female suspect said that the teenage boy revealed herself as the real criminal.

4 36 The male suspect said that the teenage boy revealed herself as the real criminal.

5 36 The female suspect said that the teenage boys revealed herself as the real criminal.

6 36 The male suspect said that the teenage boys revealed herself as the real criminal.

**Experiment 2:**

1 1 The quiet librarian said that the studious schoolgirl reminded herself about the overdue book.

2 1 The strict father said that the studious schoolgirl reminded herself about the overdue book.

3 1 The quiet librarian said that the studious schoolboy reminded herself about the overdue book.

4 1 The strict father said that the studious schoolboy reminded herself about the overdue book.

5 1 The quiet librarian said that the brief memo reminded herself about the overdue book.

6 1 The strict father said that the brief memo reminded herself about the overdue book.

1 2 The efficient secretary mentioned that the female lawyer praised herself for a good job.

2 2 The efficient manager mentioned that the female lawyer praised herself for a good job.

3 2 The efficient secretary mentioned that the rude lawyer praised herself for a good job.

4 2 The efficient manager mentioned that the rude lawyer praised herself for a good job.

5 2 The efficient secretary mentioned that the thank you letter praised herself for a good job.

6 2 The efficient manager mentioned that the thank you letter praised herself for a good job.

1 3 The flustered nurse said that the female patient pricked herself in the hospital room.

2 3 The flustered doctor said that the female patient pricked herself in the hospital room.

3 3 The flustered nurse said that the male patient pricked herself in the hospital room.

4 3 The flustered doctor said that the male patient pricked herself in the hospital room.

5 3 The flustered nurse said that the sharp needle pricked herself in the hospital room.

6 3 The flustered doctor said that the sharp needle pricked herself in the hospital room.

1 4 The democratic senator claimed that the new spokesman distinguished himself from the other politicians.

2 4 The dutiful receptionist claimed that the new spokesman distinguished himself from the other politicians.
3 4 The democratic senator claimed that the new spokeswoman distinguished himself from the other politicians.
4 4 The dutiful receptionist claimed that the new spokeswoman distinguished himself from the other politicians.
5 4 The democratic senator claimed that several unique skills distinguished himself from the other politicians.
6 4 The dutiful receptionist claimed that several unique skills distinguished himself from the other politicians.

1 5 The royal princess thought that the elderly queen depicted herself as a strict person.
2 5 The royal prince thought that the elderly queen depicted herself as a strict person.
3 5 The royal princess thought that the elderly king depicted herself as a strict person.
4 5 The royal prince thought that the elderly king depicted herself as a strict person.
5 5 The royal princess thought that the biographical film depicted herself as a strict person.
6 5 The royal prince thought that the biographical film depicted herself as a strict person.

1 6 The elderly woman said that the devout nun calmed herself down after the stressful day.
2 6 The elderly man said that the devout nun calmed herself down after the stressful day.
3 6 The elderly woman said that the devout priest calmed herself down after the stressful day.
4 6 The elderly man said that the devout priest calmed herself down after the stressful day.
5 6 The elderly woman said that a long bath calmed herself down after the stressful day.
6 6 The elderly man said that a long bath calmed herself down after the stressful day.

1 7 The city councilwoman said that the girl scout characterized herself as a helpful person.
2 7 The city councilman said that the girl scout characterized herself as a helpful person.
3 7 The city councilwoman said that the boy scout characterized herself as a helpful person.
4 7 The city councilman said that the boy scout characterized herself as a helpful person.
5 7 The city councilwoman said that the news article characterized herself as a helpful person.
6 7 The city councilman said that the news article characterized herself as a helpful person.

1 8 The female witness claimed that the distracted mistress misrepresented herself in the murder trial.
2 8 The male witness claimed that the distracted mistress misrepresented herself in the murder trial.
3 8 The female witness claimed that the distracted judge misrepresented herself in the murder trial.
4 8 The male witness claimed that the distracted judge misrepresented herself in the murder trial.
5 8 The female witness claimed that the written testimony misrepresented herself in the murder trial.
6 8 The male witness claimed that the written testimony misrepresented herself in the murder trial.

1 9 The friendly waitress mentioned that the outspoken hostess recommended herself for the new position.
2 9 The friendly waiter mentioned that the outspoken hostess recommended herself for the new position.
3 9 The friendly waitress mentioned that the outspoken chef recommended herself for the new position.
4 9 The friendly waiter mentioned that the outspoken chef recommended herself for the new position.
5 9 The friendly waitress mentioned that the reference letter recommended herself for the new position.
The friendly waiter mentioned that the reference letter recommended herself for the new position.

The aspiring actress worried that the beautiful comedian portrayed herself as a dumb person.
The aspiring actor worried that the handsome comedian portrayed herself as a dumb person.
The aspiring actress worried that the popular movie portrayed herself as a dumb person.
The aspiring actor worried that the popular movie portrayed herself as a dumb person.

The worried nanny said that the startled maid calmed herself down after the accident.
The worried mailman said that the startled maid calmed herself down after the accident.
The worried nanny said that the pool boy calmed herself down after the accident.
The worried mailman said that the pool boy calmed herself down after the accident.

The skilled businesswoman said that the new saleswoman described herself as a hard worker.
The skilled businessman said that the new saleswoman described herself as a hard worker.
The skilled businesswoman said that the new salesman described herself as a hard worker.
The skilled businessman said that the new salesman described herself as a hard worker.
The skilled businesswoman said that the annual evaluation described herself as a hard worker.
The skilled businesswoman said that the annual evaluation described herself as a hard worker.

The wealthy banker worried that the stock broker cast himself in a negative light.
The diligent secretary worried that the stock broker cast himself in a negative light.
The wealthy banker worried that the lazy mother cast himself in a negative light.
The diligent secretary worried that the lazy mother cast himself in a negative light.

The skilled businesswoman said that the new saleswoman described herself as a hard worker.
The skilled businessman said that the new saleswoman described herself as a hard worker.
The skilled businesswoman said that the new salesman described herself as a hard worker.
The skilled businessman said that the new salesman described herself as a hard worker.
The skilled businesswoman said that the annual evaluation described herself as a hard worker.
The skilled businesswoman said that the annual evaluation described herself as a hard worker.

The famous painter thought that the jazz guitarist depicted himself as a stylish individual.
The famous painter thought that the jazz guitarist depicted himself as a stylish individual.
The famous painter thought that the nimble ballerina depicted himself as a strong individual.
The famous painter thought that the nimble ballerina depicted himself as a strong individual.
The famous painter thought that the self-portrait depicted himself as a strong individual.
The famous painter thought that the self-portrait depicted himself as a strong individual.

The brave policeman reported that the elderly man saved himself from the large fall.
The brave policewoman reported that the elderly man saved himself from the large fall.
The brave policeman reported that the elderly woman saved himself from the large fall.
The brave policewoman reported that the elderly woman saved himself from the large fall.
The brave policeman reported that the safety net saved himself from the large fall.
The brave policewoman reported that the safety net saved himself from the large fall.

The hip rapper thought that the record producer branded himself as a stylish individual.
The female publicist thought that the record producer branded himself as a stylish individual.
The hip rapper thought that the excited groupie branded himself as a stylish individual.
The female publicist thought that the excited groupie branded himself as a stylish individual.

The female publicist thought that the bold style branded himself as a stylish individual.
The female publicist thought that the bold style branded himself as a stylish individual.

The famous painter thought that the jazz guitarist depicted himself as a strong individual.
The female publicist thought that the nimble ballerina depicted himself as a strong individual.
The female publicist thought that the nimble ballerina depicted himself as a strong individual.
The famous painter thought that the self-portrait depicted himself as a strong individual.
The female publicist thought that the self-portrait depicted himself as a strong individual.

The busy secretary thought that the naval officer portrayed himself as a great leader.
The brave soldier thought that the sociable wife portrayed himself as a great leader.
The busy secretary thought that the sociable wife portrayed himself as a great leader.
The brave soldier thought that the news story portrayed himself as a great leader.
The busy secretary thought that the news story portrayed himself as a great leader.
The busy seamstress said that the distracted mother pinched herself on the pinky finger.
The pool boy said that the distracted mother pinched herself on the pinky finger.
The busy seamstress said that the distracted father pinched herself on the pinky finger.
The pool boy said that the distracted father pinched herself on the pinky finger.
The busy seamstress said that the broken zipper pinched herself on the pinky finger.
The pool boy said that the broken zipper pinched herself on the pinky finger.
The friendly receptionist said that the flustered stewardess identified herself as an authorized employee.
The security guard said that the flustered stewardess identified herself as an authorized employee.
The friendly receptionist said that the flustered pilot identified herself as an authorized employee.
The security guard said that the flustered pilot identified herself as an authorized employee.
The friendly receptionist said that the name tag identified herself as an authorized employee.
The security guard said that the name tag identified herself as an authorized employee.
The talented actor mentioned that the influential spokesman praised himself for a great job.
The talented actress mentioned that the influential spokesman praised himself for a great job.
The talented actor mentioned that the influential spokeswoman praised himself for a great job.
The talented actress mentioned that the influential spokeswoman praised himself for a great job.
The talented actor mentioned that the fan letter praised himself for a great job.
The talented actress mentioned that the fan letter praised himself for a great job.
The successful businessman said that the wealthy investor characterized himself as a greedy entrepreneur.
The successful businesswoman said that the wealthy investor characterized himself as a greedy entrepreneur.
The successful businessman said that the wealthy heiress characterized himself as a greedy entrepreneur.
The successful businesswoman said that the wealthy heiress characterized himself as a greedy entrepreneur.
The successful businessman said that the news article characterized himself as a greedy entrepreneur.
The successful businesswoman said that the news article characterized himself as a greedy entrepreneur.
The undercover policeman said that the cautious sergeant disguised himself in the dense crowd.
The undercover policewoman said that the cautious sergeant disguised himself in the dense crowd.
The undercover policeman said that the female spy disguised himself in the dense crowd.
The undercover policewoman said that the female spy disguised himself in the dense crowd.
The undercover policeman said that the dark uniform disguised himself in the dense crowd.
6 22 The undercover policewoman said that the dark uniform disguised himself in the dense crowd.
1 23 The clumsy chef said that the charming butcher cut himself quite badly on the arm.
2 23 The clumsy waitress said that the charming butcher cut himself quite badly on the arm.
3 23 The clumsy chef said that the charming hostess cut himself quite badly on the arm.
4 23 The clumsy waitress said that the charming hostess cut himself quite badly on the arm.
5 23 The clumsy chef said that the sharp knife cut himself quite badly on the arm.
6 23 The clumsy waitress said that the sharp knife cut himself quite badly on the arm.
1 24 The frat boy thought that the restaurant manager presented himself as a resourceful person.
2 24 The sorority girl thought that the restaurant manager presented himself as a resourceful person.
3 24 The frat boy thought that the cleaning lady presented himself as a resourceful person.
4 24 The sorority girl thought that the cleaning lady presented himself as a resourceful person.
5 24 The frat boy thought that the job application presented himself as a resourceful person.
6 24 The sorority girl thought that the job application presented himself as a resourceful person.
1 25 The elderly man complained that the busy busboy burned himself at the new restaurant.
2 25 The elderly woman complained that the busy busboy burned himself at the new restaurant.
3 25 The elderly man complained that the busy hostess burned himself at the new restaurant.
4 25 The elderly woman complained that the busy hostess burned himself at the new restaurant.
5 25 The elderly man complained that the hot coffee burned himself at the new restaurant.
6 25 The elderly woman complained that the hot coffee burned himself at the new restaurant.
1 26 The influential congresswoman said that the kindergarten teacher inspired herself to be a better person.
2 26 The influential congressman said that the kindergarten teacher inspired herself to be a better person.
3 26 The influential congresswoman said that the school principal inspired herself to be a better person.
4 26 The influential congressman said that the school principal inspired herself to be a better person.
5 26 The influential congresswoman said that the motivational workshop inspired herself to be a better person.
6 26 The influential congressman said that the motivational workshop inspired herself to be a better person.
1 27 The trustworthy policeman said that the bank robber criticized himself for the horrible mishap.
2 27 The trustworthy policewoman said that the bank robber criticized himself for the horrible mishap.
3 27 The trustworthy policeman said that the young girl criticized himself for the horrible mishap.
4 27 The trustworthy policewoman said that the young girl criticized himself for the horrible mishap.
5 27 The trustworthy policeman said that the harsh email criticized himself for the horrible mishap.
6 27 The trustworthy policewoman said that the harsh email criticized himself for the horrible mishap.
1 28 The concerned housewife said that the clumsy beautician shocked herself in the small kitchen.
2 28 The construction worker said that the clumsy beautician shocked herself in the small kitchen.
3 28 The concerned housewife said that the clumsy plumber shocked herself in the small kitchen.
4 28 The construction worker said that the clumsy plumber shocked herself in the small kitchen.
5 28 The concerned housewife said that the faulty electrical wire shocked herself in the small kitchen.
6 28 The construction worker said that the faulty electrical wire shocked herself in the small kitchen.
1 29 The famous coach claimed that the football referee described himself as a mean person.
2 29 The football cheerleader claimed that the football referee described himself as a mean person.
3 29 The famous coach claimed that the polite newswoman described himself as a mean person.
4 29 The football cheerleader claimed that the polite newswoman described himself as a mean person.
5 29 The famous coach claimed that the candid biography described himself as a mean person.
6 29 The football cheerleader claimed that the candid biography described himself as a mean person.
1 30 The rugged hiker thought that the recreational hunter isolated himself from modern society.
2 30 The girl scout thought that the recreational hunter isolated himself from modern society.
3 30 The rugged hiker thought that the female hiker isolated himself from modern society.
4 30 The girl scout thought that the remote campsite isolated himself from modern society.
5 30 The rugged hiker thought that the remote campsite isolated himself from modern society.
6 30 The girl scout thought that the remote campsite isolated himself from modern society.
1 31 The legendary diva said that the beauty queen inspired herself to achieve great things.
2 31 The legendary rock star said that the beauty queen inspired herself to achieve great things.
3 31 The legendary diva said that the quiet cameraman inspired herself to achieve great things.
4 31 The legendary rock star said that the quiet cameraman inspired herself to achieve great things.
5 31 The legendary diva said that the beautiful poem inspired herself to achieve great things.
6 31 The legendary rock star said that the beautiful poem inspired herself to achieve great things.
1 32 The persuasive salesman thought that the skilled craftsman would set himself apart from the competitors.
2 32 The persuasive saleswoman thought that the skilled craftsman would set himself apart from the competitors.
3 32 The persuasive salesman thought that the skilled seamstress would set himself apart from the competitors.
4 32 The persuasive saleswoman thought that the skilled seamstress would set himself apart from the competitors.
5 32 The persuasive salesman thought that the new tactic would set himself apart from the competitors.
6 32 The persuasive saleswoman thought that the new tactic would set himself apart from the competitors.
1 33 The strict judge said that the jail warden convinced himself that the testimony was false.
2 33 The pretty newswoman said that the jail warden convinced himself that the testimony was false.
3 33 The strict judge said that the elderly woman convinced himself that the testimony was false.
4 33 The pretty newswoman said that the elderly woman convinced himself that the testimony was false.
5 33 The strict judge said that the new evidence convinced himself that the testimony was false.
6 33 The pretty newswoman said that the new evidence convinced himself that the testimony was false.
1 34 The teenage girl knew that the prom queen would get herself in trouble with the police.
The teenage boy knew that the prom queen would get herself in trouble with the police.
The teenage girl knew that the prom king would get herself in trouble with the police.
The teenage boy knew that the prom king would get herself in trouble with the police.
The teenage girl knew that the blatant lie would get herself in trouble with the police.
The teenage boy knew that the blatant lie would get herself in trouble with the police.

The radical feminist claimed that the polite newswoman prevented herself from commenting about the recent riot.
The violent protester claimed that the polite newswoman prevented herself from commenting about the recent riot.
The radical feminist claimed that the polite newsman prevented herself from commenting about the recent riot.
The violent protester claimed that the polite newsman prevented herself from commenting about the recent riot.
The radical feminist claimed that the strict law prevented herself from commenting about the recent riot.
The violent protester claimed that the strict law prevented herself from commenting about the recent riot.

The corrupt councilman mentioned that the outspoken senator would appoint himself as the new county commissioner.
The corrupt councilwoman mentioned that the outspoken senator would appoint himself as the new county commissioner.
The corrupt councilman mentioned that the female senator would appoint himself as the new county commissioner.
The corrupt councilwoman mentioned that the female senator would appoint himself as the new county commissioner.
The corrupt councilman mentioned that the proposed legislation would appoint himself as the new county commissioner.
The corrupt councilwoman mentioned that the proposed legislation would appoint himself as the new county commissioner.

The brief memo that the studious schoolgirl noticed was posted the notice board.
The brief memo that the studious schoolgirls noticed was posted the notice board.
The brief memo that the studious schoolgirls noticed were posted the notice board.
The brief memo that the studious schoolgirl noticed were posted the notice board.
The brief memo that the studious schoolgirls noticed reminded themselves to return the overdue books.
The brief memo that the studious schoolgirl noticed reminded themselves to return the overdue books.

The thank you letter that the helpful secretary received was sent from a very important client.
The thank you letter that the helpful secretaries received was sent from a very important client.
The thank you letter that the helpful secretaries received were sent from a very important client.
The thank you letter that the helpful secretary received were sent from a very important client.
The thank you letter that the helpful secretaries received praised themselves for a great job.
The thank you letter that the helpful secretary received praised themselves for a great job.

**Experiment 3:**

The brief memo that the studious schoolgirl noticed was posted the notice board.
The brief memo that the studious schoolgirl noticed was posted the notice board.
The brief memo that the studious schoolgirls noticed were posted the notice board.
The brief memo that the studious schoolgirl noticed were posted the notice board.
The brief memo that the studious schoolgirls noticed reminded themselves to return the overdue books.
The brief memo that the studious schoolgirl noticed reminded themselves to return the overdue books.

The thank you letter that the helpful secretary received was sent from a very important client.
The thank you letter that the helpful secretaries received was sent from a very important client.
The thank you letter that the helpful secretaries received were sent from a very important client.
The thank you letter that the helpful secretary received were sent from a very important client.
The thank you letter that the helpful secretaries received praised themselves for a great job.
The thank you letter that the helpful secretary received praised themselves for a great job.
The sharp needle that the flustered nurse used was contaminated with several strands of bacteria.

The sharp needle that the flustered nurses used was contaminated with several strands of bacteria.

The sharp needle that the flustered nurses used were contaminated with several strands of bacteria.

The sharp needle that the flustered nurse used were contaminated with several strands of bacteria.

The sharp needle that the flustered nurses used pricked themselves several times in the operating room.

The sharp needle that the flustered nurse used pricked themselves several times in the operating room.

The unique skills that the democratic candidate possessed was a major factor in the presidential election.

The unique skills that the democratic candidates possessed was a major factor in the presidential election.

The unique skills that the democratic candidates possessed were a major factor in the presidential election.

The unique skills that the democratic candidate possessed were a major factor in the presidential election.

The unique skills that the democratic candidates possessed distinguished themselves from the republican candidates.

The unique skills that the democratic candidate possessed distinguished themselves from the republican candidates.

The documentary film that the famous actor starred in was shown in all of the major theaters.

The documentary film that the famous actors starred in was shown in all of the major theaters.

The documentary film that the famous actors starred in were shown in all of the major theaters.

The documentary film that the famous actor starred in were shown in all of the major theaters.

The documentary film that the famous actors starred in depicted themselves in a very positive light.

The documentary film that the famous actor starred in depicted themselves in a very positive light.

The new medication that the sick patient took was very expensive for the insurance companies.

The new medication that the sick patients took was very expensive for the insurance companies.

The new medication that the sick patients took were very expensive for the insurance companies.

The new medication that the sick patient took were very expensive for the insurance companies.

The new medication that the sick patients took prevented themselves from having seizures.

The new medication that the sick patient took prevented themselves from having seizures.

The newspaper article that the rich executive read was quite misleading about the facts.

The newspaper article that the rich executives read was quite misleading about the facts.

The newspaper article that the rich executives read were quite misleading about the facts.

The newspaper article that the rich executive read were quite misleading about the facts.

The newspaper article that the rich executives read characterized themselves as very greedy snobs.
6  The newspaper article that the rich executive read characterized themselves as very greedy snobs.
1  The written testimony that the eye-witness read was reviewed by the lawyers.
2  The written testimony that the eye-witnesses read was reviewed by the lawyers.
3  The written testimony that the eye-witnesses read were reviewed by the lawyers.
4  The written testimony that the eye-witness read were reviewed by the lawyers.
5  The written testimony that the eye-witnesses read quoted themselves in very explicit detail.
6  The written testimony that the eye-witness read quoted themselves in very explicit detail.
1  The reference letter that the job applicant submitted was written by a recent employer.
2  The reference letter that the job applicants submitted was written by a recent employer.
3  The reference letter that the job applicants submitted were written by a recent employer.
4  The reference letter that the job applicant submitted were written by a recent employer.
5  The reference letter that the job applicants submitted recommended themselves for the new position.
6  The reference letter that the job applicant submitted recommended themselves for the new position.
1  The hilarious movie that the aspiring actor appeared in was a major hit in the theaters.
2  The hilarious movie that the aspiring actors appeared in was a major hit in the theaters.
3  The hilarious movie that the aspiring actors appeared in were a major hit in the theaters.
4  The hilarious movie that the aspiring actor appeared in were a major hit in the theaters.
5  The hilarious movie that the aspiring actors appeared in made themselves look like ridiculous idiots.
6  The hilarious movie that the aspiring actor appeared in made themselves look like ridiculous idiots.
1  The soothing tea that the nervous student drank was imported from India.
2  The soothing tea that the nervous students drank was imported from India.
3  The soothing tea that the nervous students drank were imported from India.
4  The soothing tea that the nervous student drank were imported from India.
5  The soothing tea that the nervous students drank calmed themselves down after the test.
6  The soothing tea that the nervous student drank calmed themselves down after the test.
1  The annual report that the businessman read was emailed to the manager.
2  The annual report that the businessmen read was emailed to the manager.
3  The annual report that the businessmen read were emailed to the manager.
4  The annual report that the businessman read were emailed to the manager.
5  The annual report that the businessmen read described themselves as extremely productive workers.
6  The annual report that the businessman read described themselves as extremely productive workers.
1  The harsh report that the wealthy banker read was discussed in all of the newspapers.
2  The harsh report that the wealthy bankers read was discussed in all of the newspapers.
3  The harsh report that the wealthy bankers read were discussed in all of the newspapers.
4  The harsh report that the wealthy banker read were discussed in all of the newspapers.
5  The harsh report that the wealthy bankers read cast themselves in a negative light.
6  The harsh report that the wealthy banker read cast themselves in a negative light.
1  The safety net that the brave policeman used was made of synthetic material.
2  The safety net that the brave policemen used was made of synthetic material.
3 14 The safety net that the brave policemen used were made of synthetic material.
4 14 The safety net that the brave policeman used were made of synthetic material.
5 14 The safety net that the brave policemen used saved themselves from the large fall.
6 14 The safety net that the brave policeman used saved themselves from the large fall.
1 15 The music video that the hip rappers made was shown on national television.
2 15 The music video that the hip rappers made was shown on national television.
3 15 The music video that the hip rappers made were shown on national television.
4 15 The music video that the hip rapper made were shown on national television.
5 15 The music video that the hip rappers made branded themselves as gangster thugs.
6 15 The music video that the hip rapper made branded themselves as gangster thugs.
1 16 The self-portrait that the famous artist painted was sold at a very high price.
2 16 The self-portrait that the famous artists painted was sold at a very high price.
3 16 The self-portrait that the famous artists painted were sold at a very high price.
4 16 The self-portrait that the famous artist painte were sold at a very high price.
5 16 The self-portrait that the famous artists painted depicted themselves in revealing poses.
6 16 The self-portrait that the famous artist painted depicted themselves in revealing poses.
1 17 The TV commercial that the brave soldier appeared in was broadcast on national television.
2 17 The TV commercial that the brave soldiers appeared in was broadcast on national television.
3 17 The TV commercial that the brave soldiers appeared in were broadcast on national television.
4 17 The TV commercial that the brave soldier appeared in were broadcast on national television.
5 17 The TV commercial that the brave soldiers appeared in portrayed themselves as great leaders.
6 17 The TV commercial that the brave soldiers appeared in portrayed themselves as great leaders.
1 18 The broken zipper that the skilled tailor tried to fix was replaced with a new one.
2 18 The broken zipper that the skilled tailors tried to fix was replaced with a new one.
3 18 The broken zipper that the skilled tailors tried to fix were replaced with a new one.
4 18 The broken zipper that the skilled tailor tried to fix were replaced with a new one.
5 18 The broken zipper that the skilled tailors tried to fix pinched themselves repeatedly on their fingers.
6 18 The broken zipper that the skilled tailor tried to fix pinched themselves repeatedly on their fingers.
1 19 The security system that the police officer used was recently installed in the airport.
2 19 The security system that the police officers used was recently installed in the airport.
3 19 The security system that the police officers used were recently installed in the airport.
4 19 The security system that the police officer used were recently installed in the airport.
5 19 The security system that the police officers used identified themselves as authorized employees.
6 19 The security system that the police officer used identified themselves as authorized employees.
1 20 The slanderous accusation that the wealthy executive disregarded was full of inaccurate information.
2 20 The slanderous accusation that the wealthy executives disregarded was full of inaccurate information.
3 20 The slanderous accusation that the wealthy executives disregarded were full of inaccurate information.
4 20 The slanderous accusation that the wealthy executive disregarded were full of inaccurate information.
The slanderous accusation that the wealthy executives disregarded characterized themselves as extremely greedy.

The fan letter that the famous actor received was written by a teenage girl.

The fan letter that the famous actors received praised themselves for doing such a great job.

The dark uniform that the undercover cop wore disguised themselves in the dense crowd.

The sharp knife that the clumsy chef used cut themselves when it wasn't properly used.

The annual report that the new intern submitted presented themselves as very resourceful.

The motivational workshop that the kindergarten teacher attended inspired themselves to become better people.

The apologetic email that the office manager sent was read by many of the employees.
The apologetic email that the office manager sent was read by many of the employees. The apologetic email that the office manager sent were read by many of the employees. The apologetic email that the office managers sent blamed themselves for the horrible mistake. The apologetic email that the office managers sent were read by many of the employees. The faulty electrical wire that the inexperienced electrician installed was made of copper. The faulty electrical wire that the inexperienced electricians installed was made of copper. The faulty electrical wire that the inexperienced electricians installed were made of copper. The faulty electrical wire that the inexperienced electricians installed shocked themselves when they tested it out. The candid biography that the famous athlete authorized was a best-seller for several months. The candid biography that the famous athletes authorized were a best-seller for several months. The candid biography that the famous athletes authorized described themselves as extremely rude. The remote campsite that the rugged hiker discovered was near a small creek. The remote campsite that the rugged hikers discovered were near a small creek. The remote campsite that the rugged hikers discovered isolated themselves from the loud city. The beautiful poem that the young teenager read was written by a blind person. The beautiful poem that the young teenagers read were written by a blind person. The beautiful poem that the young teenagers read inspired themselves to achieve great things. The important evidence that the clumsy criminal left behind was found by the police. The important evidence that the clumsy criminals left behind were found by the police. The important evidence that the clumsy criminals left behind incriminated themselves in the court trial. The new evidence that the skeptical juror reviewed was inspected by the police. The new evidence that the skeptical jurors reviewed were inspected by the police.
5 33 The new evidence that the skeptical jurors reviewed convinced themselves that the suspect was guilty.
6 33 The new evidence that the skeptical juror reviewed convinced themselves that the suspect was guilty.
1 34 The blatant lie that the teenage boy told was actually believed by the police.
2 34 The blatant lie that the teenage boys told was actually believed by the police.
3 34 The blatant lie that the teenage boys told were actually believed by the police.
4 34 The blatant lie that the teenage boy told were actually believed by the police.
5 34 The blatant lie that the teenage boys told got themselves in a lot of trouble.
6 34 The blatant lie that the teenage boy told got themselves in a lot of trouble.
1 35 The strict law that the peaceful protestor hated was repealed by the city mayor.
2 35 The strict law that the peaceful protestors hated was repealed by the city mayor.
3 35 The strict law that the peaceful protestors hated were repealed by the city mayor.
4 35 The strict law that the peaceful protestor hated were repealed by the city mayor.
5 35 The strict law that the peaceful protestors hated prevented themselves from speaking in public.
6 35 The strict law that the peaceful protestor hated prevented themselves from speaking in public.
1 36 The controversial legislation that the councilman authorized was disliked by many citizens.
2 36 The controversial legislation that the councilmen authorized was disliked by many citizens.
3 36 The controversial legislation that the councilmen authorized were disliked by many citizens.
4 36 The controversial legislation that the councilman authorized were disliked by many citizens.
5 36 The controversial legislation that the councilmen authorized appointed themselves to the board of trustees.
6 36 The controversial legislation that the councilman authorized appointed themselves to the board of trustees.