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Referential resolution for resumptive pronouns in island-violating sentences

A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Science in Linguistics Department from
William & Mary

by

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Accepted for _____Honors_____

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1 Introduction

One of the biggest questions that naturally arises about human cognition of language is whether our production and comprehension of language share the same language resource in mind. The success of communication depends on utterances that fall under some systematic rules, and they both seem to work reliably well. But how do we know these two entirely opposite processes are just two directions of the same road or two different roads with the same endpoints? In neuroscience terms, the question becomes whether production and comprehension share the same neuro resource in our brains.

The obvious answer is yes, they share the same resource, at least some if not all. It is pretty impractical if production and comprehension are completely separate, which would mean that, for example, a lexicon must have two copies in the brain, one for production and one for comprehension. If this is not an exact match, one would produce a word but fail to recognize it in listening, which results in speaking and comprehending two different languages. Since we all can tell that the language we produce and comprehend is the same, they should at least share some resources.

Then the question is how much they share and what the sharing mechanism is, which remains a controversy in the field. There is, however, a syntactic structure that provides unique production and perception properties – resumptive pronouns in islands. Islands have been one of the most studied structures in the field of syntax as their acceptability is judged as on the edge of English grammar which poses interesting questions about what exactly is grammaticality. Resumptive pronouns are suggested to be a strategy that “saves” the grammaticality of island-violating sentences. Resumptive pronouns in islands are even more

intriguing as they are often found in production, bearing that they are unacceptable in comprehension. Acceptability judgments and production, two common metrics used to probe grammaticality, nearly always align, which would be consistent with that production and comprehension share linguistic resources. However, the asymmetry here for resumptive pronouns in islands poses a challenge to this view. If production and perception do share the same resource, an explanation of what makes the grammaticality of resumptive pronouns fluid is required. Conversely, this central view of the production and perception of language needs to be reconsidered.

This paper will first provide a review of the up-to-date literature on resumptive pronouns in islands. It will then switch to an overview of ambiguity theory and discuss how the confusability of resumptive pronouns is potentially comparable to ambiguity. The later part discusses an experiment that probes the current problem.

1.1 Resumptive Pronouns in Islands

1.1.1 Resumptive Pronouns in English

English has filler-gap dependency where a pronominal element bounded by a clausal-periphery element is often realized as a gap. (1) gives an example of such a sentence.

(1) There was one prisoner$_i$ that the guard taunted __$_i$ mercilessly.

Cross-linguistically, some languages, such as Hebrew, Irish (McCloskey 2006), and Arabic (Aoun and Choueiri 1996), allow pronouns in these positions, known as resumptive pronouns (RP). (2) gives an example in Irish. Both a gap and a resumptive pronoun is allowed to index the filler. However, resumptive pronouns are generally ungrammatical in English, as shown in (3).

(2) Irish

a. an ghirseach a ghoid na síogaí ___
the girl C stole the fairies t
'the girl who the fairies kidnapped'

b. an ghirseach a ghoid na síogaí í
the girl C stole the fairies her
'the girl who the fairies kidnapped'
(McCloskey 2006)

(3) *There was one prisoner$_i$ that the guard taunted *him$_i$ mercilessly.

Intriguingly, bearing its unacceptability, resumptive pronouns are occasionally produced.

(4) "We have these things called aircraft carriers$_i$, where planes land on **them**$_i$."
-Barack Obama (Davidson Sorkin, 2012)

Sentences like (4) can also be reliably elicited in production studies. Bennett (2008) and Radford (2019) both found RP produced in the corpus. Ferreira & Swets (2005) successfully elicited RP in island constructions in both timed and untimed tasks. Morgan & Wagers (2018) tested RP production in various constructions and concluded that RP is mostly produced in the subject position of the adjunct island. All of these are pointing to Ross's (1967) and Chomsky's (1977) claim that islands seem to encourage RP production.

Islands are the structures that prevent the extraction of elements from inside a clause to outside, as illustrated in (5).

(5) *That's the box of sushi$_i$ that John believes the fact that the girl ate __$_i$/it$_i$.

In this sentence, since moving the object out is not allowed, gapping is ungrammatical. However, many studies have shown that using RP instead of gapping would make this sentence more acceptable. Ackerman (2018) found that readers prefer RP over gap in a forced-choice task. Keshev & Meltzer-Asscher (2017) found that RP is more acceptable than a gap in complex NP islands. Morgan & Wagers (2018) showed that RP is more acceptable when the gap is less acceptable. It has been suggested that RP "rescues" the grammaticality of island-violating sentences, although the mechanism behind these results remains unclear.

1.1.2 Current Proposals for the Processing of RP in Islands

Scholars have proposed many possible mechanisms about how resumptive pronouns may possibly "save" the island. Overall, the discussion is centered around whether RP helps production and whether it helps comprehension. The early leading account was that RP does not aid comprehension but benefits production. In recent years, it has also been shown that RP also serves as an aid to comprehension, although it still remains uncertain.

Many early studies account for the asymmetry by a production facilitation approach. This approach argues that RP production is a result of helping the speakers to deliver a complete sentence to the best of their ability. Since RP is unacceptable in comprehension (Alexopoulou & Keller 2007, Heestand, Xiang, & Polinsky 2011), it is clearly not grammatical and it is also not a rescuer of islands. Thus, it is a production strategy that speakers employ. According to Heestand, Xiang, & Polinsky (2011), RP functions like a cross-sentential anaphora, concluding that this asymmetry is not a problem with grammar but a problem in production planning.

Levelt (1989) outlined a production mechanism that involves grammatical encoding and self-monitoring. This mechanism is spelled out in Morgan & Wagers (2018) which proposed a detailed production model to explain RP in islands. In their model, speakers trigger an unsuccessful filler-gap dependency in the grammatical encoding which results in the rise of the possibility of producing RP. This is consistent with Ferreria & Swets's (2005) data that RP in islands has a longer onset time, which means that it requires more planning and look-a-head. During the production, speakers actively monitor the acceptability of the sentence produced. When the filler-gap dependency breaks down, they give up the global

well-formedness and instead use RP to satisfy local well-formedness. The likelihood of such breakdown should depend on the acceptability of gap, which is consistent with their data that RP is more common when gap is less acceptable. All of the production-based approaches could lead to the conclusion that production is at least somewhat separated from comprehension.

In recent years, more studies have pointed out the amelioration effect RP has on comprehension. Beltrama and Xiang (2016) found that RP was judged as more "comprehensible" than gap when the task asks for comprehensibility judgment instead of acceptability judgment. Ackerman, Frazier, and Yoshida (2018) found that when RP and gap structures are compared directly, RP is preferred in islands while gap is preferred in non-islands. Chacon (2019) proposed that although a gap is the preferred representation for the filler-gap dependency when the filler is lost due to length or constraints in memory load, RP permits the comprehender to reconstruct a coherent interpretation. All of these data suggest that RP aids comprehension and that the previous studies failed to detect such effect due to task effects.

In addition to these off-line judgment experiments, scholars also began to pay attention to the real-time processing of RP. Hofmeister & Norcliffe (2013) first showed that RP has a faster reading time than gap in non-islands in self-paced reading tasks. This result is replicated by Morgan et al. (2020), yet they also found that resumption hinders comprehension. Very recently, Hammerly (2021) tested the reading time of RP more specifically in islands, and found that RP is read faster than gap such that RP helps listeners to form the dependency which would otherwise be blocked by the island. His study

nevertheless also did not show a difference in comprehension between gap and RP in islands. Overall, it is still debatable whether RP helps real-time processing or not in islands.

1.1.3 The Current Puzzle

The question behind why it remains unclear if RP facilitates online processing turns out to be about the linking hypothesis: what does a faster reading time in a self-paced reading (SPR) task really entail? Being one of the most fundamental experimental methods in psycholinguistics, SPR roots in processing difficulty that could be "classified as either an ambiguity, an anomaly, or a distance dependency" (Jegerski 2013). By common sense, if one thing is more difficult to process, it will take longer to read. An ambiguity is hard to process because it contains multiple possible interpretations that the listener needs to choose from, an anomaly contains a violation of grammar that makes the presented word difficult to fit into a syntactic representation, and a long-distance dependency presents a relationship between two non-adjacent elements that would be challenging to resolve in linear order. All of these add to the difficulty in processing, but it is necessary to pinpoint the cause for such difficulty. Different causes may lead to drastically different conclusions about the processing mechanism. It is thus worth asking what the cause really is for our case, RP in island, that resulted in the faster reading times.

The RP in island problem, however, lies at the middle ground of those possible causes. Hofmeister & Norcliffe (2013) and Hammerly (2021) realize the cause as distance dependency. They claim that the faster reading times indicate that RP facilitates active dependency formation. RP in island is clearly also an anomaly since it is not grammatical in

Standard English after all. As Morgan et al. (2020) argued, the faster reading time of RP is not a result of processing facilitation but of listeners giving up processing. This anomaly may nonetheless also lead to confusion at the resumption site, as listeners are in need to search for an antecedent that would form a coherent interpretation. If the listeners have abandoned grammatical representation and begun to accept ungrammatical features (Chacon 2019), they would search not for the grammatical filler but for a possible, coherent filler. This confusability may thus potentially be comparable to ambiguity, and the faster reading time may fall under the ambiguity advantage effect, as speculated by Cokal et al. (2022) who presented the first SPR data that showed slower reading times for RPs in islands. Overall, it remains unclear what is the linking hypothesis for SPR for our RPs in islands problem. This paper aims to make the first effort to test out the real cause of faster reading time for RPs in islands.

Observe that the stimuli from Morgan et al. (2020) have multiple feature-matching referents, as shown in (6)[1]. Although there is only one (arguably) structurally possible antecedent, having more than one feature-matching referents may make the referent of the RP more confusable.

(6) *It is Mr. Dino$_{i?}$ that Mr. Rabbit$_{i?}$ wondered whether Miss Piggy tickled __$_i$/him$_i$ with a feather.
(Morgan et al. 2020)

On the contrary, Cokal et al.'s (2022) stimuli only have one feature-matching antecedent, as shown in (7).

[1] Here we only consider Morgan et al.'s (2020) data because it tests RP in an island and the task is word-by-word reading. Hofmeister & Norcliffe (2013) is not with island and Hammerly (2021) is a phrase-by-phrase reading, so they are less a good comparison with Cokal et al. (2022).

(7) *This is the magazine$_i$ that Jane wondered whether the hairdresser had talked about __$_i$/it$_i$ before going to the salon.
(Cokal et al. 2022)

We can see that both Morgan et al. (2020) and Cokal et al. (2022) used whether islands – a weak island – in their stimuli, yet they yielded different results. The first was shown to have a faster reading time, and the latter has a slower reading time. One possible reason, thus, is the difference in the number of feature-matching referents (Cokal et al. 2022). Going back to a point made earlier, if this is indeed the cause of such reading time difference, RP's confusability may relate to the ambiguity advantage effect, discussed below, which states that pronouns with multiple feature-matching referents are easier to process relative to those that only have one feature-matching referent. The current study builds on this gap in the literature. I hypothesize that RP processing is sensitive to the number of feature-matching referents. Its faster reading time might be a result of a special kind of confusion that is comparable to ambiguity. This is to say, listeners do not entirely "give up" processing, but they are satisfied to associate the RP with an ambiguous referent. In the next section, we will turn to discuss the ambiguity theory and how it connects to RP processing.

1.2 Ambiguity Resolution

Another place where people need to resolve an interpretation among multiple possibilities is ambiguity. How people resolve ambiguous utterances has been another major topic in language processing. Ambiguity generally has three main types: lexical ambiguity,

structural ambiguity, and referential ambiguity. Lexical ambiguity happens when a single word may have multiple interpretations. This could be due to syntactic reasons (e.g., *present* can be as a noun or as a verb) or semantic reasons (homonymy or polysemy) (Small et al. 1988). Structural ambiguity occurs when a sentence could have more than one representation. Referential ambiguity is when a pronoun or anaphora could have two possible antecedents. The three examples below illustrate the three types.

(8) Lexical: I went to the *bank*.

(9) Structural: The son of the driver that had the moustache was pretty cool.
(Traxler et al. 1998)

(10) Referential: Kenny assured Harry that he was prepared for the new job.
(Badecker & Straub 1994)

As a type of pronoun, RP falls the referential ambiguity. While there are pretty clear pieces of evidence that showed lexical ambiguity and structural ambiguity have different processing strategies, the resolution of referential ambiguity remains a debate. Some argue it is affected by the competition and thus has an ambiguity disadvantage effect as it does in lexical ambiguity; others claim that it is processed in parallel and allows underspecification as structural ambiguity does, which fosters the ambiguity advantage effect. Here, we will take a closer look at the current question for referential ambiguity by how pronouns work in general and what the state-of-art literature tells about its processing.

1.2.1 Pronoun Interpretation

Firstly, let's take a closer look at how we interpret pronouns in unambiguous cases. Previous studies suggested three constraints that confine the pronoun to the correct antecedent: morphosyntactic features, semantic focus, and structural binding.

Morphosyntactic features include gender, number, person, and more according to the inflection system of the language. Each feature constrains the matching of the pronoun to an antecedent that conforms to the pronoun's features. Studies such as Erlish (1980) showed that processing is facilitated when there is only one feature-matching antecedent in local contexts. Studies such as Gordon & Chan (1995) and Grosz et al. (1995) have illustrated that in addition to morphosyntax constraints, more prominent members of the semantic focus of the sentence would facilitate interpretation. That is, if the antecedent is at the focus of the discussion, it would also help with the interpretation of the pronoun.

Moreover, syntactic structures also play a key role in interpreting a pronoun. As a dependent component of an entity mentioned earlier in the sentence (although not necessarily), a pronoun is governed by the binding theory and its Principle B which states that a pronoun must be free in its binding domain (Chomsky 1981). As illustrated in (11), (11a) complies with these constraints, whereas (11b) violates Principle B because the pronoun is c-commanded by its antecedent..

(11) a. Mary_i said that [John kissed her_i].

b. *Mary_i kissed her_i.

1.2.2 Current Proposals for Pronoun Referential Ambiguity

People have been looking at the processing difficulty of pronoun ambiguity from three aspects. The first aspect is how the overall parsing architecture behind ambiguity processing is reflected in referential ambiguity. Many have argued for various models of such architectures that could explain referential ambiguity behaviors. The second aspect is what factors influence pronoun ambiguity. For factors discussed in the previous section, people are curious about how each factor affects the resolution process and how they intertwine together, if they do. The third aspect, which could be the most relevant to our discussion, argues about if pronoun ambiguity has an advantage effect on processing or the opposite, a disadvantage effect. As a similar question we discussed for RPs in islands in section 1.1, it asks about how pronoun ambiguity influences processing difficulty. This section will outline how each aspect has been discussed in the field and what the state-of-art evidence is like.

Ambiguous reference is where there are multiple referents that fulfill all the requirements (as shown in example 10). Many studies have proposed models and strategies for how people resolve referential ambiguity. Three major models include the competition-based race model, the unrestricted race model, and the parallel model. The competition-based race model proposes that when a new possible referent appears, it will compete against the current interpretation. This model is rooted in the competition effect and reanalysis. The competition effect adds to the difficulty of processing and thus leads to a longer reading time. The unrestricted race model differentiates global ambiguity from local ambiguity. In local ambiguity, when a referent is realized to be impossible, reanalysis is triggered and thus adds to the difficulty of processing. However, in global referential ambiguity, as in (10), since there is no unlicensed referent, no reanalysis is triggered and there

should not be any competition. The last model, the parallel model, allows for underspecification. It states that comprehenders keep track of all possible referents and allow multiple possible referents to be activated, so it is not thought to trigger competition. Overall, the competition-based model is all but ruled out by available evidence, but there is insufficient evidence that could substantiate either the unrestricted race model or the parallel model.

One thing we do know about referential ambiguity is that its processing difficulty is not a result of a single constraint; rather, all the constraints discussed in section 1.2.1 contribute to this difficulty. Nicol & Swinney (1989) presented the first study that reported facilitation for structural licensed antecedents. They tested both anaphora and pronouns and concluded that the initial set of candidates is determined by grammaticality and that only referents allowed by the binding theory are included in the candidate set. They argue that this is an exceptionless process and semantic-based selection is only processed after this initial filtering. Sturt (2002) tested the role of morphosyntactic features and presented evidence that processing difficulty is observed when the gender of the antecedent mismatches with the target anaphora. Badecker & Straub (2002) further studied the effects of these constraints. They claim that instead of a stage-wise process, the candidate set results from multiple constraints simultaneously influencing the selection. Their data showed that structurally unlicensed referents interfere with the resolution process if they are also semantically prominent and match with the morphosyntactic features. From here, it is clear that no matter how the constraints influence the resolution process, the difficulty in processing ambiguous references holistically results from all three constraints.

Moreover, a similar question as the one discussed for RP above also arises for ambiguity resolution – does ambiguity facilitate processing or hinder processing? Many studies have made efforts to find out about this question in the past twenty years, and the current data seems to point to that it depends on the depth of processing. The depth of processing is task-dependent. Tasks that involve comprehension are usually considered as deep processing since they ask the participants to thoroughly process the information in the sentence. Comparatively, tasks that do not include comprehension are shallow. Stewart et al. (2007) tested whole sentence reading time and found that ambiguous pronouns are read at the same speed as unambiguous ones in shallow processing yet slower in deep processing. Sentences with ambiguous pronouns were read the fastest, although this failed to be statistically significant. Swets et al. (2008) further tested with self-paced reading and found an ambiguity advantage effect in reading time in shallow processing. This advantage is attenuated in deep processing, but the reading time is still faster than in unambiguous cases. Grant et al. (2020) again reported that ambiguous pronouns are read faster in their SPR study (shallow processing), supporting an ambiguity advantage effect. Creemers et al. (2021) made partial replication of Stewart et al. (2007) and directly compared pronoun ambiguity in deep and shallow processing with either SPR only or SPR plus comprehension questions. Their data again shows that a processing penalty exists for deep processing but none for shallow processing. To sum up, we observe contradictory data from the literature. While it is plausible that the depth of processing contributes to the difficulty of processing, we could not tell exactly how it is reflected.

1.3 The Confusability of RP in Islands and Ambiguity

Recall that in 1.1, we discussed that the main hindrance of resolving RPs in islands is the difficulty in resolving filler-gap dependency. Islands syntactically prohibit such dependency resolution, making it a difficult task for comprehenders due to the incompleteness of syntactic representation. Here, we propose the confusability of RPs in islands could be comparable to be of a kind of ambiguity.

As discussed in the last section, ambiguity resolution seems to depend on the depth of processing, although the current data are not very consistent. We find further inconsistencies when looking at the RP data with respect to the depth of processing. While no current study has directly tested the effect of the depth of processing on RPs in islands, we can infer the processing depth required by their methods used by past studies to compare the effect of processing depth across them. Results from Hofmeister & Norcliffe (2013), Morgan et al. (2020), and Hammerly (2021) all showed faster reading time, although Hofmeister & Norcliffe's task was shallow while Morgan et al. and Hammerly's tasks require deep processing which involves comprehension. Cokal et al.'s (2021) study reported slower reading times, yet it is a shallow processing task in contrast to the faster reading time shown by Hofmeister & Norcliffe (2013) which is also a shallow processing task. Together with the noise of experimental methods and stimuli sentence types, we do not have enough evidence to consider the depth of processing as a factor that influences the processing difficulty of RPs in islands.

The problem of resolving the filler-gap dependency of RPs in islands is comparable to resolving referential ambiguity in many ways. Firstly, since RPs in islands are ungrammatical, none of the referents are licensed by syntax. Compared to structural

ambiguity which has multiple licensed representations, RPs in islands is the opposite – multiple unlicensed representations. The two share the factor that all possible representations are either all acceptable or unacceptable. This could thus make the confusion of RPs in islands "ambiguous" but in the opposite way. In fact, there is one study, Meng & Bader (2000) that makes direct comparisons between ambiguity and ungrammaticality. Their data show that ambiguous sentences and the corresponding ungrammatical sentences have similar mismatch effects at the disambiguating site and that factors that regulate the reanalysis for ambiguity have the same effects on ungrammatical ones. Their finding reinforces our assumption that the processing difficulty caused by ungrammaticality may work in a similar fashion as ambiguity resolution.

Another more straightforward reason for processing difficulty is the morphosyntactic features. Since all the possible referents are structurally unlicensed, it could be favorable for comprehenders to thus put at least some weight on the morphosyntactic features to resolve the filler-gap dependency. As morphosyntactic features also play a role in filtering possible referents in ambiguity, from this aspect, we could also assume that the confusability caused by having multiple feature-matching referents is comparable to the processing difficulty in ambiguity. One such example is the stimuli used by Morgan et al. (2020). Their stimuli have multiple feature-matching referents and they lead to faster reading time, which could be directly comparable to referential ambiguity.

If the two constraints discussed above all contribute to the confusability of RPs in islands, just as both structural and morphosyntactic constraints both play a role in referential ambiguity resolution, it is logical to compare confusability and ambiguity. In the present study, we will build on this assumption and probe the comparison between the confusability

of RPs in islands and referential ambiguity. By doing so we also aim to explain the reading time discrepancy between Morgan et al. (2020) and Cokal et al. (2022).

2 The Present Study

To address the question of whether RPs in islands has confusability advantage effect, a self-paced reading experiment was run that manipulated the number of feature-matching referents for RPs in islands sentences. A comprehension task will force deep processing, which could be informative about whether the listeners make an effort to comprehend the sentence or simply give up processing it. If we assume a confusability advantage effect parallel to the ambiguity advantage effect, we should expect a faster reading time in sentences that have multiple feature-matching referents and the same comprehension accuracy.

2.1 Methodology

Each trial in this experiment consists of two tasks. The first task is a word-by-word self-paced reading task where participants are asked to read through a given sentence one word at a time, clicking a key to advance. The second task is a multiple-choice comprehension question that asks the participants to retrieve a referent for the pronoun in the sentence. The experiment consists of a total of 24 items, including 8 target items and 16 filler items. The target sentences are complex NP islands, an unlicensed structure in English. Each sentence introduces a gender-clear person entity, two other persons by gender-clear names, and a pronoun (him/her) in the island clause that refers to the first of the three names. The

gender of person names is manipulated to have a controlled number of referents that match with that of the pronoun. One of the three name sites, the only (semi) grammatical site, always matches the gender. I include a total of four conditions in this experiment: 1 possible referent (PR), 2 possible referents (high, the attractor that is further from the RP), 2 possible referents (low, the local attractor), and 3 possible referents. (12) gives an example of the target items used in this experiment[2].

(12)

a. 1PR: That's the boy$_i$ that Maria believes the claim that Katie knew the government hired him$_i$ in elementary school.
b. 2PR high: That's the boy$_{i?}$ that James$_{i?}$ believes the claim that Katie knew the government hired him$_i$ in elementary school.
c. 2PR low: That's the boy$_{i?}$ that Maria believes the claim that James$_{i?}$ knew the government hired him$_i$ in high school.
d. 3PR: That's the boy$_{i?}$ that James$_{i?}$ believes the claim that Benjamin$_{i?}$ knew the government hired him$_i$ in high school.

A forced-choice comprehension question task follows the self-paced reading task. Each question is a forced-choice task. Four choices are given: the three person entities and an unsure choice that gives participants the choice to demonstrate their confusion and avoid guessing. (13) gives an example of the comprehension question task that would follow (12a).

[2] The word “referents” is used here and below meaning the collection of the antecedent and the attractors. In the examples, all referents that match the gender of the RP are co-indexed with “i?”, although syntactically only the first one could co-refer.

(13) Who did the government hire?

a. The boy

b. Maria

c. Katie

d. I don't know

The experiment includes a pseudo-block design. Each participant saw equal numbers of the four conditions (two 1PR, two 2PR high, two 2PR low, and two 3PR). Each block also included the same 16 filler items that have a similar structure to the target items but are grammatical.

2.2 Implication of Possible Outcomes

The results contain two parts: reading time and comprehension accuracy. The reading times indicate the difficulty of surface processing. As the experiment includes a comprehension task, which forces deep processing, different outcomes will have different implications. Reading times are compared across target conditions (between more or fewer numbers of feature-matching referents), and the comprehension results are compared across conditions. This section provides an overview of what each outcome combination may potentially imply for the processing mechanism.

We do not expect a better comprehension accuracy for our targets (RPs in islands) than fillers since people should always successfully resolve the referents in the fillers. If the resumptive pronouns with multiple feature-matching referents are read faster than those with

fewer feature-matching referents, an equal comprehension accuracy will support a true confusability (ambiguity) advantage effect, given the faster reading time. The interpretation of a faster reading time with lower comprehension accuracy would depend on the distribution of the comprehension data. If the comprehension result has an overwhelming amount of "I don't know" answers, it would mean that comprehenders do not fully process the sentence, which aligns with Morgen et al. (2020)'s "give-up" explanation. If other cases with faster reading times result in lower comprehension accuracy, it would support Cokal et al. (2021)'s speculation that processing is facilitated but comprehenders are satisfied with any feature-matching referent. In this scenario, comprehenders find it easier to resolve the dependency, but the dependency is not the logically successful one.

Another possibility is that the experiment yields slower reading times for pronouns with multiple feature-matching referents. The comprehension accuracy will again lead to different explanations. Since the task forces deep processing, an equal accuracy with slower reading time indicates that having more feature-matching referents adds to processing difficulty. Comprehenders fully process the sentence and are able to successfully resolve the dependency, yet it takes a longer time. A lower accuracy with longer reading times would mean that it adds to processing difficulty in both the processing layer and the comprehension layer. In this scenario, comprehenders still have a lower chance of successfully resolving the dependency even they are using a longer processing time. In contrast to the advantage effect, this indicates a profound disadvantage effect, which means that adding feature-matching referents makes people truly unable to resolve the dependency.

3 Results

55 undergraduate students at the William & Mary participated in this study for course credit through the SONA system. The experiment was hosted on PCIbex (Zehr, J. & Schwarz, F., 2018) and conducted on a web browser in a sound-attenuating booth. Each condition received a total of 109 data points (each participant reads two sentences for each condition), with half of one participant's data excluded due to a data recording glitch.

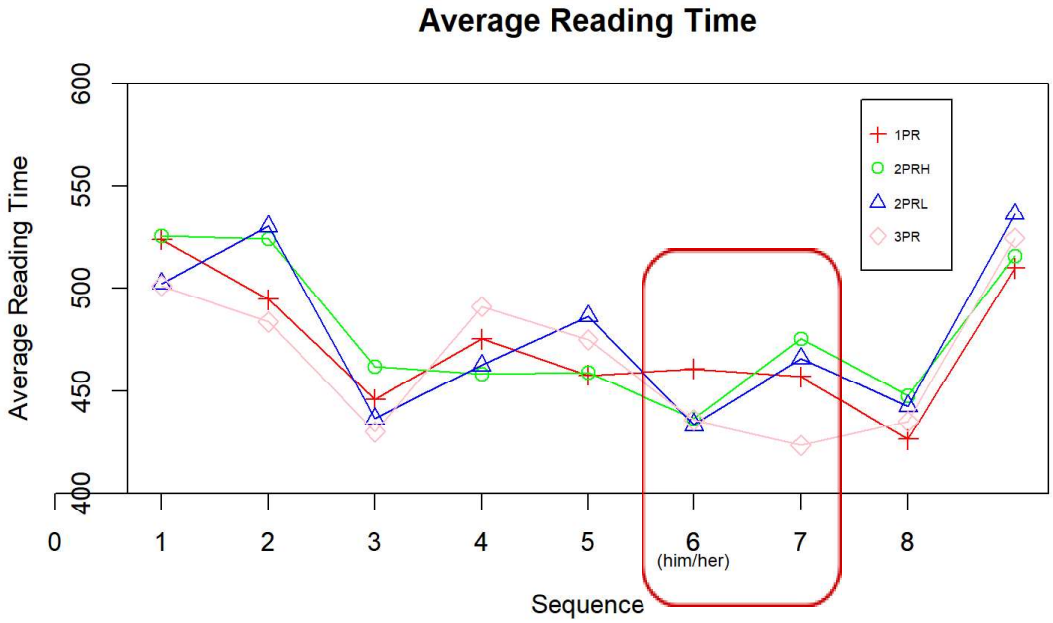
In reporting the reading time, I include the critical region at the RP site and a one-word spill-over after the RP. Data points above 1500 ms (1.5 seconds) are excluded as they are considered to be unnatural reading speeds[3]. According to the data, at the critical region, having 1PR slows down the reading time (see Table 1 and Figure 1; outlying reading time is bolded). 1PR and 2PR conditions are patterned together. At the spill-over region, 3PR significantly speeds up the processing, while the other three conditions have about similar average reading time.

Table 1 Mean Reading Time at Critical Region and Spill-over Region

	Critical Region (ms)	Spill-over (ms)
1PR	**460.6147**	456.8716
2PRH	436.6355	475.2617
2PRL	433.5192	465.7308
3PR	435.8972	**423.6075**

[3] The exclusion criteria of 1500 milliseconds seem to have an impact on the overall result. It mostly influenced the pattern for the 2PRL condition, which have five data points between 1500ms to 2000ms. If the exclusion criteria is 2000ms, 2PRL has the slowest average reading time at both the critical region and the spill-over region.

Figure 1 Average Reading Time



Two-sample t-tests were conducted for statistical analysis in R between all four conditions (R Core Team, 2020). The difference in mean at the critical region is not significant (possibly due to insufficient power, discussed in Section 4), and while the reading time for 3PR is faster than for the others in the spill-over region, only the difference between 3PR and 2PRH was statistically significant. Table 2 shows *p*-values for all tests.

Table 2 Two-sample t-test Results at Critical Region

p-value	1PR	2PRH	2PRL	3PR
1PR				
2PRH	0.34			
2PRL	0.32	0.89		
3PR	0.32	0.97	0.91	

Table 3 Two-sample t-test Results at Spill-over Region

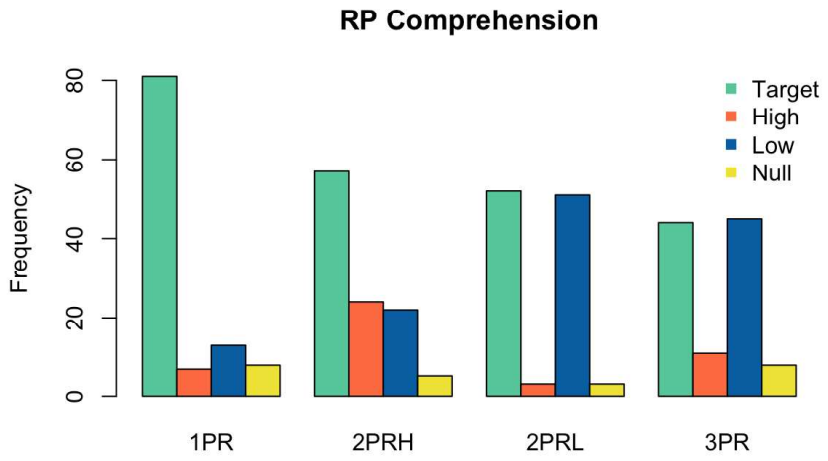
p-value	1PR	2PRH	2PRL	3PR
1PR				
2PRH	0.48			
2PRL	0.70	0.73		
3PR	0.11	0.05*	0.07	

Comprehension results show a negative relationship between the percentage of correctness and the number of PRs available (see Table 4 and Figure 2). 1PR has the best comprehension with 74.3% accuracy. 2PRH and 2PRL have similar accuracy around 50%. 3PR has the worst accuracy about 40%. This is the pattern we predicted in Section 2.2: the more feature-matching referents available, the worse the comprehension.

Table 4 Overall Comprehension Results

	Target	High Attractor	Low Attractor	"I don't know"	Percent Correct
1PR	81	7	13	8	74.3%
2PRH	57	24	22	3	52.2%
2PRL	52	3	51	3	47.7%
3PR	44	11	45	8	40.3%

Figure 2 Comprehension Distribution



4 General Discussion

The current evidence appears to be in support of our hypothesis that RP has confusability advantage effect. This section will discuss evidence in support of RP confusability advantage, insights for the model of RP processing, and other implications.

4.1 Evidence for RP Confusability Advantage

Firstly, the difference in comprehension accuracy indicates that people are able to use the morphosyntactic features as a cue in resolving the reference of an RP. Having more referents that match the gender of the RP brings more confusion, which leads to worse comprehension. The difference in distribution across the four conditions also reinforces that participants are actively tracking the gender feature throughout the sentence. People are sensitive to the number of gender-matching referents and their location.

The first piece of evidence for our hypothesis is the slow-down of 1PR at the RP site. Numerically it is about 25 milliseconds slower than the other three conditions. While these differences are not significant in statistical testing, it could be due to not enough power since the difference is not large. Although the 1PR condition has the best comprehension, participants have a harder time resolving a referent to match the feature of the RP in real time when they reach the RP. In comparison, the other conditions have more than one feature-matching referent, whereby participants find it easier to resolve the RP. This suggests that having only one feature-matching referent does have a disadvantage in the real-time processing of RP.

The second piece of evidence is the speed-up of 3PR in the spill-over region. 3PR is processed about 40 milliseconds faster than the other three conditions. This means that having all feature-matching referents leads to less hesitation after the critical region. People are satisfied with the referent they resolve the RP for after the critical region, although it may not be the logically correct one. In other words, people do not seem to question their comprehension of the RPs in the 3PR condition. People do question their comprehension in 2PR conditions, which is shown in their slower reading time at the spill-over region. 3PR and 1PR does not have this effect. People unambiguously resolve the only feature-matching referent in 1PR condition, so there is less hesitation and it resulted in having the best comprehension. In 3PR, on the other hand, people are more likely to be happy with an ambiguous referent. There is little hesitation at the spill-over region but 3PR showed the worst comprehension of all four conditions.

Overall, the results of our experiment illustrate the confusability advantage effect for RPs. Having more feature-matching referents facilitates real-time processing of RP but worsens comprehension. It supports Cokal et al.'s speculation that the confusability of RPs may work in a similar fashion to the ambiguity advantage effect.

4.2 Insights for RP Processing

Previous studies on the processing of RPs mostly focused on how RPs perform compared to gaps in island-violating sentences. The current study provides a novel perspective that looks at how RPs can be sensitive to the availability of referents. Here, I provide some insights to further understand results in light of the previous literature and argue for a more comprehensive analysis for RPs in islands.

One main question is whether the faster reading time of RPs corresponds to easier processing than that of gaps. Recall that Morgan et al. (2020) argued that this speed-up in reading is due to people giving up processing. This current study seems to show evidence against this proposal. Morgan et al's study did not allow the participants to make a null selection to the comprehension question, whereas the current study did so. However, in all four conditions, people very rarely choose to say that they did not know about the answer, although they are explicitly told that they could do so and there is no absolutely correct answer before the experiment starts. The consistent pattern in the distribution of comprehension results seems to indicate people's satisfaction with the interpretation they found.

The current study found that the confusability of RPs in islands is comparable to the ambiguity advantage effect for pronoun interpretation. On the one hand, our study finds a new property of RP processing. On the other hand, it suggests that RPs may root more in referential interpretation than previously assumed. This comparable performance between RPs in islands and ambiguity may indicate that the ungrammatical sentences here are processed in similar ways as grammatical sentences. Both cases involve having multiple possible interpretations which build up processing difficulties. This is a piece of new evidence supporting that RPs save (at least some of) the grammaticality of islands to a level that is similar to hard-to-process grammatical sentences. In more general terms, the processing of ungrammatical sentences seems to involve similar cognitive processes as those used in processing grammatical ones. When a sentence is at the edge of grammar, its processing may not be that different from the grammatical ones. People may actually be quite good at finding ways to "save" the grammaticality of these bad sentences.

4.3 Other Implications

The comprehension results show that RP confusion has a strong local effect. Comparing 2PRL and 2PRH, we can see that although both have the same number of feature-matching referents and subjects show about the same accuracy on both, their comprehension distribution is very different. 2PRL received a lot more selections for the local referents, which indicates that when the local referent matches the gender, people have a strong preference to associate it with the RP. This can also be seen in the comprehension distribution of 3PR, in which the first referent and the local referent are both very frequently selected.

5 Conclusion

The current study shows that the processing of resumptive pronouns (RPs) in islands is sensitive to the number of feature-matching referents available in the sentence. This paper first explores the similarities and differences between RP processing and ambiguity resolution. It then shows a novel self-paced reading experiment that tested the reading times and comprehension of RPs manipulated with different numbers of feature-matching referents. The data supported the hypothesis that there exists an RP confusability advantage effect which is similar to the ambiguity advantage effect. A similar study with larger power may allow the finding to reach statistical significance. While this study showed the confusability advantage effect with animate pronouns, Cokal et al. (2022) first speculated this confusability advantage effect with their data on inanimate pronouns. Testing the effect with animate and inanimate pronouns may thus also be helpful to inform broader RP processing.

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Appendix

Appendix 1: Target Stimuli

Color codes indicate the group of stimuli (out of four) assigned to participants.

	1PR	2PRH	2PRL	3PR
1	That's the boy that Maria believes the claim that Katie knew the government hired him in elementary school.	That's the boy that James believes the claim that Katie knew the government hired him in elementary school.	That's the boy that Maria believes the claim that James knew the government hired him in high school.	That's the boy that James believes the claim that Benjamin knew the government hired him in high school.
2	That's the man that Beth acknowledges the possibility that Mary thought the conference invited him a month ago.	That's the man that Jack acknowledges the possibility that Mary thought the conference invited him a month ago.	That's the man that Beth acknowledges the possibility that Jack thought the conference invited him a month ago.	That's the man that Jack acknowledges the possibility that Tom thought the conference invited him a month ago.
3	That's the gentleman that Lily learned the fact that Grace heard the company fired him two weeks ago.	That's the gentleman that Andy learned the fact that Grace heard the company fired him two weeks ago.	That's the gentleman that Lily learned that Andy heard the company fired him two weeks ago.	That's the gentleman that Andy learned the fact that Henry heard the company fired him two weeks ago.
4	That's the king that Emma discovered the fact that Sarah thought the car belonged to him in the past.	That's the king that Michael discovered the fact that Sarah thought the car belonged to him in the past.	That's the king that Emma discovered the fact that Michael thought the car belonged to him in the past.	That's the king that Michael discovered the fact that Luke thought the car belonged to him in the past.
5	That's the lady that Leo believes the claim that Andrew heard the college admitted her before last spring.	That's the lady that Emily believes the claim that Andrew heard the college admitted her before last spring.	That's the lady that Leo believes the claim that Emily heard the college admitted her before last spring.	That's the lady that Emily believes the claim that Jenny heard the college admitted her before last spring.
6	That's the girl that Kevin acknowledges the possibility that Robert saw a	That's the girl that Victoria acknowledges the possibility that	That's the girl that Kevin acknowledges the possibility that Victoria saw a	That's the girl that Victoria acknowledges the possibility that

	publisher interview her a year ago.	Robert saw the publisher interviewed her a year ago.	publisher interview her a year ago.	Barbara saw a publisher interview her a year ago.
7	That's the queen that Nicholas revealed the fact that Joshua knew the book is written by her under a pseudonym.	That's the queen that Olivia revealed the fact that Joshua knew the book is written by her under a pseudonym.	That's the queen that Nicholas revealed the fact that Olivia knew the book is written by her under a pseudonym.	That's the queen that Olivia revealed the fact that Claire knew the book is written by her under a pseudonym.
8	That's the woman that Jimmy discovered the evidence that Adam learned the program enrolled her during the summer.	That's the woman that Alice discovered the evidence that Adam learned the program enrolled her during the summer.	That's the woman that Jimmy discovered the evidence that Alice learned the program enrolled her during the summer.	That's the woman that Alice discovered the evidence that Anna learned the program enrolled her during the summer.

Appendix 2: Filler Stimuli

1	That's the police officer who believes the claim that Betty witnessed the traffic accident on 31st Street.
2	That's the customer who believes the claim that the waiter mixed up all the food and drink orders.
3	That's the celebrity who raised the fact that the reporter hid in the bushes to photograph her new house.
4	That's the person who witnessed the process that the fireman had to smash a window to gain entrance to the house on fire.
5	That's the suspect who wonders whether the boy told the detectives what happened last night about the crime.
6	That's the student who doubted whether the teacher would bring a box of chocolate to class the next day.
7	That's the inspector who wonders whether the engineer pressed a button to activate the new machine.
8	That's the guest who wondered whether vegetarian dishes will be served at the dinner party.
9	That's the policeman who is trying to find out the source of the virus outbreak.
10	That's the software engineer who thinks that there is a bug in the system.

11	That's the presidential candidate who acknowledged the possibility that there might be an error in the poll result.
12	That's the trainer who believes the claim that the team needs a more sophisticated training regimen.
13	That's the analyst who wonders whether the level of competition on college sports has become fiercer.
14	That's the waiter who recommended the new cocktail to the guests who sat on the patio.
15	That's the reporter who thinks that the politician will give a speech at the fundraising event.
16	That's the tourist who wondered whether the art exhibition at the city museum was worth going to.