The pronoun which comprehenders who process it in islands derive a benefit*

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Final Version accepted for publication in *Linguistic Inquiry*

Abstract There is ongoing debate about the role that resumptive pronouns play in the processing of islands in intrusive resumption languages such as English. This squib provides evidence that resumptive pronouns facilitate the comprehension of islands in online processing. The results fall in line with filler-gap processing more generally: when fillers are difficult or impossible to keep active, resumption provides support for forming a dependency. This occurs when dependencies span multiple clauses, when memory resources are otherwise taxed, or, as the present paper shows, when grammatical constraints such as islands prohibit the use of the active filler strategy.

Keywords: resumptive pronouns, intrusive resumption, filler-gap processing, active filler strategy, islands, language comprehension

1 Introduction

Resumptive Pronouns (RPs) are well known to "rescue" island-violating structures in many languages of the world (Aoun, Choueiri, and Hornstein, 2001; McCloskey, 2006). However, the effect of RPs on the felicity of islands in so-called *intrusive* resumption languages such as English is far less clear. Intuitive judgments within theoretical syntax have frequently suggested that RPs in English do in fact rescue syntactic islands, or at least aid in the comprehension of the argument structure relations within an island (Ross, 1967; Prince, 1990; Asudeh, 2004, 2012). For example, while still considered sub-standard English, many re-

port an increase in acceptability with the resumptive sentence in (1a) compared to its gapped counterpart (1b) (example from Ross, 1967, p. 433).

(1) a. %All the students who the papers which they submitted were lousy I'm not going to allow to register next term.
b. *All the students who the papers which ___ submitted were lousy I'm not going to allow to register next term.

Recent decades have seen a proliferation of attempts to test whether these effects can be observed experimentally. In contrast to the reported judgments, initial studies in this vein found no evidence that RPs in English ameliorate islands, as measured by changes in acceptability with Likert scales (Heestand, Xiang, and Polinsky, 2011; Polinsky, Clemens, Morgan, Xiang, and Heestand, 2013) and magnitude estimation (Alexopoulou and Keller, 2007; Omaki and Nakao, 2010).

Taking these results at face value, a puzzle that emerges is why resumption is so commonly observed in production both in natural speech and in the lab (e.g. Prince, 1990; Ferreira and Swets, 2005; Morgan and Wagers, 2018) if it is considered unacceptable by comprehenders. The leading idea is that resumption in English provides no detectable benefit to listeners, but does serve as an aid for speakers (Polinsky et al., 2013). This amounts to adopting a so-called "selfish-speaker" model, where speakers (unconsciously) optimize based on decreasing processing cost for themselves, rather than decreasing costs for the listener. Speakers, who are presumably aware of the argument structure dependencies which they intend to convey, use resumption just in case these dependencies become difficult to produce: i.e. in islands and dependencies that span multiple clauses. In contrast, the use of RPs is claimed to have no benefit for comprehenders, accounting for the low ratings in acceptability judgment tasks.

Recent work has challenged the claim that RPs in English entirely fail to aide comprehenders with dependency formation into islands. Beltrama and Xiang (2016) attribute the previously observed lack of acceptability to the framing of the task and context: ratings increase when participants are asked to judge the comprehensibility of a sentence rather than the acceptability, and more contextually salient antecedents for RPs are rated more highly. In a similar vein, Ackerman, Frazier, and Yoshida (2018) show that when participants engage in a task where they explicitly compare gapped and resumptive counterparts, the befit of RPs increases, again suggesting that previous failures to observe an ameliorating effect of resumption is the result of a task effect. Finally, Chacón (2019) reports that resumption becomes increasingly acceptable as memory load increases, supporting an account where the acceptability of resumption is tied to difficulty in a listener's ability to engage in active gap filling (see also Asudeh, 2004, 2012).

While the above results are suggestive, none provides a direct test of whether RPs benefit the comprehension of islands *online*. Until very recently (while this paper was under review; see Morgan, von der Malsburg, Ferreira, and Wittenberg, 2020, discussed further in section 6.2), work on the real-time processing of resumption in English has only examined the role of RPs in non-island violating structures (Dickey, 1996; Hofmeister and Norcliffe, 2013), both of which show that RPs speed-up reading time as dependency length grows longer. Therefore, the debate about whether RPs ease the comprehension of islands in intrusive resumption languages remains unresolved.

2 The Current Experiment

The current study examines the role of resumptive pronouns in the online comprehension of *wh*-islands. There are two questions: (i) whether there is evidence of a real-time benefit for RPs in island violating structures as measured by a speed-up in reading time, and (ii) whether such a speed-up can be linked to better performance in questions targeting sentence comprehension. A full list of items and fillers including comprehension questions, as well as raw data, analysis scripts, and experimental scripts, can be accessed here: https://osf.io/g9q5a/.

The experiment (N = 48) included 24 experimental items of the form in (2), where ISLANDHOOD (non-island/wh-island) and DEPENDENCY (gap/RP) were manipulated. Names stereotypically mismatching the gender of the RP were used to prevent a locally coherent parse of the embedded clause from creating a decrease in reading time (e.g. as in *...Aaron announced that the agency had recruited him...*). Each sentence was split into chunks, denoted by slashes in (2), for moving-window self-paced reading (run in lab using Ibex Farm; Drummond, 2013). Participants read through the chunks of the sentence one-by-one, pressing the spacebar with their right pointer finger to move from one chunk to the next. Response time (RT) was measured by recording the time between button presses, providing an approximate measure of reading time for each chunk of the sentence. The critical region included the embedded verb and the RP/gap. The spillover was a three-word PP. The spillover region was always followed by a final wrap-up region.

(2) *Non-island (a) and wh-island (b) example experimental stimulus. Slashes denote self-paced reading regions. Critical and spillover regions labeled.*

a. Mary trained / the spy / who Beth / announced that the agency / /$_{\text{ctir}}$ had recruited {him, __ } /$_{\text{spill}}$ over the summer / for the program /

b. Mary trained / the spy / who Beth / announced which agency / /$_{\text{crit}}$ had recruited {him, __ } /$_{\text{spill}}$ over the summer / for the program /

Following the final chunk, a comprehension question with response options of the type exemplified in (3) was displayed. To prevent guessing and to gather a measure of comprehension difficulty, participants were specifically instructed to use the *confusion* response "I don't know" (3d) in case they felt they could not answer the question accurately. The other possible responses always corresponded to the *filler* (3a), the *non-local* gender mismatching distractor (3b), or the *local* distractor (3c). The order of responses was randomized for each trial, except for the confusion response which was always the fourth option. Participants made responses with their left hand using the number keys on the top of the keyboard.

(3) *Example comprehension question for example item in (2)*
Who was recruited over the summer?

a.	The spy	*Filler*
b.	Beth	*Non-local*
c.	The agency	*Local*
d.	I don't know	*Confusion*

A total of 60 grammatical filler sentences were randomly interspersed with the experimental items, making 86% of the sentences in the experiment grammatical. 24 of the fillers were items for a separate experiment on presupposition accommodation. Half of these fillers included a multi-clausal filler-gap dependency. Given that the comprehension questions for the critical experimental items always had the filler response as the target answer, we formulated questions that targeted different aspects of the sentence. The remaining 36 fillers were designed to further counterbalance the experimental items, including items that allowed for a valid resolution of the pronominal dependency in the embedded clause and items with superficial similarities to the island conditions. Comprehension questions for these fillers were also designed to target a variety of aspects of the sentence.

3 Results: SPR response time

Trials where RT for any given chunk was lower than 100ms or higher than 6s were discarded, resulting in a loss of 3.23% of trials overall. The goal of the absolute cutoffs was to choose values that correspond to the minimum amount of time to uptake information on the lower end, and the maximum amount of time that an attentive participant would spend on a given region on the upper end. These absolute cutoffs preserve the shape of the distribution, standing in contrast to standard deviation-based cutoffs, which can have a more severe effect. All reported values, including those for comprehension discussed in the following section, are based on the trimmed data set where these trials were rejected.

In the critical region, the key contrast between gaps and RPs was confounded by length (conditions with an RP were always 3 characters longer than those with a gap). Furthermore, it is common for effects in SPR to appear in the region following the critical portion of the sentence. Therefore the focus of the analysis is on the spillover region. Full region-by-region RT for each condition is given in table 1, with RT for the spillover region alone shown in figure 1. Mean RT in the spillover shows that when the dependency was tailed by a gap, RT was slower with *wh*-islands (902ms) compared to non-islands (768ms). However, the slowdown associated with *wh*-islands in the gapped conditions was attenuated by the presence of an RP (815ms), while RPs slowed reading relative to gaps in non-islands (826ms).

Raw RT for the spillover region was submitted to a maximal linear mixed effects model using the *lmerTest* package in R (Kuznetsova, Brockhoff, and Christensen, 2017) with fully crossed fixed effects of DEPENDENCY and ISLANDHOOD and subject and item random effects. The decision was made to test raw rather

than transformed RT, as raw RT increases power for interactive effects, is more interpretable, decreases researcher degrees of freedom, and is not associated with increases in Type 1 error rates, despite violating assumptions of normality (Liceralde and Gordon, 2018). The model revealed a significant main effect of ISLANDHOOD (Estimate (SE) = -54.96 (25.35), t = -2.16, p = 0.031), as well as a significant two-way interaction between DEPENDENCY and ISLANDHOOD (Estimate (SE) = 143.73 (50.71), t = 2.84, p = 0.005). In addition to a general slow-down in the *wh*-island conditions compared to non-islands, the results support the presence of a critical *crossover interaction*. Contrasts comparing RT in the gap versus RP conditions showed a marginal effect in the non-island conditions ($t(47)$ = 1.965, p = 0.055) such that RPs were read slower than gaps. In the *wh*-island condition the effect was significant ($t(47)$ = -2.586, p = 0.013), such that RPs were read faster than gaps. This supports the view that RPs aide in the comprehension of island violating structures.

4 Results: Comprehension questions

The average response proportion for each of the four response options, broken down by the four conditions, is given in figure 2, with the proportion of filler responses and confusion responses shown in figure 2. For the analysis of comprehension questions, I focus on the proportion of correct *filler* responses as well as the proportion of *confusion* responses. More filler responses were given in the non-island compared to the *wh*-island condition, and in turn more confusion responses were given in the *wh*-island condition compared to non-islands. The decrease in filler responses associated with *wh*-islands is slightly attenuated by the presence of

an RP. Similarly, RPs are associated with a decrease in the proportion of confusion responses in the *wh*-island condition.

Maximal logistic mixed effects models with the same effects structure as in the RT analysis were fit separately on the response data for the filler and confusion response types. Both models revealed only a significant main effect of ISLANDHOOD (*Filler model*: Estimate (SE) = 0.61 (0.17), $z = 3.62$, $p < 0.001$; *Confusion model*: Estimate (SE) = -0.41 (0.20), $z = -2.07$, $p = 0.039$). In neither case did the interaction of ISLANDHOOD and DEPENDENCY approach significance (*Filler model*: Estimate (SE) = -0.15 (0.32), $z = -0.48$, $p = 0.631$; *Confusion model*: Estimate (SE) = 0.34 (0.46), $z = 0.75$, $p = 0.455$).

5 Discussion

5.1 Interpretation of results

The present experiment provided a test of whether there is a real-time benefit for resumptive pronouns in island-violating structures. The finding of faster RT in island-violating structures containing an RP compared to those with a gap is consistent with the hypothesis that RPs ease the comprehension of otherwise difficult to form argument structure dependencies, rather than only benefitting the producer of an utterance (cf. Heestand et al., 2011; Polinsky et al., 2013). Previous studies have shown that RPs show faster reading time compared to gaps in longer (i.e. multi-clausal) non-island structures (Alexopoulou and Keller, 2007; Dickey, 1996; Hofmeister and Norcliffe, 2013), which was attributed to memory limitations in comprehending lengthy dependencies. Here, there was a marginally significant effect in the non-island condition, and it was in the opposite direction as would be expected: slower RT with an RP compared to a gap. Given that all

conditions were matched in length, as measured by number of intervening clauses between the filler and the tail of the dependency, the *speeding* effect of RPs in *wh*-islands cannot be attributed to this factor. If length were the relevant factor, RPs would be expected to show similar effects on RT in both the non-island and *wh*-island conditions.

The findings are generally expected under the theory of comprehension put forward by Asudeh (2004, 2012), who took for granted the idea that RPs aide comprehenders in forming dependencies into islands. The present study provides supporting evidence for this assumption, as well as Asudeh's view that RPs are not a uniform phenomenon in intrusive resumption languages. Asudeh makes a spilt between *complexity* RPs, which appear in non-island contexts, versus *island* RPs, which appear in island-violating structures. Here, would-be complexity RPs in the non-island conditions were associated with a processing disruption, as measured by slower RT in the RP compared to the gap conditions. As referenced in the previous paragraph, the complexity conditions were not met in the single-clause structure, and were matched across the conditions. As a result, the presence of an RP intruded on the processing of the filler-gap dependency rather than aiding in the formation of the dependency in the non-island conditions.

In contrast, island RPs showed evidence of facilitating the formation of a link between the filler and the direct object position, as measured by faster RT in the RP compared to the gap conditions. The theory put forward by Asudeh (2004, 2012) shows that, despite being ungrammatical, an informative *interpretation* can be reached in islands containing RPs. Eschewing the formal details (see Asudeh, 2012, p. 305–307), the RP allows the matrix and embedded clauses to each have a locally coherent parse, as shown in (4a). Critically, in embedded clauses, the RP fills the otherwise open argument position of the embedded verb, rather than

leaving a gap that results in a locally incoherent parse, as shown in (4b). The RP, when present, is ultimately interpreted as coreferent with the filler introduced in the matrix clause, allowing a sensible interpretation to be reached.

(4) a. Mary trained the spy who Beth announced which agency had recruited him.
(i) ✓Mary trained the spy
(ii) ✓Beth announced which agency had recruited him
b. Mary trained the spy who Beth announced which agency had recruited __.
(i) ✓Mary trained the spy
(ii) *Beth announced which agency had recruited __

While this provides a framework for understanding how RPs facilitate convergence to a useful interpretation in ungrammatical island-violating structure, Asudeh stops short of providing details on the role of "actual incrementality" (Asudeh, 2012, p. 312). This could be due in part to the dearth of evidence about the online profile of RPs in islands at the time the proposal was written. With these data now in hand, I extend the proposal by directly considering the relevant connections to parsing and interpreting these structures online.

The pattern of results can most readily be understood in light of what we know about filler-gap processing outside of resumptive contexts. Considering first the *wh*-island conditions, previous work has shown that islands generally block a comprehender's ability to assign a filler into a gap (e.g. Traxler and Pickering, 1996; Wagers and Phillips, 2009). This amounts to a suspension of the *active filler strategy* (Frazier and Flores d'Arcais, 1989) within islands. Under normal conditions, when a filler is encountered, the parser engages in an active search for an open argument position. This leads the parser to attempt dependency formation between the filler and the first encountered gap site. Islands are argued to block active dependency formation of this sort.

Returning to the present experiment, we observed an increase in RT following an unfilled argument position within an island (i.e. in the gapped *wh*-island condition). The disruption is consistent with the idea that confusion caused by the presence of an unfilled argument position, with no immediately available filler to form a dependency into this site, is responsible for slower reading. This converges with the independently motivated idea that the activity of the filler, and therefore the active search for a gap, is suspended in islands. However, the disruptive effect caused by the lack of an active filler is attenuated when the argument position is filled by an RP. The RP meets the need for the direct object position to be associated with an argument, and facilitates the formation of a dependency between the displaced filler and the argument position within the island in lieu of the active-filler strategy. This connection can be assumed to follow from the semantics provided by Asudeh (2012) for these structures.

On the other hand, the marginally significant disruptive effect of RPs compared to gaps in the non-island condition can be attributed to a *filled-gap effect* (Crain and Fodor, 1985; Stowe, 1986). For example, in sentences containing a filler-gap dependency like those in (5a), reading time is slowed at *students* compared to a non-filler-gap counterpart (5b). This is directly due to the active-filler strategy: when the verb *like* is encountered and there is an active filler, the parser immediately posits a gap to place the filler into. When this gap turns out to already be filled by *students*, reading is slowed due to the need to reanalyze the parse.

(5) a. Kaan forgot which font the professor **likes** students to use __.
b. Kaan forgot whether the professor **likes** students to use a specific font.

In the present experiment, the filler remained active in the non-island conditions, therefore the RP "filled" the gap site that would otherwise be expected to be empty, leading to a processing disruption in these conditions compared to

conditions where this position was unfilled. The results from the comprehension questions show that ultimately this pronoun was interpreted as coreferent with the filler, but not without causing an initial disruption.

5.2 Broader connections

The general picture is one in which a parser's ability to actively maintain a filler is the critical determinant of whether RPs in intrusive resumption languages lead to faster dependency formation, or whether a gap is preferred and RPs disrupt this process. In short, RPs become useful just in case fillers are difficult or impossible to keep active. This can occur as the result of grammatical boundaries that block movement dependencies, such as islands, or, as other studies have shown, by stressing memory resources so the filler falls out of its active status. While the source of the pressure differs, the end result of diminishing or eliminating the activity of the filler is the same, and the presence of an RP creates better conditions for an anaphoric link to be formed.

The proposal can therefore maintain the idea that increased memory-load due to dependency length or task demands is responsible for the facilitatory effect of RPs in certain structures (Hofmeister and Norcliffe, 2013; Chacón, 2019). Again, these are the *complexity* RPs discussed by Asudeh (2012). RPs in these cases aid in the formation of a link to the filler, allowing an otherwise unfillable (or difficult to fill) argument position to be resolved. Island-violating structures differ in that they are independently known to suspend the active filler strategy regardless of memory pressures, resulting in an inactive filler that cannot be used to immediately associate with the argument position. The interpretation of the otherwise unfilled argument position is again made possible by the presence of an RP, allowing a dependency to be formed with the filler. The present study showed that the

effect of each type of RP is independent. The would-be complexity RP in the non-island conditions had a disruptive "filled-gap" effect, while the island RP lead to faster reading, which is consistent with easier dependency formation.

One question that remains is why the RT measure showed evidence of an effect of RPs in islands, but the comprehension questions did not. There are a number of reasonable possibilities (which are not mutually exclusive). The first relates to the relatively small effect size. While the numerical trends in the averages aligned with the RT patterns, it is possible that the experiment did not provide sufficient power to observe the effect of interest. The second concerns the distribution of responses. Filler responses (which can be considered "correct" responses) generally appeared to be close to ceiling. Similarly, the overall proportion of confusion responses was relatively low. It is possible that a more difficult set of comprehension questions would lead to increased variability in responses and allow the effect to be observed. Finally, it is possible that by the time the comprehension question was encountered, participants were generally able to reconstruct the gist of the sentence regardless of online difficulty. That is, comprehenders benefitted from (or were disrupted) by RPs online, but by the end of the sentence participants could recover the target meaning anyway.

The presence of high comprehension accuracy even in the absence of a difference between RPs and gaps provides a critical point of evidence against the conclusions drawn in a recent study by Morgan et al. (2020). Morgan et al. also tested the online processing of RPs versus gaps in islands versus non-islands in sentences like (6), but concluded that RPs do *not* facilitate comprehension.

(6) *Example stimuli for non-island (a) and strong island (b) conditions from Morgan et al. (2020) Experiment 2*

a. It was Miss Piggy that Miss Cat reported that Mr. Dog poked {her, __} with a pencil.
b. It was Miss Piggy that Miss Cat snacked while Mr. Dog poked {her, __} with a pencil.

The result of interest is that, like the current study, Morgan et al. found faster SPR RTs following RPs compared to gaps in island conditions. However, participants showed low comprehension accuracy, with a high rate of responses being associated with the locally coherent parse where the RP is coreferent with *Miss Cat*—a confound explicitly avoided in the design of the current study. The authors argue that while RPs are indeed associated with faster RT compared to gaps, when comprehension is probed, the pronoun is not dependably interpreted as resumptive (i.e. as coreferent with the filler). They extend this result to call into question whether previous studies (e.g. Hofmeister and Norcliffe, 2013) should be taken as supporting a theory where RPs aid comprehension—in the absence of comprehension accuracy data, the RT effect cannot necessarily be taken as evidence that interpretation was facilitated, since the "wrong" interpretation might have been reached. This argument does not extend to the current study, where comprehension accuracy was equally high for both RPs and gaps in islands (with numerical trends showing better performance for RPs, if anything). The finding of faster RT for RPs versus gaps therefore occurred in conjunction with the target resumptive interpretation, a critical point in favor of the adopted comprehension model where RPs aide in the formation of difficult dependencies.

While the results do not support the view that RPs in English are part of the grammar, it is clear that they serve a purpose that goes beyond what the speaker-oriented model advocated by Polinsky et al. (2013) would suggest. It is still possible that speakers produce resumptive pronouns solely to help themselves, but the current study shows that comprehenders derive a benefit anyway. This benefit is

not, so far, reflected strongly in acceptability, but has been evident in comprehensibility ratings (Beltrama and Xiang, 2016). To the extent that acceptability reflects the state of the grammar, and comprehensibility the difficulty with which a sentence is understood, resumption in English continues to live in a gray zone: not grammatical, but still beneficial under the various pressures of real-time processing.

		Matrix	Filler	Name	Island	Critical	Spillover	Wrap-up
Non-island	Gap	1053 (62)	1025 (53)	1203 (75)	1635 (113)	854 (51)	768 (35)	819 (45)
	RP	1162 (71)	1118 (81)	1197 (78)	1617 (100)	1039 (63)	826 (41)	819 (47)
wh-island	Gap	1151 (74)	1013 (53)	1159 (65)	1537 (86)	884 (43)	902 (46)	875 (49)
	RP	1228 (80)	1051 (58)	1198 (81)	1671 (87)	1031 (56)	815 (43)	853 (50)

Table 1: Average RT (ms) and by-subjects SEM by region and condition. Regions denoted by slashes in (2). Note that the Island and Critical regions are confounded by number of characters across conditions.

		Filler	Confusion	Non-local	Local
Non-island	Gap	0.80 (0.029)	0.10 (0.018)	0.07 (0.018)	0.04 (0.012)
	RP	0.79 (0.028)	0.10 (0.020)	0.07 (0.016)	0.03 (0.011)
wh-island	Gap	0.69 (0.031)	0.16 (0.023)	0.07 (0.016)	0.08 (0.018)
	RP	0.72 (0.038)	0.11 (0.023)	0.11 (0.026)	0.06 (0.012)

Table 2: Average response proportion and by-subjects SEM by response type and condition. Rows may not add up to 1 due to rounding error.

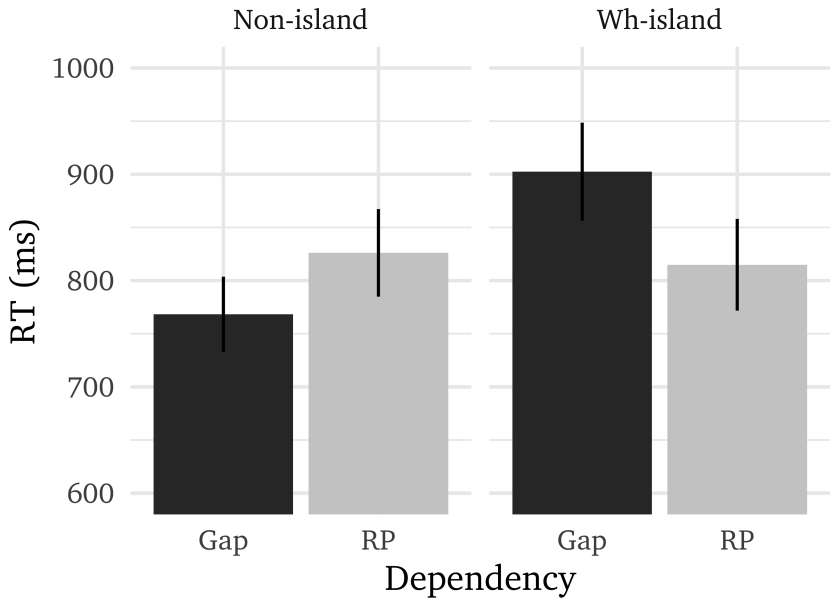

Figure 1: Average RT (ms) and by-subjects SEM for spillover region only. RPs slow RT in the non-island condition compared to gaps, but speed RT in the *wh*-island condition.

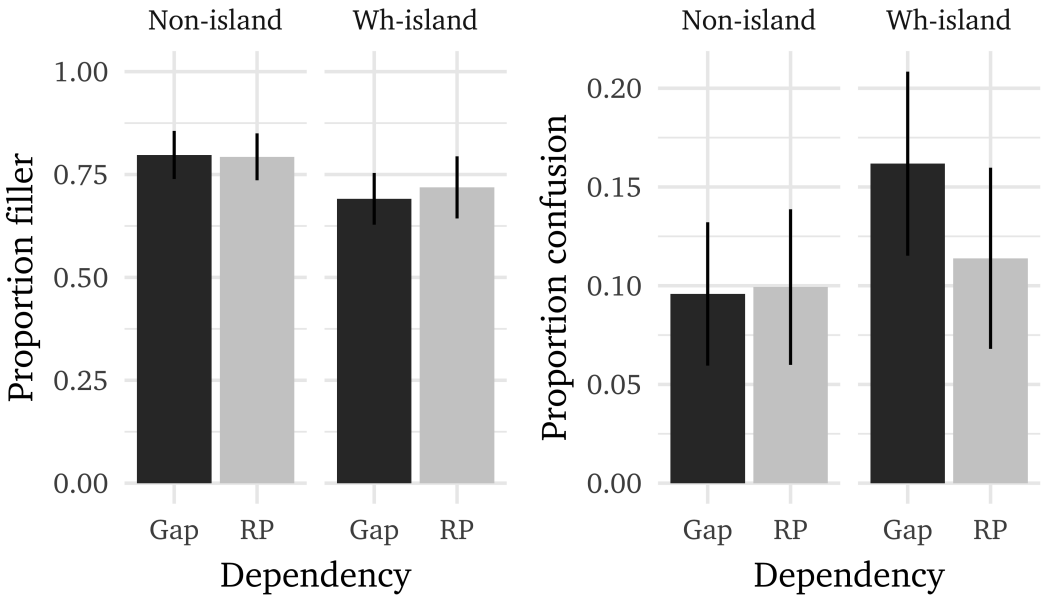

Figure 2: Average response proportion and by-subjects 95% confidence intervals for filler (left) and confusion (right) response options. Non-islands show increased filler responses and decreased confusion compared to *wh*-islands. RPs numerically increase filler responses and decrease confusion in *wh*-islands, but the result is not statistically significant in the reported models.

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[*]Thanks to Alex Göbel for assistance in running participants. Special thanks to Lyn Frazier, Brian Dillon, Chuck Clifton, Dustin Chacón, Maayan Keshev, Elaine Francis, and the participants of CUNY 2018 and the Pronouns in Competition Workshop at UC Santa Cruz for helpful discussion and feedback. This research

was supported in part by National Science Foundation Graduate Research Fellowship (DGE-1451512). All errors and claims are the responsibility of the author.