Which Subject Islands Will the Acceptability of Improve with Repeated Exposure?

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1. Introduction

Since Chomsky & Miller (1963) and Chomsky (1965), linguists have recognized that a grammatical sentence can be deemed as unacceptable for many extra-grammatical reasons, including memory limitations, context, and stylistic factors. More recently, evidence is mounting that sentences of moderate or even low acceptability can become more acceptable with repeated exposure (Hiramatsu, 1999; Snyder, 2000; Luka & Barsalou, 2005; Francom, 2009; Crawford, 2011a,b), a phenomenon that is sometimes referred to as *satiation*. In other words, sentence acceptability can increase with repeated exposure. An analogous effect seems to arise in on-line sentence processing. As Braze (2002) and Hofmeister et al. (2013) show, reading times for sentences with low acceptability can decrease with repeated exposure.

In this work we focus on the controversy surrounding the existence of satiation in Subject Island violations. Whereas Snyder (2000), Hiramatsu (1999, 2000), and Francom (2009) found evidence for satiation in Subject Islands, others have failed to replicate this result (Sprouse, 2009; Crawford, 2011a,b). In particular, Sprouse (2007, 2009) argues that the Subject Island satiation effects found in Snyder (2000) might be due to a confound, created by the fact that Snyder's design was not properly balanced. Since the ungrammatical sentences outnumbered the grammatical ones, this could have led participants to employ an equalization strategy, balancing out their *yes/no* responses. Sprouse (2007:123) goes on to argue that non-satiation is the expected result: since ungrammatical sentences have no licit representation (they cannot be constructed by the available mental computations), it follows that extra-grammatical factors that affect the acceptability – and are predicated on the existence of a representation – such as syntactic priming, should not affect the acceptability of ungrammatical sentences. In other words, if there is no licit representation for a subject island violation, then there is nothing to satiate.

We show that certain Subject Islands reliably satiate, including subject islands with non-derived subjects, which indicates that Sprouse (2009) and Crawford (2011) have overstated the generality of their findings. Our results are consistent with Francom (2009) and Hiramatsu (2000), who observe that the satiation effect is not an across-the-board phenomenon; satiation does not occur for all sentence types equally. For example, Subject Island satiation seems to be harder with transitive verbs (e.g. *what does Clinton worry that an ally of will boycott the airline?*). This finding is corroborated by the reading time studies in Kravtchenko et al. (2009); Polinsky et al. (2013), where unaccusative subjects are shown to make for weaker islands than other types of predicates. The number of exposures may also play a role in satiation. For example, Hiramatsu (2000) did not find satiation effects with 5 exposures, but did find them with 7 exposures. And finally, the complexity of the items may also be important. Hofmeister et al. (2013) report that satiation vanishes when items are made too complex.

The structure of this paper is as follows. In Section 2 we briefly discuss Subject Island effects and their gradient acceptability. In Section 3 we describe several experiments where satiation of Subject Islands was reliably obtained. These experiments rule out the possibility for confounds like the 'equalization strategy' discussed by Sprouse (2009). Section 4 discusses the findings.

2. Subject Island effects (and their circumvention)

Various authors have noted that Subject Island violations are sometimes passable, such as Pollard & Sag (1994:195,ft.32), Postal (1998), Sauerland & Elbourne (2002:304), Culicover (1999:230), Levine

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& Hukari (2006:265), and Jiménez–Fernández (2009:111), among others. Typically, such data involve unaccusative or passive predicates, as illustrated in (1), precisely those that involve derived subjects under transformational assumptions.

(1) a. What were pictures of seen around the globe?
(Kluender, 1998:268)

b. It's the kind of policy statement that jokes about are a dime a dozen.
(Levine et al., 2001:204)

c. There are certain topics that jokes about are completely unacceptable.
(Levine & Sag, 2003:252, ft.6)

d. What did the attempt to find end in failure?
(Hofmeister & Sag, 2010:370)

Chomsky (2008:147) argues that Subject Islands only arise with derived subjects, but this generalization cannot be right. First, there are various Subject Island examples involving derived subjects which have low acceptability, going back to data like (2a) from Ross (1967). More recent examples are listed in (2c,d). Note also that some of these examples involve specific *wh*-phrases, which are usually claimed to be D-linked (Pesetsky, 1987).

(2) a.*Which cars were the hoods of damaged by the explosion?
(Ross, 1967)

b.*Which constraint are good examples of needed?
(adapted from Sauerland & Elbourne (2002:304))

c. ??What did a bottle of appear in the kitchen?
(Polinsky et al., 2013)

d.*Which man was the friend of fired?

e.*What was the owner of arrested?
(Haegeman et al., 2013)

Second, there are various Subject Island violations involving non-derived subjects that are much more acceptable than predicted. Consider the data in (3), based on Chaves (2013). The square brackets indicate prosodic constituency boundaries, without which the location of the gap is less obvious.

(3) a. [Which president] [would the impeachment of] [cause outrage]?

b. [Which doctors] [have patients of] [filed malpractice suits in the last year]?

c. [Which school] [has the principal of] [recently resigned]?

The ameliorative effect of prosody on Subject Island violation was first noted by Ross (1967), with regard to cases like *That piano – which the boy's loud playing of drove everyone crazy – was badly out of tune*. Ross deemed this datum passable in English with the proper intonation. Hence, it is clear that Ross did not believe that NPs could not be extracted from subject phrases. See Fodor (2002a,b), Kitagawa & Fodor (2006), Zahn & Scheepers (2011), Ackerman et al. (2011), and references cited for experimental evidence that prosody can have a measurable impact in syntactic judgments.

Kravtchenko et al. (2009) and Polinsky et al. (2013) offer experimental evidence suggesting that unaccusative subjects make for weaker islands than other types of predicates. Although the data used in their experiments are fairly low in acceptability – compare (4) with the sentences in (3) – the predicate type created statistically significant differences.[1]

[1] Note, however, that these sentences are not equally felicitous: *Janet wonders if the conference on nanotechnology succeeded/ignored for a week* is less natural than *Janet wonders if the conference on nanotechnology lasted for a week*. Further research is necessary to exclude this as a potential confound.

(4) a.*Janet wonders what the conference on ignored the proposals for a week. (*transitive*)

b.*Janet wonders what the conference on succeeded for a week. (*unergative*)

c.*Janet wonders what the conference on lasted for a week. (*unaccusative*)

It is possible that Sprouse (2009) and Crawford (2011) failed to find satiation because of the high complexity and lack of naturalness of their experimental items. Consider the sample of items in (5).

(5) a.*Who do you think the email from is on the computer?
(Sprouse 2007)

b.*What does that you bought anger the other students?
(Sprouse 2009)

c.*Who does the guide believe a crowd of arrived late?
(Crawford 2011)

First, note that the non-extracted counterparts are not particularly plausible utterances. The non-extraction counterpart of (5b) is pragmatically and stylistically marked to begin with: *that a student bought X caused other students to be angered*. It is hard to imagine an *X* and a context that make the sentence not sound awkward. Similarly, the non-extraction counterpart of (5c) is marked as well: ?*the guide believes a crowd of tourists arrived late*. Crowds of tourists (or any other type of people) are not the type of groups that guides usually interact with. The non-extraction counterparts of the examples in (6a,b), from Snyder (2000) and Hiramatsu (2000) respectively, are more plausible sentences.

(6) a.*What does John know that a bottle of fell on the floor?
('John knows that a bottle of X fell on the floor')

b.*What does Clinton worry that an ally of will boycott the airline?
('Clinton worries that an ally of X will boycott the airline')

There are two other potential problems in (5) that may cause difficulty, in addition to the pragmatic issues noted above and therefore, and create further resistance to satiation. First, finite clause embeddings have been argued to incur additional processing difficulty (Kluender, 1992; Gibson, 2000). Second, all the examples in (6) involve non-specific *wh*-phrases *who/what*, rather than specific *wh*-phrases like [*which* N]. Non-specificity is known to have a negative effect on extraction phenomena (Erteschik-Shir, 1973; Kluender, 1992; Kluender & Kutas, 1993; Kluender, 2004; Sag et al., 2007; Hofmeister, 2007b; Hofmeister et al., 2012, 2013). This is illustrated in (7).

(7) ??[What] / ?[Which car] don't you know how to fix _ ?

Crucially, this effect is not restricted to *who/what* versus *which*-phrases. As Hofmeister et al. (2013) show, the more informative indefinite NP *an influential communist-leaning dictator* in (8) – by simple subset relation – allows faster retrieval at the gap site than its less informative counterpart NP *a dictator*.[2]

(8) It was [a dictator] / [an influential communist-leaning dictator] that Sandy said she liked.

Clausen (2011) shows that *wh*-phrase specificity has a measurable effect in the acceptability of gerundial Subject Islands, and in the experiments that we describe below, Subject Island violations with specific *wh*-phrases like (3) are rated as more acceptable. Previous Subject Island satiation studies have also neglected the pragmatic relation between the *wh*-phrase, the subject, and the verb. Kluender (2004) argues that Subject Island effects are reduced if the filler-gap dependency into the subject position is

[2] Such an account can potentially explain so-called D-linking effects (Pesetsky, 1987, 2000), for which there is currently no non-circular definition: If extraction is possible then the *wh*-phrase is arguably D-linked, and if extraction is not possible then the *wh*-phrase is not D-linked. As (Pesetsky, 2000:16) admits, the relation between D-linking and extraction remains obscure. For more controversy about D-linking see Kroch (1989), Ginzburg & Sag (2000:247–250), Levine & Hukari (2006:242,268–217), and Hofmeister (2007a).

construed to be of pragmatic relevance to the main assertion of the sentence. In fact, this is a more general claim about extraction, orginally made by Kuno (1987). Consider the contrasts in (9). Writing is an action that typically involves a topic, hence, the book topic is relevant for the verb in (9a). However, there is no coherent relevance between a book topic and the situation of losing a book, as in (9b).[3]

(9) a. Who did you write a book about _ ?
b. ?Who did you lose a book about _ ?

In this work we follow Chaves (2013) in assuming that a subject island extraction is pragmatically relevant if: (i) the concept denoted by the subject noun entails the concept denoted by the extracted noun (e.g. the existence of a *cure* entails the existence of a *disease*, the existence of an *answer* entails the existence of a *question*, and so on and so forth); and (ii) the extracted noun is relevant for the predicate's truth value (*discovering a cure* hinges on the *disease*, *knowing an answer* hinges on the *question*, etc.). Hence the relative acceptability of cases like *which disease will the cure for never be found* or *which question will the answer to never be found*.

3. Experiments

3.1. Experiment 1

3.1.1. Method

A total of 92 participants with IP addresses originating from the United States were recruited through Amazon's MT, and compensated at the hourly rate $10. The task was open to anyone, and participants were asked to report if they were native speakers of English. Participants were asked to judge how natural each sentence was, by giving it a number from 1 (very unnatural) to 7 (very natural). Data from 32 participants were discarded either because (a) they only provided responses on distractors; or (b) they did not report to be native speakers of English. Analyses were conducted on responses provided by the remaining 60 participants. These individuals gave judgments on a total of 20 experimental items in a Likert rating task with a scale from 1-7. There were two versions for each experimental item, varying on the specificity of the *wh*-phrase (e.g., *Who/Which politician did opponents of organize a protest?*). All experimental items were designed to satisfy the relevance conditions discussed above. Half of the items involved transitive verbs. A sample of the experimental items, in the specific condition, is given in (10).

(10) EXPERIMENT 1 ITEMS (SPECIFIC CONDITION)
a. Which politician did opponents of organize a protest?
b. Which law firm did partners of receive the most awards?
c. Which building did tenants of decide to start an illegal business?
d. Which drug did side effects of include mild migraines?
e. Which saint did apparitions of frighten the rural community?
f. Which celebrity did photos of get international attention?
g. Which restaurant did bartenders of serve drinks to minors?
h. Which violin did forgeries of get sold in the auction?
i. Which folk song did renditions of become popular last year?
j. Which autobiography did details of recently circulate online?
k. Which slaughterhouse did pictures of sadden you the most?
l. Which company did employees of agree to forgo salary increases?
m. Which textbook did chapters of seem not well-organized?
n. Which tribes did leaders of refuse to pay more taxes?
o. Which committee did members of reach an agreement?
p. Which two theorems did implications of revolutionize mathematics?

[3] As Kuno observes, the acceptability of (9b) improves if it is known that the addressee is prone to lose books authored by particular types of authors. This is further evidence for a pragmatic 'aboutness' constraint at work.

q. Which sculpture did replicas of sell for over a thousand dollars each?

r. Which dialog did transcripts of contain an obscene typo?

s. Which beer brands did logos of contain various typos?

t. Which DVD did pirated copies of sell very well in Asia?

Following standard practice, the items were counterbalanced across two lists so that each participant only responded to one version of each experimental item. Items were interspersed among 40 distractor items, and different participants saw items in different orders. Distractors were of three types, as illustrated in (11). Half of the distractors were made ungrammatical by using incorrect prepositions (i.e., *Which boat did the soldiers think at attacking?*) and simultaneously, half of the distractors featured a non-specific *wh*-phrase whereas the other half featured a specific *wh*-phrase.

(11) i. Which store did the plate of cookies get delivered to yesterday?
(20; NP-of-NP subject)

ii. Which workers did the lay-off cause to move to a different state?
(10; VERB-off subject)

iii. Which boat did soldiers think of attacking?
(10; Simple NP subject with gerund phrase)

3.1.2. Results

Responses were analyzed using a linear mixed-effects regression model with *wh*-phrase specificity and order of experimental presentation (to detect for satiation) as predictors. The model incorporated three random-effect factors: a by-item adjustment to the intercept (SD = 0.17), a by-subject adjustment to the intercept (SD = 0.88), a by-list adjustment to the intercept (SD = 0.00), and the residual error (SD = 1.08). The model revealed that subject islands with specific *wh*-phrases were more acceptable than those with unspecific *wh*-phrases (mean ratings were 2.88 vs. 2.25 respectively, t = 3.039, p = 0.002). Additionally, we observed that presentation order was a significant predictor, suggesting that satiation occurred: participants' responses improved as a function of presentation order, t = 3.427, p = 0.001. The latter result refutes Sprouse's (2009) and Crawford's (2011) conclusions. Moreover, of all the ungrammatical fillers, only those of type iii exhibited satiation. Finally, no interaction was observed between specificity and presentation order, suggesting that satiation occurred irrespective of the specificity of the *wh*-phrase in the subject island constructions (t = 0.949, p = 0.341). Table 1 summarizes the fixed-effect structure of the regression model on the participants' responses, including beta weights, standard errors, t-values, and p-values.

	Estimate	**SE**	**t-value**	**p-value**
(intercept)	1.937	0.167	11.555	
Specificity	0.494	0.162	3.039	0.002
Presentation Order	0.015	0.004	3.427	0.001
Specificity × Presentation Order	0.005	0.005	0.949	0.341

Table 1: Fixed effects of the linear mixed-effects regression model for the Likert ratings in Experiment 1, with subjects, items, and lists as random effects.

3.2. Experiment 2

3.2.1. Method

Sprouse (2007, 2009) argues that the Subject Island satiation effects found in Snyder (2000) might be due to a confound created by an unbalanced design. Since the ungrammatical sentences outnumbered the grammatical ones, this could have led participants to employ an equalization strategy, balancing out their *yes/no* responses. Our Experiment 1 has as many grammatical distractors as ungrammatical ones,

and therefore is a more balanced design than Snyder's. In Experiment 2 we rule out the possibility of an equalization strategy entirely, by using only grammatical sentences as distractors. If all the distractor items are grammatical, then an equalization strategy would cause ratings for subject islands to gradually decrease as the experiment progresses.

In Experiment 2, 67 participants were recruited through Amazon's MT, as in the previous experiment. Data from 12 participants were discarded due to the same data filtering criteria used for Experiment 1. Analyses were conducted on responses provided by the remaining 55 participants. Participants gave judgments on a total of 14 experimental items in a Likert rating task with a scale from 1-7. As with Experiment 1, there were two versions for each experimental item, varying on the specificity of the *wh*-phrase (e.g., *What/Which problem will the solution to never be found?*). All experimental items in Experiment 2 were designed to satisfy Kluender's relevance condition discussed above. In addition, the items were normed to satisfy the following criteria: (i) high semantic relatedness between the noun in the specific *wh*-phrase and the subject noun (e.g. *problem* highly related to *solution*); (ii) highly plausible non-extracted counterpart of the item (e.g. *the solution to that problem will never be found* is highly plausible). In order to easily achieve high plausibility ratings, our items involve passive structures, which are typically more transparent to extraction than transitives. Following Chaves (2013), given that the subject is not in control of the action denoted by the verb (i.e. is not an agent or actor), it is easier for a phrase other than the subject to be construed as relevant for the main assertion (such as the extracted subject-internal phrase). The list of items in the specific *wh*-phrase condition for Experiment 2 is given in (12).

(12) EXPERIMENT 2 ITEMS (SPECIFIC CONDITION)

a. Which problem will the solution to never be found?
b. Which crisis will a resolution to promptly be reached?
c. Which musician will the full discography of never be released?
d. Which word will the misspelling of definitely be noticed?
e. Which movie will the soundtrack of never be popular?
f. Which company will the employees of certainly be laid off?
g. Which bill will an amendment to probably be proposed?
h. Which crime will the punishment for never be carried out?
i. Which book will the author of never be revealed?
j. Which transaction will the value of never be known?
k. Which disease will the cure for never be found?
l. Which film will the sequel to never be produced?
m. Which question will the answer to never be known?
n. Which poison will the antidote to never be discovered?

As before, items were presented in random order, interspersed among 50 distractor items. Distractors were all acceptable sentences, of five different types, illustrated in (13). For each of the five types of distractors, half featured specific *wh*-phrases, and half featured non-specific *wh*-phrases.

(13) i. Which laptop will you probably donate to the library?
(10; Sentence-medial non-embedded complement gap)

ii. Which exam did the teacher fail to correct?
(10; sentence-final gap in infinitival complement)

iii. Which theorem will mathematicians have a hard time understanding?
(10; Sentence-final gap in gerundial complement)

iv. Which storyteller do you believe the children will never like?
(10; sentence-final gap embedded in CP, temporarily compatible with a matrix gap)

v. Which movie do you predict the Academy will award Best Picture to?
(10; Sentence-final gap embedded in CP, incompatible with a matrix gap)

3.2.2. Results

As with Experiment 1, responses were analyzed using a linear mixed-effects regression model with *wh*-phrase specificity and order of experimental presentation as predictors. The model incorporated three random-effect factors: a by-item adjustment to the intercept (SD = 0.21), a by-subject adjustment to the intercept (SD = 1.16), a by-list adjustment to the intercept (SD = 0.00), and the residual error (SD = 1.15). The model replicated the results of Experiment 1 and revealed that subject islands with specific *wh*-phrases were more acceptable than those with unspecific *wh*-phrases (mean ratings were 3.22 vs. 2.41 respectively, t = 4.437, $p < 0.001$). Presentation order was a significant predictor, suggesting that satiation still occurred: participants' responses improved as a function of presentation order, t = 5.971, p = 0.001. Table 2 summarizes the fixed-effect structure of the regression model on the participants' responses, including beta weights, standard errors, t-values, and p-values.

	Estimate	**SE**	**t-value**	p**-value**
(intercept)	1.665	0.217	7.668	
Specificity	0.862	0.194	4.437	$<$0.001
Presentation Order	0.103	0.017	5.971	$<$0.001
Specificity $\times$ Presentation Order	0.002	0.024	0.099	0.922

Table 2: Fixed effects of the linear mixed-effects regression model for the Likert ratings in Experiment 2, with subjects, items, and lists as random effects.

Figure 1 below is a scatterplot of the mean responses grouped according to the order of presentation. Items were presented randomly within participants. The mean responses shown in this scatterplot are thus computed by averaging across different tokens of subject islands. The trendline is a linear regression showing the gradual increase of mean response as a function of presentation order.

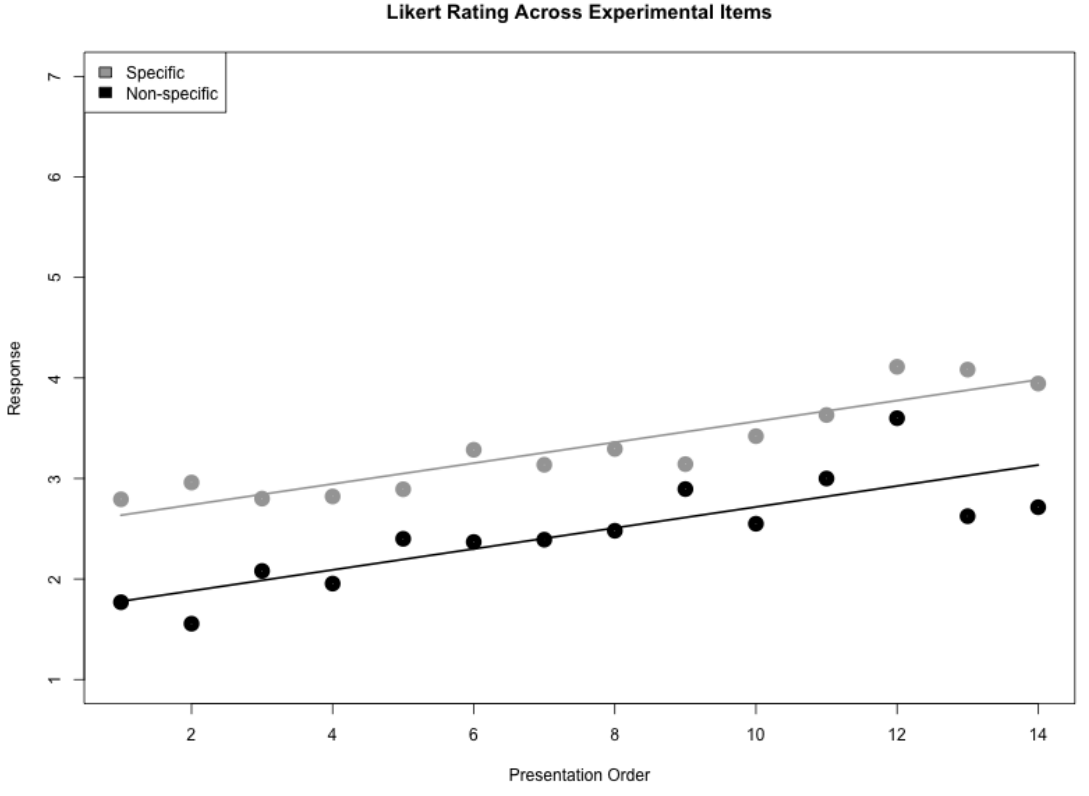

Figure 1: Linear regression fitted on the response means as a function of presentation order.

4. Discussion

The results of the above experiments indicate that Subject Island violations *can* reliably exhibit satiation, regardless of the *wh*-phrase specificity and regardless of the type of verb predicate. Moreover, we have shown that satiation can even occur in a crowdsourcing setting that disfavors satiation. In Mechanical Turk, there is no guarantee that participants will see the same amount of experimental items, or in the same order. In fact, of the 55 participants that saw experimental items in Experiment 2, only 32 saw the complete set of items in their lists. Crucially, however, satiation occurred in both groups of participants. Moreover, satiation was not an artifact of the Mechanical Turk crowdsourcing setting: previous versions of the experiments that we reported above were ran in the lab, where all items were presented randomly within and across all native speaker participants (43 people from the University at Buffalo community), so that no two participants encountered the experimental items in the exact same order. We again obtained significant satiation effects. Finally, our results indicate that some Subject Island extractions can have fairly high acceptability (e.g. 5.6 out of 7). This is expected in accounts where Subject Islands are the cumulative effect of pragmatic and performance factors (Kluender, 2004; Chaves, 2013) but not by standard syntactic accounts.[4]

Phillips (2006) argues against such performance-based accounts by showing that speakers actively postulate gaps inside non-finite subjects like (14a), which are known to allow parasitic gaps, but not inside finite subjects (14b), which are claimed to block parasitic gaps. Basically, although speakers postulate a gap immediately after *expand* in (14a), no such postulation is made after *expanded* in (14b).

(14) a. The school superintendent learned **which schools** the proposal to **expand** drastically and innovatively upon the current curriculum would overburden _ during the following semester.

b. The school superintendent learned **which schools** the proposal that **expanded** drastically and innovatively upon the current curriculum would overburden _ during the following semester.

Phillips (2006) reasons that if islands were due to performance then there should be no difference in how the processor handles such structures. We take issue with this argument. First, it is possible that the extra processing load incurred by tense (Kluender, 1992; Gibson, 2000) hampers the filler-gap linkage. Second, it is more likely for a gap to reside in a complement (as is the case of the *to*-phrase in (14a)) rather than in a modifier phrase (as is the case of the CP in (14b)). Third, the premise that finite subjects block parasitic gaps is dubious. As Phillips (2006:803,ft.6) himself admits, such parasitic extraction patterns *are* possible, at least for some speakers, as shown by (15). Brackets indicate prosodic boundaries.

(15) a. [She is the kind of person] [that everyone who meets _] [ends up falling in love with _].
(Kayne, 1983)

b. [John is someone] [who everyone who meets _] [dislikes _].
(Culicover, 1999:179)

Phillips (2006:803,ft.6) claims that (15) are unproblematic for his account, by conjecturing that their acceptability is somehow dependent on the presence of the quantificational head NP *everyone*. Such a mysterious interaction between *everyone* and parasitism is not only suspicious, but arguably incorrect, as suggested by counterexamples like (16) which do not involve quantificational pronominal heads.

(16) a. [Which woman] [do men who meet _] [usually ask out _]?
(attributed to Elisabet Engdahl (p.c.) by Pollard & Sag (1994:226))

b. [Which virus] [did the mice that were infected with _] [never recover from _]?

c. [This is a bill] [that the senators who objected to _] [would probably not benefit from _].

[4] More recently, Haegeman et al. (2013) argue that Subject Islands have degrees of grammaticality, determined by the cumulative effect of the violation of various grammatical conditions (e.g. (i) Extraction from a constituent at the head of a non-trivial A-chain is degraded; (ii) A θ-prominent argument occupying a θ-local A-position resists extraction; (iii) Extraction out of an island is severely degraded when the extractee is not an argument; (iv) Extraction is ameliorated when the extractee is D-linked, etc.). However, such conditions strike us as somewhat stipulative.

We conclude that the argument against non-representational accounts in Phillips (2006) is problematic, and that further research is needed to identify the factors behind the lack of filled-gap effects in (14b).

5. Conclusion

This work shows that Subject Islands can reliable satiate, regardless of the predicate type and regardless of the specificity of the *wh*-phrase. These findings support the conclusions of Snyder (2000), Hiramatsu (1999, 2000), and Francom (2009). We conclude that the failure to find satiation reported by Sprouse (2009) and Crawford (2011) must be attributable to some other factor, specific to such experiments. We conjecture that Subject Island violations do not satiate when the experimental items are too complex (e.g. employ non-specific *wh*-phrases and contained finite clause embeddings) and are insufficiently coherent to begin with. This is consistent with the findings of Hofmeister et al. (2013), who show that satiation of other types of islands vanishes when the items are made more complex. Our results also challenge the widespread notion that only derived subjects can license Subject Island extraction, and are most consistent with accounts that allow graded acceptability as the cumulative effect of pragmatic and performance factors, as in Kluender (2004) and Chaves (2013), and contra Phillips (2006).

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