

Processing Factors in the Study of Island Effects

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The Standard View in MGG

- All Filler-Gap Constructions are unbounded.
- FGDs are to be analyzed in terms of bounded transformational movement operations.
- There are general principles of (U)G constraining movement rules (or rules that try to associate variables and their binders).
- These principles – **island constraints** – are defined in terms of syntactic structure.

A Common View of Competence in MGG:

- Island constraints are intricate, arbitrary, and irreducible.
- Island constraints are universal and specific to language.
- Island constraints couldn't be learned from experience.
- Island constraints are part of the human biological endowment for language.

The Instability of Island Constraints

Long history of acute observations about problematic data: Kuno, Ross, Erteschik-Shir (& Lappin), Lakoff, Chung, McCloskey, Engdahl, Allwood, Maling, Zaenen, Kroch, Szabolcsi, Zwarts, Deane, Goldberg, a.o.

Within and across languages, there are counterexamples to island constraints and a gradedness (or 'gradience') in the data that remain unpredicted by standard island theories.

The Instability of Island Constraints

- Which reports does the government prescribe the height of the lettering on? [violating Subjacency] (Ross 1967)
- What crimes does the FBI know how to solve? \geq
What crimes the FBI know whether to solve?
- Chomsky 1973: "the *know how to* examples ... are unique in permitting further *wh*-movement".

The Instability of Island Constraints

- (1) a. Den där gamla skräphögen kanner ja killen som
That old piece junk know I the guy who
köpte?
bought.
'That old piece of junk, I know the guy who bought
(it).'
- b. Vilken bok kunde ingen minas vem som
Which book could no one remember who that
skrivit?
had written?
'Which book could no one remember who had writ-
ten?'

Swedish: Andersson(1982)

'Violations' of Complex NP Constraint

Kuno 1976, Erteschik Shir & Lappin 1979, Engdahl 1980, McCawley 1981, Chung and McCloskey 1983, a.o

This is the child that there is [*nobody who's willing to accept*].

That's one trick that I've known [*a lot of people who've been taken in by*].

You've been talking with a person that I've never met [*anyone who doesn't like*].

‘Violations’ of Adverb Island Constraint

So that’s Quick Look, a huge time saver and a feature that you will wonder how you could have ever lived [*without*]. [<http://www.apple.com/macosex/guidedtour/small.html> -BSant]

The magazine I spend most of my days [*reading*]. [advertisement for *The Economist*, attributed to Bill Gates. -BSant]

Reynolds completed Sayers’ translation of The Divine Comedy, which Sayers died [*before finishing*]. [www.touchstonemag.com/archives/article.php?id=13-04-028-f]

‘Violations’ of Subject Condition

<http://www.ling.upenn.edu/~beatrice/examples/>

a letter of which [*every line*] was an insult... (Jane Austen)

These are the Iranian dignitaries that [*my talking to*] would have been considered inappropriate.

Already Agassiz had become interested in the rich stores of the extinct fishes of Europe, especially those of Glarus in Switzerland and of Monte Bolca near Verona, of which, at that time, [*only a few*] had been critically studied. (Encyclopaedia Britannica Online)

Superiority Violations (Arnon et al. 2006; Frazier and Clifton 2006; Hofmeister et al. 2008)

- Although nothing on this planet (or any other) can compete with the utter horror that is cilantro! Where the heck did who the heck come up with adding that gawdawful weed to otherwise civilized hote-cue-zeen? [<http://www.scrappleface.com/MT/archives/001655.html>]
- I must have missed something. What did who do to Pierre Salinger? [<http://www.freerepublic.com/forum/a3b1c8a4d1847.htm>]

The Instability of Island Constraints

- Essentially every proposed structure-based island constraint has been challenged on empirical grounds.
- Beyond the existence of counterexamples, there is also an observable pattern to the gradience in judgments regarding island effects.

Gradience in Islands

Who did you see pictures of? \geq

Who did you see the pictures of? \geq

Who did you see John's picture of? (Chomsky, 1973, p. 239)

Many other examples of non-structural manipulations affecting the acceptability of island violations.

Dispute the Data

Counterexamples and gradience have not been interpreted as a problem for island theory.

"exceptional", "special", "unique" or "to be explained later".

More Mechanisms

If a FGD appears to violate an island constraint, it's not really a FGD – it's something else, e.g. an anaphor-antecedent dependency.

'Reanalysis', 'Restructuring', ad hoc features (e.g. Chomsky's def feature),

'D-Linking', etc.

Counterculture

An increasing amount of research concludes that, at a minimum, not all island phenomena can be explained via syntactic constraints.

Emergence of semantic and pragmatic accounts that highlight interpretation problems (Szabolcsi & Zwarts 1993, Kroch 1989/1998, Erteschik-Shir 1973, 2006), a.o.

A Competing Tradition

Grosu 1972, Deane 1991, Kluender 1991, 1992, 1998, 2005, Kluender and Kutas 1993, Alexopoulou and Keller 2007, a.o.

Acceptability is the end result of a series of cognitive processes.

Acceptability reflects the contribution of both grammar (competence) and resource limitations (performance).

Performance-Based Accounts

- [[[That [that [[that Kim left] bothers Sandy] upsets them]] is a problem].

$S \rightarrow NP VP$

$NP \rightarrow CP$

$CP \rightarrow COMP S$

Performance-Based Phenomena: Graded Acceptability

- [[that [[that Kim left] bothers Sandy]] upsets them].
- [that [[for Kim to leave] would bother Sandy] upsets them].

Low Acceptability: Competence or Performance?

- The boy the host the man knew brought left.
- The boy someone I knew brought left.
- Gradience and amelioration by orthogonal factors are predicted by a performance account, since processing difficulty is inherently a graded notion.

Processing and Acceptability

- Intuitions of sentence well-formedness are intuitions of **acceptability**.
- Grammatical deviance can make sentences unacceptable.
- Processing difficulty can make grammatical sentences unacceptable. (Chomsky & Miller, 1963, Bever 1970; Osterhout, Holcomb, & Swinney 1994, Fanselow & Frisch, 2006, a.o.)

Our Goal

- reexamine the factors leading to variation in acceptability judgments,
- show the problems facing competence-based theories.
- show that these same factors have been independently identified as factors influencing processing difficulty.

- a different kind of 'Minimalist Program'
- a 'kinder, gentler' competence grammar
- processing ('performance') assumes a greater explanatory role.

**Judging Islands:
the Specificity of the Filler Phrase**

Superiority Effects

Who ___ saw what?

*What did who see ___ ?

Who ___ talked to who?

*Who did who talk to ___ ?

Superiority Condition (Chomsky 1973)

No rule can involve X,Y in the structure:

$$\dots X \dots [\dots Z \dots - WYV \dots] \dots ,$$

where the rule applies ambiguously to Z and Y,
and Z is superior to Y.

Some Important Contrasts

Which medications did which patient get? \geq

What did who get? (Karttunen 1977)

Which article don't you remember who wrote? \geq

What don't you remember who wrote?

(Maling & Zaenen 1982)

Clinging to Competence: D-Linking

- I know what just about everybody was **asked** to do, but **what** did **who** (actually) **do** __ ?
[Bolinger 1978]
- Superiority Violations (SUVs) were explained away by Pesetsky (1987, 2000) as the result of a new grammatical mechanism which he called 'D(iscourse)-Linking'.

What is D-linking?

“Context sets previously mentioned in the discourse qualify a phrase as D-linked, but so do sets that are merely salient (e.g. *which book*, in a context where speaker and hearer both know that reference is being made to a reading list for a course) and sets whose salience is culturally determined (e.g. *what day of the week, which sign of the zodiac*)” [p. 16].

What is D-linking?

Any phrase can be D-linked if some plausible context set has been pre-established in the discourse

This characterization leaves unexplained basic contrasts in SUVs with *which*-NPs and bare *wh*-items, because the standard examples have no prior context, i.e. without a context, the set of possible books is infinite, so *which books* is not very specific

Irrespective of these issues, the proposal raises the question of why contextualization should affect putatively universal grammatical principles?

What is D-linking?

A reliable rule of thumb is that if a *wh*-word in a multiple *wh*-question can be felicitously paraphrased with an expression of the form which of the X, it can cause the Superiority effect to disappear. The reason for this link between semantics and syntax is obscure, and will remain obscure even at the end of this book. [Pesetsky 2000]

Problems with Superiority + D-Linking Accounts (Sag et al. ms.)

Problem 1: What exactly is D-Linking? No one knows.

Problem 2: All *wh*-expressions can be D-Linked. Hypothesis untestable.

Problem 3: Distinction between *which*-NP and bare *wh*-word persists even when the prior discourse 'links' the relevant entities.

Problem 4: The phenomenon is graded, with intermediate degrees of informativity; There is no dichotomy of mechanisms.

Problem 5: Even if it were defined, there is no motivation for a theory that says contextualization should change or influence the rules of grammar.

Rizzi/Cinque

Rizzi and Cinque notice that properties of filler phrases affect the extraction possibilities of a range of NPs/DPs, not just *wh*-phrases

Rizzi 1990 & Cinque 1990: **referential** (*who/every* NP/ *someone/whoever/etc.*) vs. **non-referential** (*what/all* DP/*many* DP/*some* NP).

Only arguments that “refer to specific members of a set in the mind of the speaker or preestablished in discourse” can be exceptions to antecedent government requirements.

Rizzi, Cinque: long distance binding possibilities observed with anaphora are shared by “referential” arguments

Chung: “Rizzi’s referential indices cannot be identified with the indexing mechanism that is a mainstay of current approaches to anaphora ... [is no] more than a diacritic to distinguish the DPs that allow long movement from those that do not.”

Index Dissonance: Bound variable anaphora can be anteceded by nonreferential DPs (e.g. **Who** explained **himself** best?, **Each girl** loves **her** mother)

Summary: Clinging to Competence Accounts

In spite of the violability of island constraints in certain certain conditions, MGG has never seriously considered the view that island effects come from outside grammar.

Instead, ancillary and ad hoc grammatical principles are introduced to modulate the normal domain and authority of island constraints.

These principles have offered little insight into the relationship between the information content of fillers and the acceptability of island-violating FGDs.

Referentiality and Specificity of Intervening Constituents

Definiteness Effects

Who did you see a picture of? \geq

Who did you see the pictures of? \geq

Who did you see John's picture of?

Definiteness Effects

“A refinement of the condition (26) [*the Specified Subject Condition*] incorporating the feature [definite] as well as the property of lexical specification might be proposed to accommodate these judgments. Specified subjects in NPs are [+ definite]. If (26) is revised to include [+ definite] as well as specified subjects, then (31b) [*Who did you see John’s picture of*] will involve a double violation and *Who did you see the pictures of* only a single violation. This might account for the gradation of acceptability.” [Chomsky 1973]

The Definiteness Dilemma

In English, as in Scandinavian languages, the graded amelioration effect of less definite intervening NPs is pervasive:

The host [someone [I knew ___] brought ___] left. \geq
The host [the boy [the girl [I knew ___] brought] left.

Chomsky's account is ad hoc and it fails to generalize to the full range of available data.

Not Just Nouns, but Verbs, Too

Which book did you see pictures of? \geq
Which book did you destroy pictures of?

Who did you say that John believes you saw? \geq
Who did you lisp that John believes you saw?

Not Just Nouns, but Verbs, Too

Deane (1991):

Who did you obtain votes for the impeachment of?

≥

Who did you find votes for the impeachment of? ≥

Who did you buy votes for the impeachment of? ≥

Who did you criticize votes for the impeachment of?

Not Just Nouns, but Verbs, Too

Various semantic, pragmatic, and information structure-based explanations have been proposed to account for these differences (Takami, Erteschik-Shir, a.o.)

These accounts sharply delimit the role of syntactic structure in explaining the relevant contrasts.

Processing Island Structures

Known Processing Effects: the uncontrolled background

A wide array of experiments and experimental methodologies in psycholinguistics has confirmed the difficulty of processing long-distance dependencies.

Inside long-distance dependencies, reading times and response times to various tasks increase. (Wanner and Maratsos 1978; Chen et al. 2005).

Island constructions typically complicate these already considerable difficulties of dependency processing.

- For instance, many island constructions require processing numerous referential entities and relatively long-term storage of syntactic predictions for incomplete propositions, while simultaneously retaining the filler phrase in memory and searching for the correct gap site which has no phonological manifestation.
- In this sense, syntactic islands are akin to the center-embedding examples, discussed in Chomsky and Miller 1963, which represent the paradigmatic case of performance difficulties.

Processing Difficulty from Dependency Length

- The longer the distance between filler and gap, the harder the sentence is to process. (Gibson 1998, 2000; Grodner and Gibson 2005)
- Activation of a mental representation decays over time, making it harder and harder to efficiently re-access the memory item.

Processing Difficulty from Dependency Length

Arnon et al. (2005) verified that (shorter) subject *wh*-interrogatives were judged more acceptable than (longer) object *wh*-interrogatives:

Which man saw the girl in the bar on California Avenue? \geq

Which man did the girl in the bar on California Avenue see?

Processing Difficulty from Distractions Along the FG Path

Intervening constituents that require more resources to process reduce the resources available to process the dependency, i.e. to retrieve and integrate the filler.

Basically, FGDs are easier to process when the stuff inside the dependency is easy to process.

Lots of things can make this intervening material harder to process,

for instance . . .

Processing Difficulty from Low Referent Accessibility

Less accessible NPs intervening between filler and gap make dependencies harder to process. (Warren and Gibson 2002, 2005)

The consultant who we avoided ...

The consultant who Donald Trump avoided ...

The consultant who the chairman avoided ...

Certain types of NPs engender more processing difficulty than others because they contain more information or instructions for identifying and/or situating referents.

Processing Difficulty from Low Frequency Items

Frequency of lexical items. (Hale 2001; Jurafsky 2003)

Which letter did the judge decide to send back immediately? ≥

Which epistle did the magistrate opt to remand forthwith?

Processing Difficulty from Semantic Complexity

On similar grounds, verb choice affects processing difficulty.

SAY contains a subset of the information in a manner-of-speaking verb like **LISP** and is much more frequent with a clausal complement.

Hence, it is unsurprising that it should be more acceptable inside a FG dependency.

Processing Difficulty from Low Filler Informativity

- Less informative fillers (**who** instead of **which man**) are harder to retrieve at the gap site. (Hofmeister 2007; Hofmeister et al. 2008; Sag et al. 2007)
- This effect is not particular to *wh*-expressions or islands:

It was **an alleged Venezuelan communist** that the members of the club banned from entering the premises __ . ≥

It was **a communist** that the members of the club banned from entering the premises __ .

Hofmeister 2007

- The effect is based on strength of a mental representation in working memory.
- More complex linguistic encodings effectively boost the activation of the associated mental representation, making it easier to get back to later.
- The effect is grounded in independent findings that have been established in the psychological literature on memory and elaboration (e.g. Bradshaw & Anderson, 1982).

Building more complex mental representations facilitates retrieval from memory.

Contextualization Difficulty is Processing Difficulty

Contextualization

- Supporting context and background help listeners and readers to understand
- Decontextualized questions are hard to process

“Who left?” presupposes someone left.

*?How much money was John wondering whether to pay ___ ?

There was a sum of money about which John was wondering whether to pay it. [Kroch 1989/1998]

- Just as eliminating a clausal embedding in the center-embedding structures facilitates processing, a variety of factors in island constructions can be manipulated so as to maximize overall processing ease.
- Under such conditions, acceptability may rise to levels comparable to the acceptability of minimally different non-islands.
- While one single factor is unlikely to be responsible for perception of unacceptability, these factors can “gang up” to drive difficulty past some threshold to yield unacceptability
- Can processing difficulty explain island effects without competence grammar constraints?

Processing Studies

WH-Island Effects

WH-Island RT study: Materials

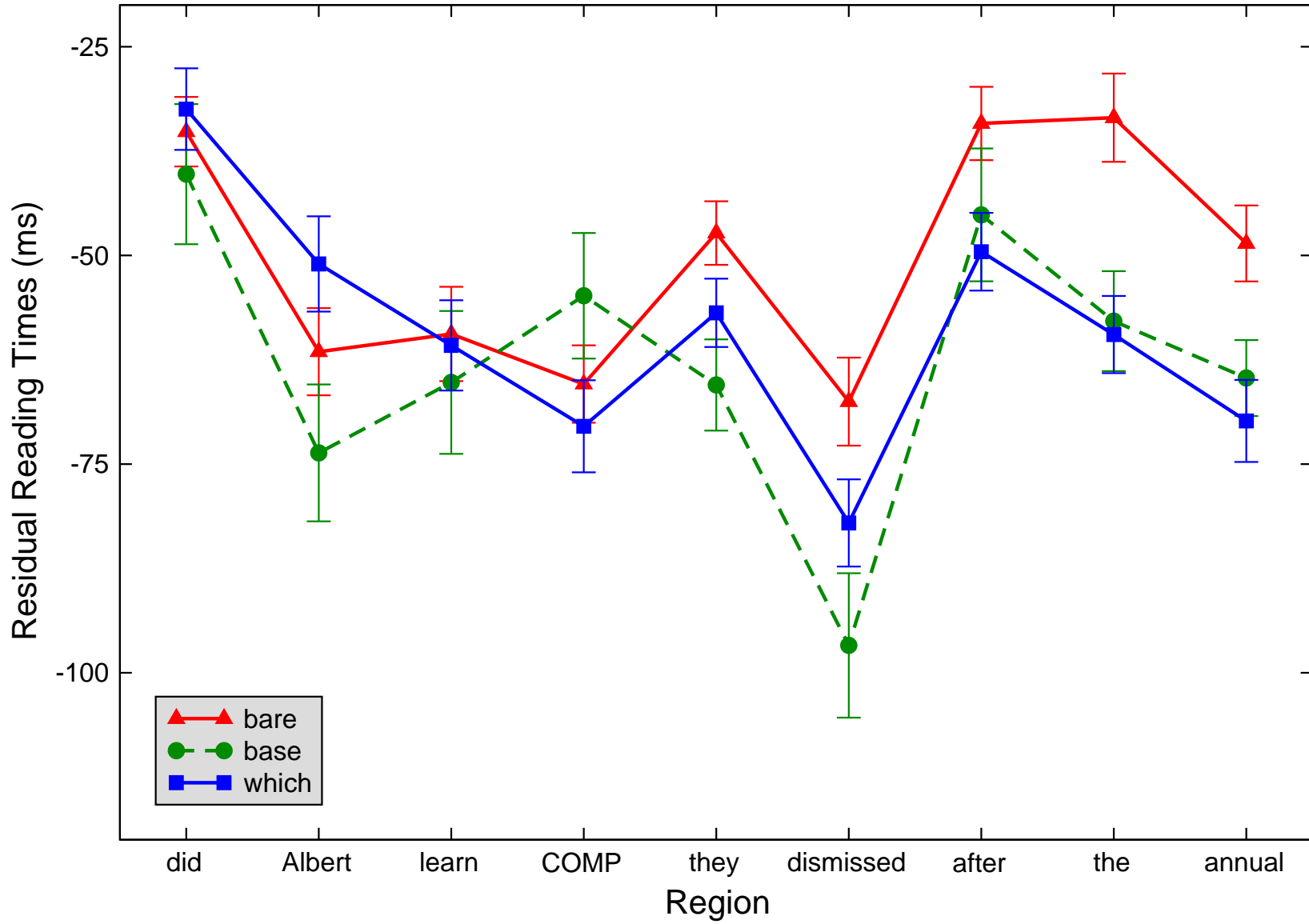
- Albert learned that the managers dismissed the employee with poor sales after the annual performance review.

bare: Who did Albert learn whether they dismissed after the annual performance review?

which: Which employee did Albert learn whether they dismissed after the annual performance review?

baseline: Who did Albert learn that they dismissed after the annual performance review?

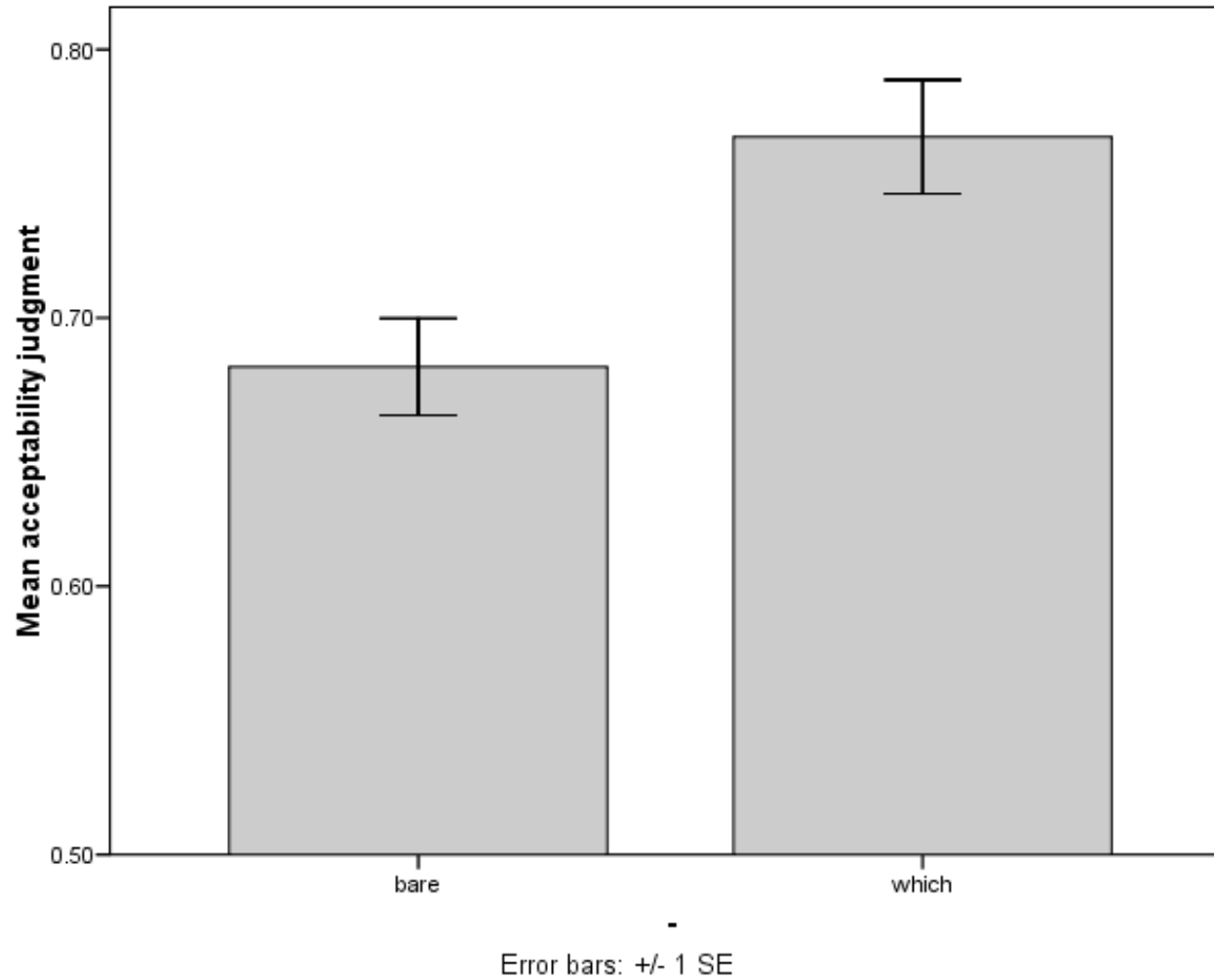
WH-Island RT study: Results



WH-Island RT study: Results

- Effect of informativity: WHICH condition read faster than BARE condition ($t_1(19) = 3.600, p = .001$; $t_2(23) = 3.669, p = .001$)
- Inside embedded clause, no significant difference between WHICH and BASELINE
- Effect emerges around retrieval and integration site (n.s. in previous regions)
- These processing differences are reflected in the acceptability judgments
- Reading time items were presented as embedded questions and judged on 7-point scale

Acceptability Judgment Results: Wh-Islands



WH-Island: Acceptability

- Which-NPs significantly improve acceptability of wh-island violations ($F1(1,14) = 17.796, p < .001$; $F2(1,19) = 13.811, p < .001$).
- Hence, we see that acceptability differences mirror processing differences.
- Lower acceptability sentences have the behavioral correlate of slower RTs.

CNPC/Subjacency Effects

- He realized **which prisoner** Ashley countered **the belief** that we had interrogated without regard to international law. (WHICH-DEF)
- He realized **which prisoner** Ashley countered **a belief** that we had interrogated without regard to international law. (WHICH-INDEF)
- He realized **which prisoner** Ashley countered **beliefs** that we had interrogated without regard to international law. (WHICH-PLURAL)

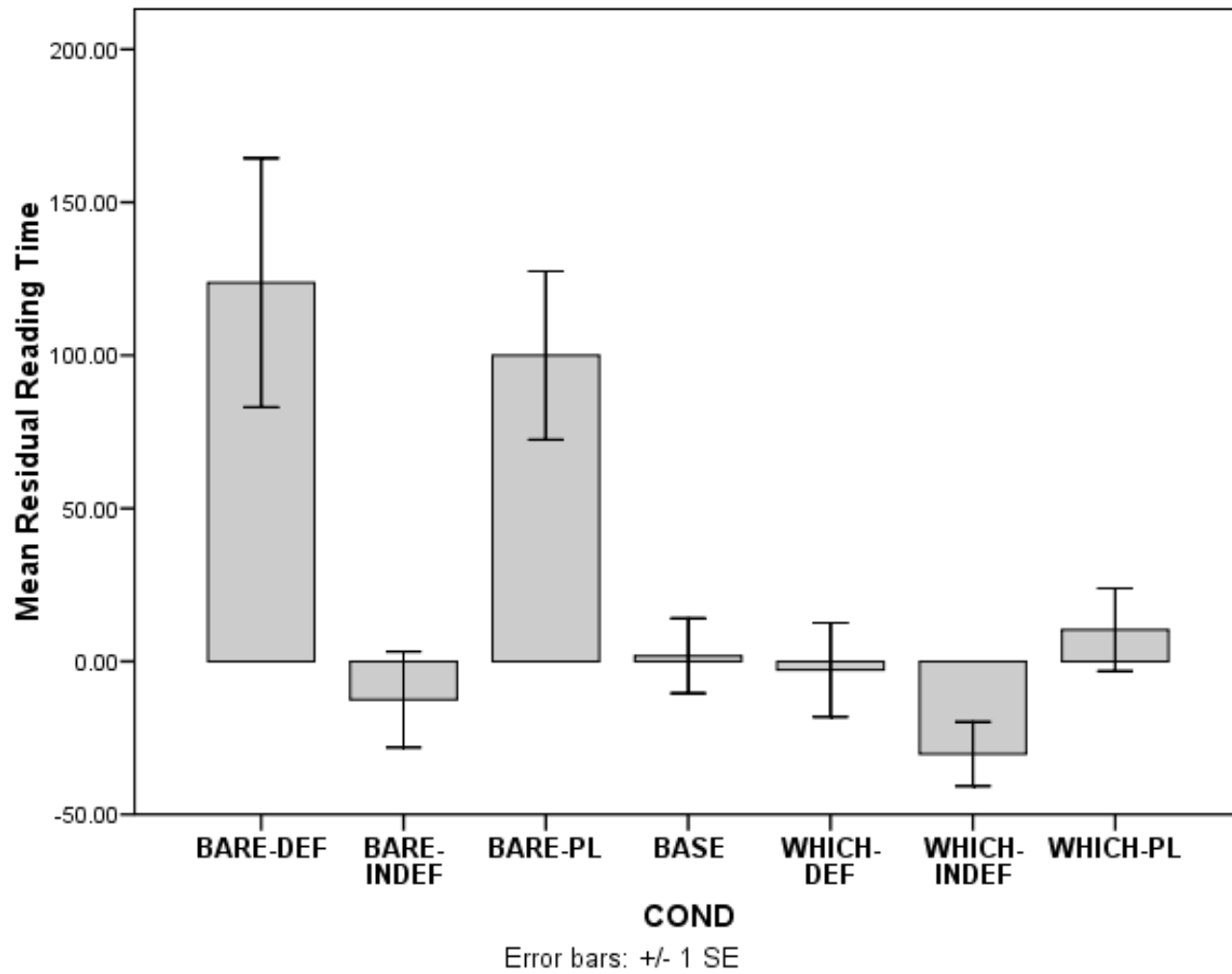
- He realized **who** Ashley countered **the belief** that we had interrogated without regard to international law.
(BARE-DEF)
- He realized **who** Ashley countered **a belief** that we had interrogated without regard to international law.
(BARE-INDEF)
- He realized **who** Ashley countered **beliefs** that we had interrogated without regard to international law.
(BARE-PLURAL)
- He realized **who** Ashley countered **that** we had interrogated without regard to international law.
(BASELINE)

Results: CNPC Experiment 1

Beginning at the complementizer (that), WHICH condition generates significantly faster reading than the BARE condition.

This effect persists for the next five words, yielding a highly significant main effect of *wh*-phrase type.

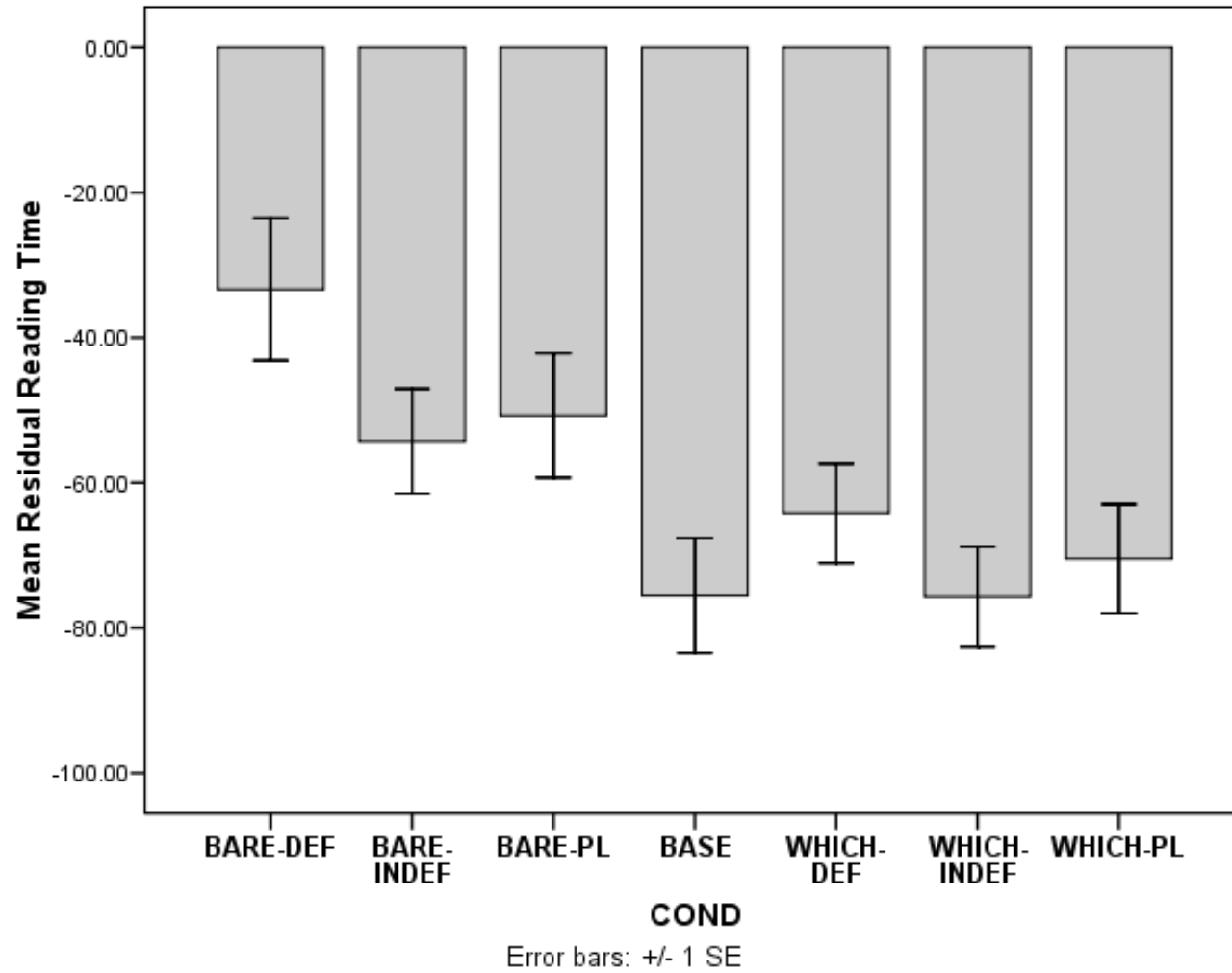
Reading Times at Complementizer: Experiment 1



Reading Times at Complementizer: Experiment 1

- Main effect of *wh*-type
- $F_1(1, 24) = 13.776, p = .001$; $F_2(1, 35) = 18.953, p < .001$
- *which*-conditions not significantly different than baseline
- Effect of NP-type stemming from faster reading in the INDEF conditions
- $F_1(1,24) = 9.415, p = .001$; $F_2(1,34) = 11.619, p < .001$

Reading Times at Aux+Verb: Experiment 1



Reading Times at Aux + Verb in CNPC Experiment 1

- Main effect of *wh*-type
- $F_1(1, 24) = 7.311, p = .012$
- $F_2(1, 35) = 8.494, p < .01$
- *which*-conditions not significantly different than baseline
- no significant effect of definiteness

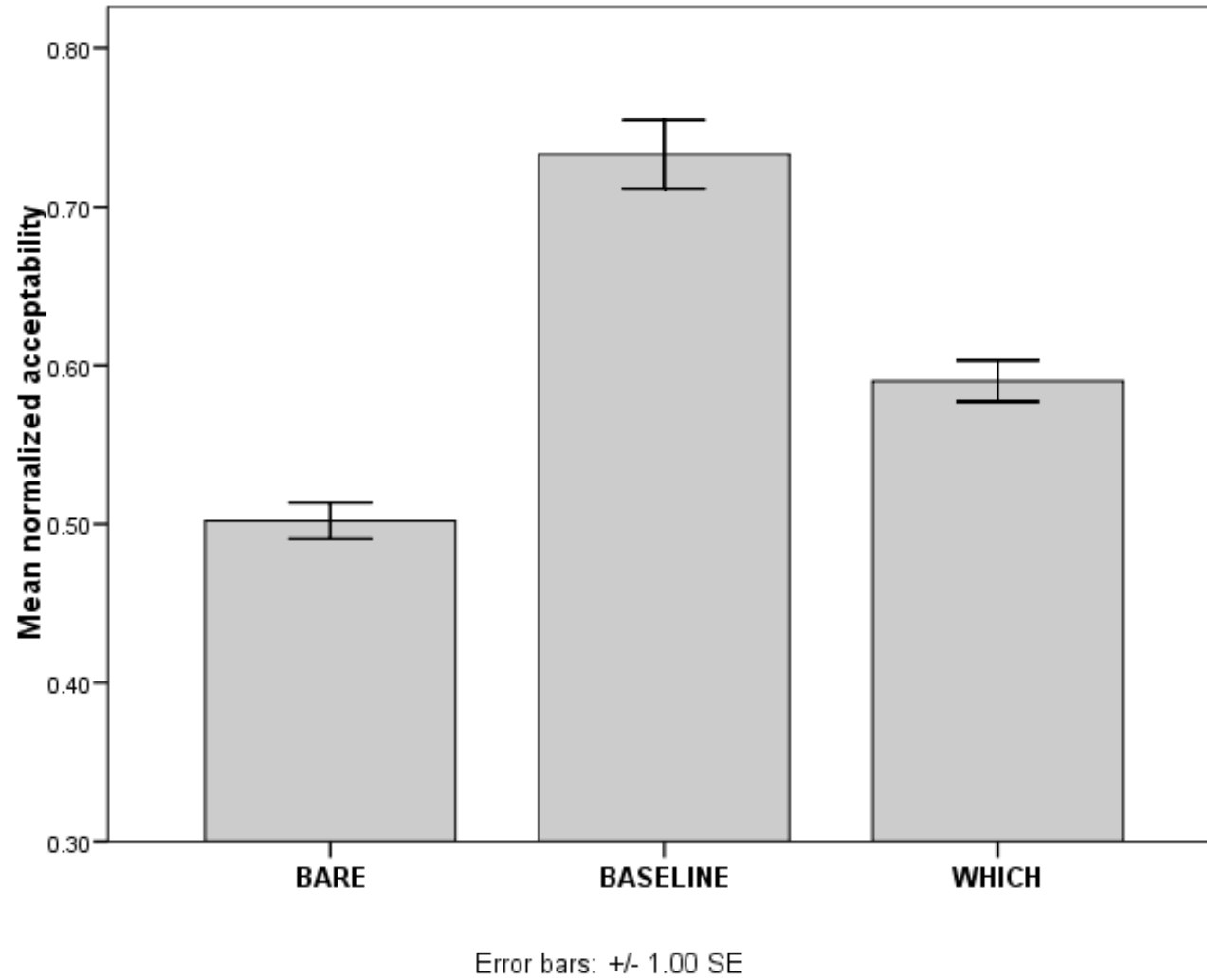
CNPC Reading Time Experiments: Summary

- Clear effect of *wh*-type – informativeness of the *wh*-expression, beginning at complementizer and lasting throughout almost the entire embedded clause
- Reading time in WHICH conditions is similar to those of the baseline—no statistical difference
- Question-answer accuracies show no effect of condition, but there is a (non-significant) trend for faster responses in the baseline condition
- Want to verify that this processing difficulty converges with (controlled) acceptability results

Acceptability Judgments in CNPCs

- Same design and items as in reading-time study
- 16 subjects (different from 25 participants in reading-time study), given course credit for participation
- Sentences judged for naturalness on a scale of 0-7 to eliminate midpoint

Acceptability Judgment Results 1



Acceptability Judgment Results 2

- Main effect of *wh*-type: which-NPs judged as being better than bare *wh*-items.
- $t_1(1,15) = 6.394, p < .001$
- $t_2(1,35) = 5.263, p < .001$
- Observed power = .998, i.e. .002 percent chance of a false positive
- Trend, but no significance, in definiteness: plurals judged better than definites and singular indefinites.
- Baseline significantly better than any island condition.

Linking Acceptability and Processing

Manipulating non-structural factor (informativity) produces parallel acceptability and processing results

Where processing difficulty significantly increases, acceptability decreases

A reasonable inference to draw is that these results are related to another

In particular, the results are compatible with the notion that processing difficulty is influencing judgments of acceptability

We will return to arguments for why we believe this is the right conclusion to make, after considering further evidence

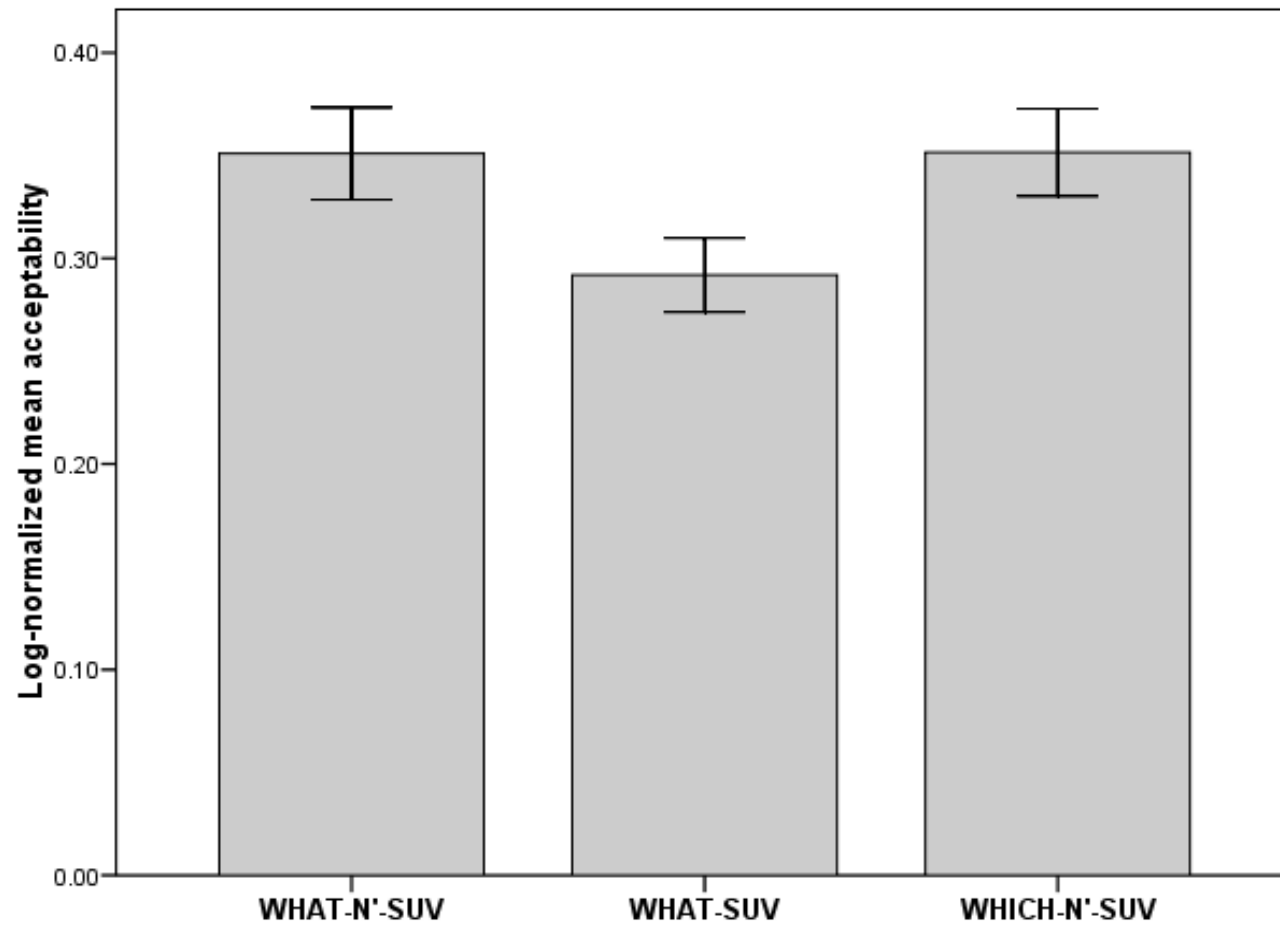
Processing Superiority 'Violations' (SUVs)

SUVs (Hofmeister et al. 2007)

Evaluated the effect of *wh*-phrase type (in both argument positions) on acceptability

- Ted revealed **what who** invented ...
- Ted revealed **what device** who invented....
- Ted revealed **which device** who invented....
- We found that both **which**-NPs and **what**-NPs improve acceptability.

SUVs-Acceptability (Hofmeister et al. 2007)

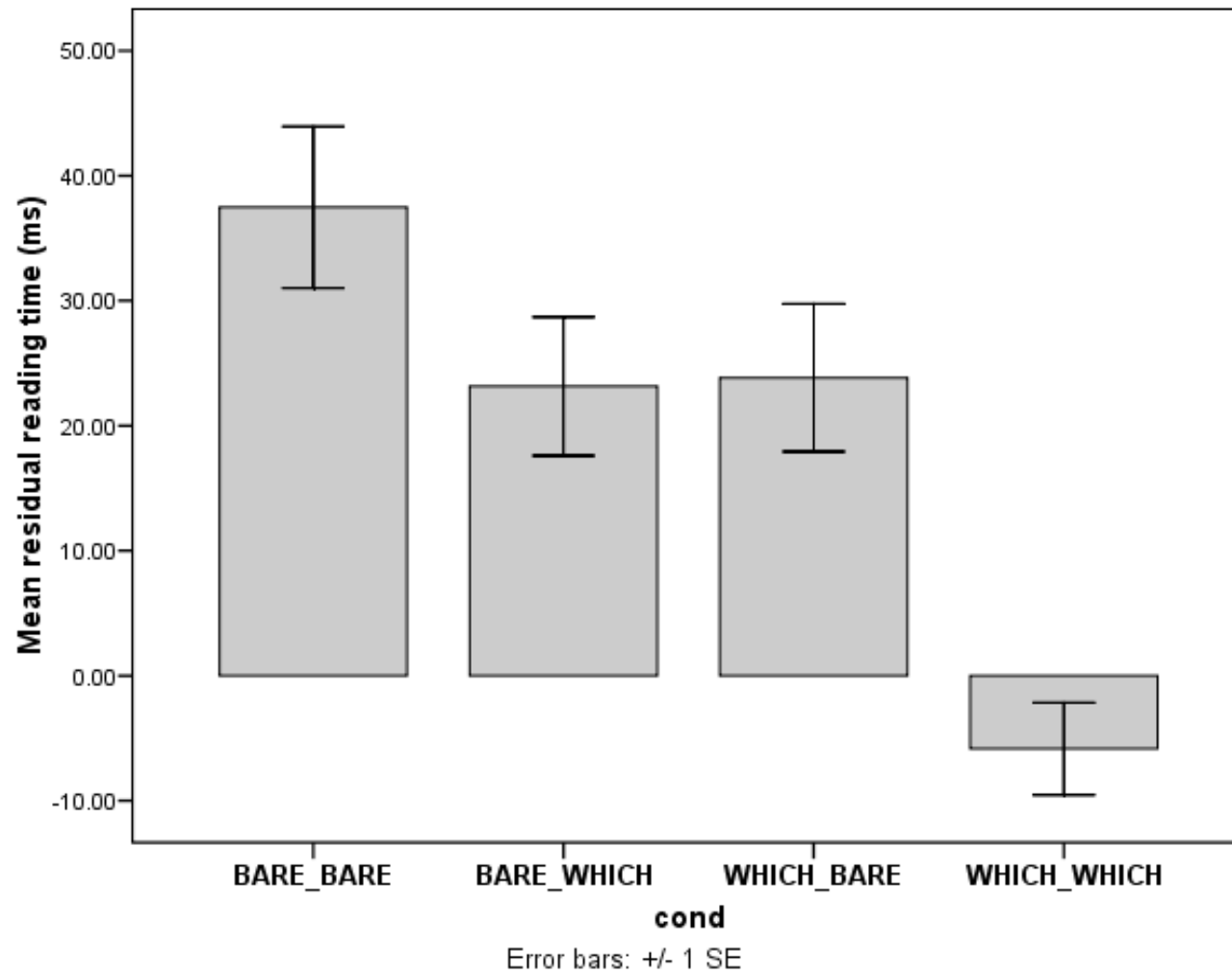


Error bars: +/- 1 SE

SUVs-Reading Time Stimuli (Hofmeister et al. 2007)

- Ashley disclosed what who signed after receiving permission from the president.
- Ashley disclosed which agreement who signed after receiving permission from the president.
- Ashley disclosed what which diplomat signed after receiving permission from the president.
- Ashley disclosed which agreement which diplomat signed after receiving permission from the president.

SUVs-Reading Times (Hofmeister et al. 2007)



SUVs-Reading Time Stimuli (Hofmeister et al. 2007)

- The most acceptable condition with 2 *which*-NPs is read fastest, and that the worst condition (2 bare *wh*-words) is read slowest
- SUVs with one *which*-NP have intermediate reading times
- These reading time results closely parallel acceptability judgments

Adjunct Extraction

'Weak' (Selective) Islands

Adjunct Extractions: Materials

(28 subjects, 24 items, 3 conditions)

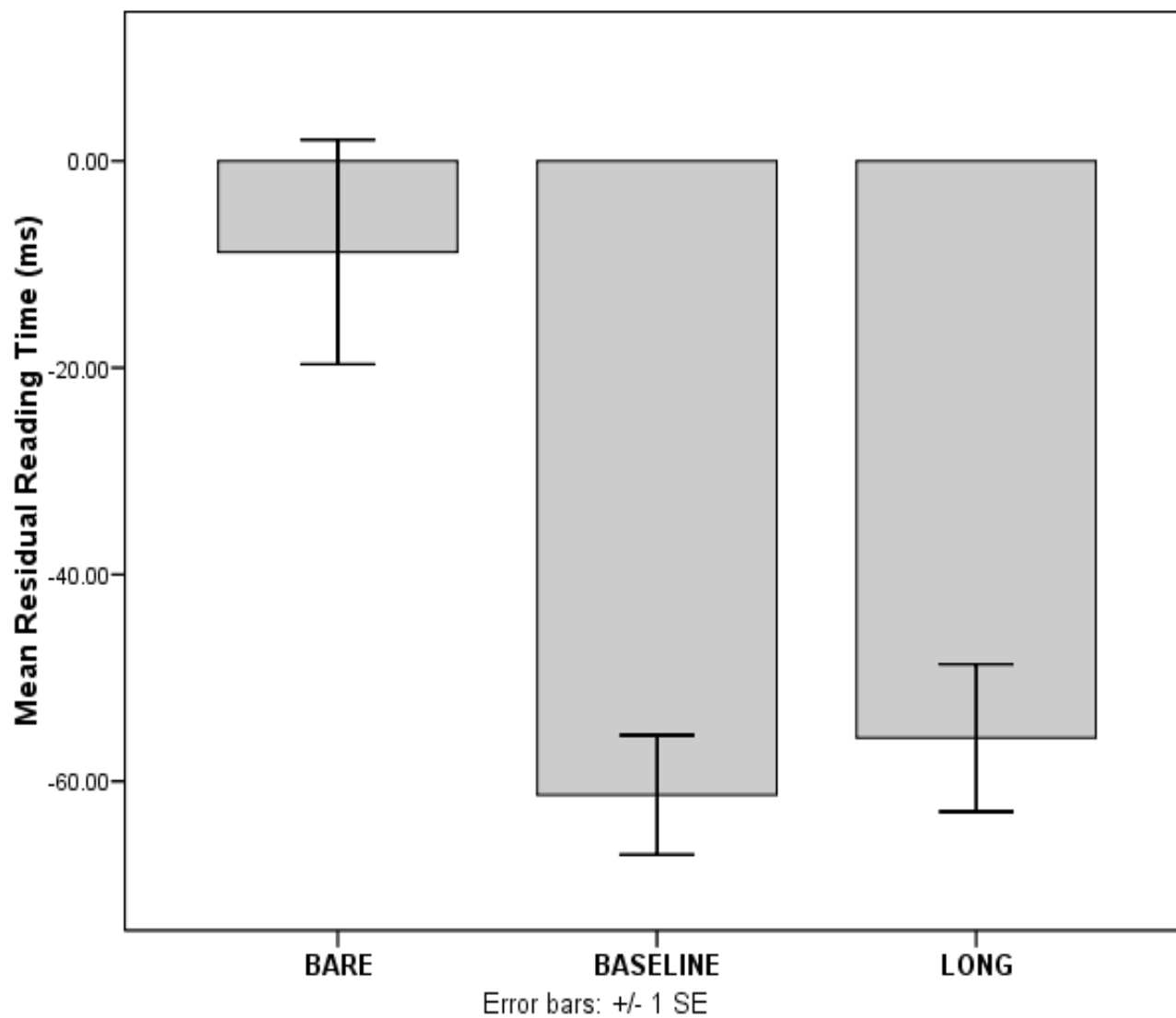
Julie discerned that the survivor had managed to stay alive for eight days after the crash in the harsh conditions.

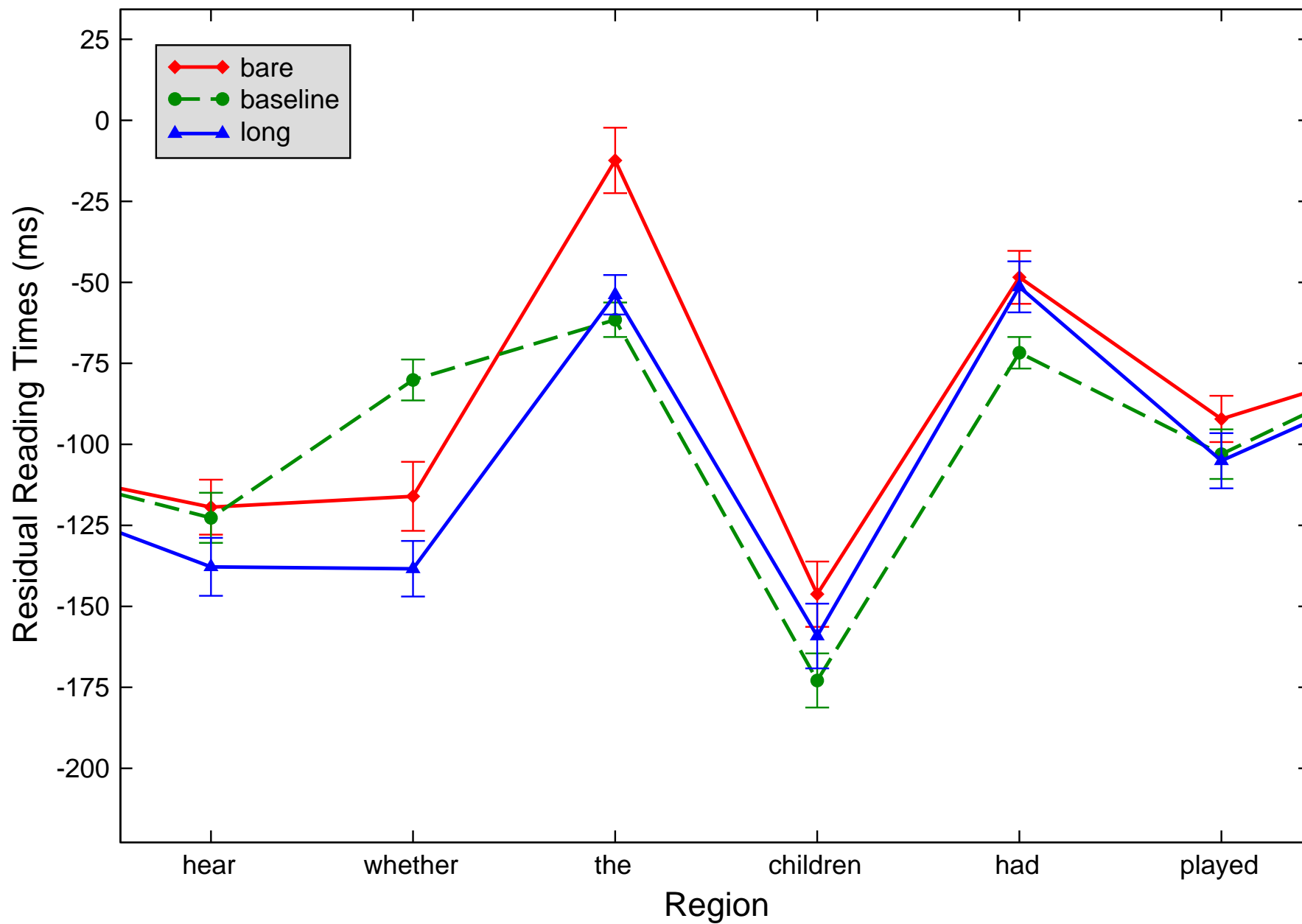
BARE: How long did Julie observe whether the passenger had survived in the unbelievably harsh conditions?

LONG: For what period of time after the crash did Julie observe whether the passenger had survived in the unbelievably harsh conditions?

BASELINE: How long did Julie observe that the passenger had survived in the unbelievably harsh conditions?

Adjunct Extractions





Reading Times at 1st Word in Embedded Clause

- Significant difference between LONG and BARE conditions
- $t_1(27) = 3.484, p = .002$
- $t_2(23) = 3.513, p = .002$
- LONG condition not significantly different than baseline (t s less than 1)
- No effect at embedded verb

Adjunct Extraction

- The effect of filler-informativity on processing is not restricted to referential arguments
- Simple dichotomies between referential and non-referential phrases fail to predict any differences like this
- This effect appears to be quite stable and replicable across constructions
- As mentioned earlier, this effect of informativity is not restricted to *wh*-phrases or islands—it is found in completely grammatical contexts with definites, indefinites, and other *wh*-phrases

Conclusions

- In various island configurations, we find that the amount of information encoded in the filler phrase affects processing and acceptability in parallel ways.
- Judgments of reduced acceptability may thus be a consequence of processing difficulty.
- This interpretation is no different than that applied to center-embeddings or garden-path sentences.

- There is considerable effect of orthogonal factors on the acceptability of island-violating sentences.
- The observed findings are in large part explained by appeal to processing factors known to affect other types of unbounded dependencies.
- The gradient, variable nature of these effects follows from a processing-based (performance) account (in line with the standard distinction between competence and performance).

- This explanation for the variation in acceptability judgments is preferable to a competence-based approach because:

(1) It appeals to independently motivated principles of cognition that are necessary even if they explain nothing about islands. These principles may even be independent of language.

It is thus “cost free” because no new constraints have to be introduced into the grammar.

(2) This type of explanation can account for variation/gradience and processing differences in sentences that do not violate any proposed grammatical constraint.

(3) A processing-based explanation can better model variation across and within speakers.

Individual differences in working memory can explain why some individuals are more accepting.

A single language user's judgments can vary across time due to distractions, fatigue, repeated exposure, other cognitive tasks, etc.

Reminder...

- **We are not proposing to eliminate grammar or grammatical constraints.**
- *Who did you meet Kim and ___ ?
- But what we've started to find in looking at adverb islands, subject islands, and so forth, suggests that these too are processing effects.

Conclusions

- The generative grammar literature on FG-dependencies is based on highly questionable datasets.
- The study of competence grammar must go hand in hand with the study of sentence processing.
- Understanding the various processing factors that affect acceptability will change the nature of competence theories – the data sets left to be accounted for will be considerably altered.

- We're proposing to derive the gradient space of acceptability from the very mechanisms that explain processing times.
- This approach holds promise for maximizing the explanation of linguistic phenomena, while at the same time minimizing the assumptions about the grammar that a child must learn.
- A fundamental simplification of Generative Grammar in general and UG in particular.

Thanks!

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