

# English restrictive relative clauses are subject to crossover violations

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*Abstract:* The literature on crossover effects has yet to arrive at a consensus on the status of weak crossover (WCO) in restrictive relative clauses (RRCs). We present the first experimental investigation of this construction, finding clear evidence for the presence of WCO effects in English RRCs, contra claims in the theoretical literature (e.g., Chomsky 1982, Reinhart 1997, Rouveret 2002). In our large-scale acceptability judgment task, participants consistently rated WCO-inducing constructions lower than their non-WCO counterparts. Our results also show similarly strong crossover effects for both referential and quantificational antecedents, a finding that aligns more closely with a head-external analysis of relative clauses rather than a head-raising analysis. While our results do not adjudicate among the many analyses of crossover effects in the literature, they confirm the presence of WCO in English RRCs, thereby refuting the empirical claim that English RRCs do not exhibit this effect whatsoever. Accordingly, our findings can be used to argue against analyses of WCO that predict its absence in RRCs. This

work also sets the stage for cross-linguistic investigations of WCO, extending our paradigm to other, lesser-studied languages.

*Keywords:* (weak) crossover, relative clauses, binding, coreference, experimental syntax

## 1 Introduction

It is well known that the relationship between pronouns and their potential antecedents in sentences is not a free for all. In the context of A-bar movement, ungrammatical or degraded strings can arise when a phrase is displaced across a coreferential pronoun (hence the term “crossover”). Depending on whether the “crossed-over” pronoun c-commands the base position of the moved constituent, crossover phenomena are further divided into strong (SCO) and weak (WCO); see Postal 1971 and Safir 2017 for an overview of WCO. In more technical terms, the overarching generalization behind crossover phenomena is as follows: pronouns that are coindexed with an operator must be locally A-bound, or alternatively, operators must not locally A-bar bind pronouns (the formulation following Ruys 2000). Familiar examples of SCO and WCO, with corresponding grammatical counterparts, are given below:

(1) *Strong crossover:*

- a. Who<sub>1</sub> did John see t<sub>1</sub>?
- b. \*Who<sub>1</sub> did he<sub>i</sub> see t<sub>1</sub>? (SCO)

(2) *Weak crossover:*

- a. Who<sub>1</sub> did John’s sister see t<sub>1</sub>?
- b. \*Who<sub>1</sub> did his<sub>1</sub> sister see t<sub>1</sub>? (WCO)

Weak crossover gets its name from the observation that judgments in the absence of c-command between the antecedent and pronoun (as in (2b)) are less clear than under c-command, shown in (1b) (Wasow 1972). Further still, among WCO environments, there are constructions where the WCO effects are even less obvious, and ones for which there is simply no consensus. Restrictive relative clauses in English are one such construction for which consensus is lacking. Taking the examples from Lasnik and Stowell (1991:698), consider (3).

- (3) a. the man<sub>i</sub> [who<sub>i</sub> [his<sub>i</sub> mother loves t<sub>i</sub>]]  
 b. the book<sub>i</sub> [which<sub>i</sub> [its<sub>i</sub> author read t<sub>i</sub>]]

On the surface, these strings have a perfectly grammatical parse, one where *the man* and *his* (or *the book* and *its*) are not coreferential. Even with the intended coreference, which is our main focus, these examples remain grammatical for some researchers (most notably, Chomsky 1982; Reinhart 1997) but are judged as unacceptable by others who disagree with “the empirical claim that WCO effects are fully absent in restrictive relatives” (Lasnik and Stowell 1991:698; e.g., Safir 1986, 1996, 2017; Postal 1971, 1993; Higginbotham 1980). This situation contrasts with examples like (2b), which elicit consistent judgments of degradedness.<sup>1</sup> The conflicting judgments reported by various authors may reflect variation within a community of speakers with respect to WCO sensitivity. We would then expect to find a solid bimodal distribution across speakers with respect to WCO effects in restrictive relative clauses.

Further still, some of the observed variation in judgments may be explained by a factor proposed by Lasnik and Stowell (1991), namely the intrinsic quantificational status of the pronominal binder. For Lasnik and Stowell, the relevant binder in restrictive relatives is the operator inside the relative clause; their approach treats it as a true QP (Lasnik and Stowell 1991:707). On their account, local A-bar binding occurs at LF only when a quantifier ranges over a possibly non-singleton set (that is what they call true quantifiers). Accordingly, the mere availability of A-bar binding configurations is not sufficient for assessing WCO; instead, the logical status of the operator in the A-bar position must be taken into consideration as well. However, the operator inside the restrictive relative clause may play a different role depending on the actual analysis of the relative clause (see Bianchi 2002a,b, Hulsey and Sauerland 2006 for different approaches). Assuming possible differences in the derivation of restrictive relative clauses, one would expect WCO violations only in the context of what they call true quantificational expressions, as opposed to regular R-expressions. In addition, specificity and details of the discourse have been proposed as factors that also play a role in the presence/absence of WCO effects (see Falco 2007 on the role of the former in English).

There exist many analyses of the WCO phenomenon, both syntactic and semantic (see Safir 2017 for an overview). However, from our perspective, the empirical target of analysis remains unclear—particularly because of the conflicting judgments on WCO effects in RRCs. Given

the rich tradition of experimental and theoretical work on relative clauses, it is actually surprising that WCO in such clauses has not been studied systematically. We therefore set as our goal in this paper arriving at a clearer picture of the status of WCO in English restrictive relatives. In the next section, we present the design and results of an experiment testing for WCO effects in this environment.

## 2 Experiment

To test for the presence of WCO in English, we designed a acceptability judgment study in which participants encountered sentences in short contexts; contexts were included to help encourage participants to access the target interpretation.<sup>2</sup> Ours is not the first experimental investigation of crossover phenomena (e.g., Kush, Lidz, and Phillips 2017, Ross, Chierchia, and Davidson 2023). However, experimental investigations of crossover phenomena commonly compare strong vs. weak crossover without a baseline comparison against environments with no crossover (Kush, Lidz, and Phillips 2017 is an exception in this regard as they have baseline sentences where regular NPs contrast with pronouns in the target stimuli). Moreover, at the time of writing, we are unaware of experimental investigations of WCO in English RRCs, one of the constructions where the status of crossover phenomena is still unclear.

Our predictions, based on the primary, introspective data summarized above, are as follows. First, given the diverging reports in the literature, we expect to find at least two patterns of response in our data: one from participants who report crossover violations, and another from participants without violations. Second, given Lasnik and Stowell’s judgments, we expect to find crossover violations for quantified expressions but not for RRCs headed by a regular R-expression.

### 2.1 Participants

We recruited 230 participants via email and classroom advertisements; 110 indicated that English was their only native language. Of those, 78 (81% female; average age: 21) passed the attention checks; we include their data in the analyses reported below.

Sentence	WCO	determiner	animacy
Every flight attendant who her pilot flew around the country avoided turbulence.	WCO	quantifier	animate
Every plane which its pilot flew around the country avoided turbulence.	WCO	quantifier	inanimate
The flight attendant who her pilot flew around the country avoided turbulence.	WCO	R-expression	animate
The plane which its pilot flew around the country avoided turbulence.	WCO	R-expression	inanimate
Every flight attendant who the pilot flew around the country avoided turbulence.	no WCO	quantifier	animate
Every plane which the pilot flew around the country avoided turbulence.	no WCO	quantifier	inanimate
The flight attendant who the pilot flew around the country avoided turbulence.	no WCO	R-expression	animate
The plane which the pilot flew around the country avoided turbulence.	no WCO	R-expression	inanimate

Table 1: Example experimental item.

## 2.2 Materials and design

We designed a series of 24 experimental items; two items were excluded from analysis due to typographical errors that were observed once the experiment was running.<sup>3</sup> Each item had eight variants, corresponding to our eight conditions. We manipulated three factors, each with two levels: WCO (presence vs. absence of a configuration that should yield WCO), determiner (R-expression vs. quantificational determiner), and animacy (whether the RC head was animate vs. inanimate). We manipulated animacy of the RC head as a way to introduce diversity into our items; we did not have a specific prediction regarding the role of animacy in WCO violations. However, animacy distinctions have been shown to play a role in relative-clause grammar and processing (e.g., Gennari and MacDonald 2009), which further warrants the inclusion of this contrast. An example item appears in Table 1.

Each item was presented with a context to ensure that the sentence was interpreted with a bound/coreferential interpretation; this context facilitated a pairing relationship between the two nouns in the target sentence. Because the sentences containing WCO are not themselves ungrammatical (i.e., an interpretation where the pronoun is not bound is acceptable), the context ensured that sentences were judged with respect to the bound interpretation. Additionally, all of the RC verbs were introduced in a passive construction, setting up an expectation for the verb to be transitive. Participants were asked to evaluate how natural the sentence was in

Progress:

Planes are operated by certain pilots. Some planes were flown around the country by their pilot, and others were not.

How natural is the following sentence in the context of the story?

**Every plane which its pilot flew around the country avoided turbulence.**

unnatural                      natural

Continue

Figure 1: Example experimental trial with the item in Table 1; this trial features a WCO, quantificational determiner, inanimate condition.

the context of the story, adjusting a slider with endpoints labeled “unnatural” (coded as 0) and “natural” (coded as 1). To discourage participants from providing truth-value judgments instead of naturalness ratings, participants were instructed that “All the sentences are true; please evaluate the sentences exactly as they are written to decide whether they sound natural given the context.” An example trial for the item in Table 1 appears in Figure 1.

After reading the instructions and encountering two practice examples, participants completed a total of 30 trials—24 test sentences (3 from each of the eight conditions) using a Latin Square design that ensured participants saw one variant from each item together with 6 attention checks—in a random order. The attention checks were designed to elicit a straightforward response, either clearly acceptable or clearly unacceptable. For acceptable attention checks, the expected response was 0.5 or greater; for unacceptable attention checks, the expected response was less than 0.5. Only participants who provided the expected response on at least five of the six attention checks were included in analysis; 32 participants were excluded based on this criterion.

### 2.3 Results

Figure 2 plots average responses grouped by experimental condition. We fit a linear mixed-effects regression predicting response by WCO, determiner, and animacy, together with their interactions; the model included random intercepts by participant and by item. The only effect

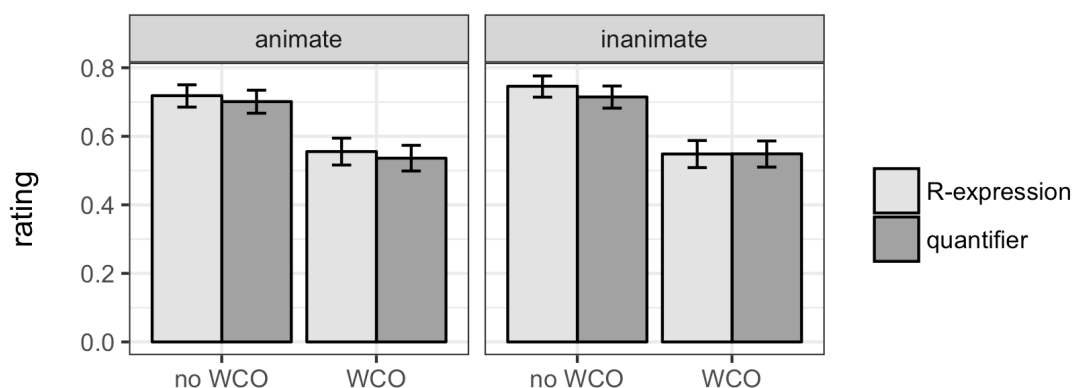


Figure 2: Average slider rating grouped by condition.

that reaches significance is that of WCO ( $\beta = -0.17$ ,  $t = -7.51$ ,  $p < 0.001$ ), such that WCO conditions were rated lower than no WCO conditions (WCO: 0.55, no WCO: 0.72). For reference, our clearly-acceptable attention checks were rated 0.81 and our clearly-unacceptable attention checks were rated 0.21.

To see whether we observe diverging patterns of responses for responding to WCO violations that would be suggestive of distinct subgroups of participants within our data, we calculated an average rating difference score for each participant: the average rating a participant gave to no-WCO trials less the average rating that participant gave to WCO trials. Positive values for the rating difference score indicate that a participant rated no-WCO trials higher than WCO ones. Figure 3 plots a histogram of these difference scores. Visual inspection suggests that most participants treat WCO trials as degraded relative to no-WCO trials (as we would expect given the significant effect of WCO reported above); we do not observe evidence of a bimodal distribution suggestive of diverging response strategies.<sup>4</sup>

### 3 General discussion

Our experiment was designed to detect contrasts across our experimental conditions; the only contrast for which we have evidence is that between WCO effects and their absence (no WCO). Thus, we have shown that experimental methods allow us to identify the presence of WCO effects in English RRCs.<sup>5</sup> This result is consistent with the informal judgments drawn by Lasnik and Stowell (1991), who contend that there are clear WCO effects in restrictive relatives (in

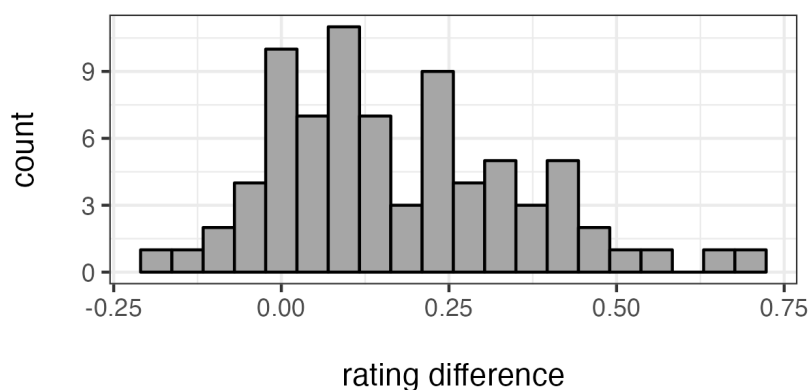


Figure 3: Histogram of response difference scores calculated for each of our 78 participants.

contrast with appositives, which they also discuss).

Our findings inform syntactic theory along at least three dimensions. First, having found that English RRCs are indeed sensitive to crossover violations, our results limit the viable analyses to those that predict such violations. Second, the absence in our data of a quantifier vs. R-expression distinction with respect to crossover violations suggests that, to the extent that WCO effects should be explained by the nature of the A-bar binder associated with a pronoun (Sportiche 1983, Lasnik and Stowell 1991, Safir 2017), it is the nature of the quantificational operator in the relative clause and less so the nature of the external head noun that matters. Finally, our results also have a bearing on the existing approaches to the structural design of restrictive relative clauses in English (and beyond). Among the various competing syntactic analyses for relative clauses, the head-raising analysis and the operator-movement (head-external) analysis stand out as the most influential. Under the head-raising analysis, the head noun originates within the relative clause and moves to its surface position as the head of the relative clause (Kayne 1976, 1994, Bianchi 1999, 2002a,b, Cinque 2020). Under the head-external analysis, the head noun both originates and remains outside the relative clause, while a separate element, either a *wh*-word or null operator, moves from within the relative clause to the specifier of the clause adjoined to that head noun (for discussion, see Cinque 2020). Assuming the proposed differences between true quantificational operators and their non-quantificational counterparts, the head-raising analysis suggests that we should expect a difference between quantified head nouns (*every plane*) and regular R-expressions (*the plane*), such that only the relative clause with an overtly-quantified head noun would show WCO ef-

fects. However, as mentioned above, in our results WCO is observed equally with quantified NPs and regular R-expressions as head nouns. This finding suggests that the head-external analysis provides a better model, at least for the clauses with relative pronouns (*who*, *which*) that were used in our stimuli. (A separate study would be needed for relative clauses headed by *that*.)

Methodologically, crossover phenomena pose a challenge to acceptability judgment paradigms because the sentences involved have parses that are uncontroversially grammatical; the phenomenon of interest requires raters to access a specific interpretation. We addressed this challenge in our design by providing contexts to encourage the interpretation of interest. Still, we cannot guarantee that participants accessed a particular interpretation, which makes the contrast in judgments we observed even more striking: had participants accessed a non-coreferential interpretation instead, we would not expect to observe WCO effects.

We are left with the question of why some authors in the extant body of research on English relative clauses fail to see WCO effects, and why some only observe them under quantified NPs. Note that until now, the presence or absence of WCO was established solely using introspection, and yielded a bimodal distribution. We attempted to address this issue by looking for subgroups of participants who diverge in their response to WCO effects; however, we did not find patterns in the data that would suggest substantial sub-populations of speakers.<sup>6</sup> Still, it is possible that looking at aggregate data obscures the presence of individuals whose grammar differs systematically with respect to WCO. Regardless, if syntactic analysis aspires toward broad empirical generalizations, then our results should not be dismissed: WCO effects are indeed present in English RRCs. Analyses to the contrary fail to characterize the broad English-speaking population surveyed in our study.

Having demonstrated the viability of our paradigm for diagnosing crossover effects in English, a natural next step would be to extend this paradigm to other languages, especially those where the presence of crossover effects has been questioned (see Bresnan 1998 for a cross-linguistic overview and discussion of some questionable cases, or Grewendorf 2002, Salzmann 2006, on the absence of WCO under local A-bar movement in German).

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## **Notes**

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<sup>1</sup>Due to this difference between examples like (2b) and (3), Lasnik and Stowell (1991) coin the term “weakest crossover” for environments like (3).

<sup>2</sup>Ross, Chierchia, and Davidson (2023) asked participants to rate the availability of two interpretations, one which did not violate the crossover constraint and one which did, and found that participants dispreferred the interpretation which violated the crossover constraint. Kush, Lidz, and Phillips (2017) found WCO effects without controlling for context, suggesting that participants avoided an otherwise grammatical interpretation.

<sup>3</sup>A supplement with our experimental items, anonymized results, and analysis scripts are available online at OSF (web link).

<sup>4</sup>We find similar results if we control for by-participant and by-item variation by calculating Z-scores. Please see our OSF repository for these analyses.

<sup>5</sup>One might worry that the WCO effect we observe in our materials is simply a complexity effect brought on by DPs with possessives in subject position. However, we suspect that making precise the notion of complexity at play in our materials is likely to reconstitute the formal notion of WCO.

<sup>6</sup>A reviewer suggests that the contrast between reports in the literature and our results has to do with generational differences, namely, our speakers, who are at least two generations younger than such authors as Postal or Chomsky, have different judgments. While not impossible, we find this interpretation unlikely. First, older speakers in the literature also noticed WCO effects; in other words, conflicting reports in the literature come from authors of the same generation. Second, English binding phenomena other than WCO have been studied for quite a long time, at least since

the 1980s (cf. Nicol and Swinney 1989), and the patterns have not changed since.