Locative Inversion, PP Topicalization, and Weak Crossover in English*

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Abstract

The syntax on locative inversion in English currently disputes whether locative inversion differs from PP topicalization in permitting a quantifier in the fronted PP to bind a pronoun in the subject. In order to resolve this dispute, this paper runs two experiments on Amazon Mechanical Turk, one an acceptability judgment task and the other a forced-choice task. Both find that PP topicalization does not differ from locative inversion: both permit variable binding. Locative inversion also does not differ from a minimally different sentence with the overt expletive there. These findings remove an argument against the null expletive analysis of English locative inversion (Lawler 1977, Postal 1977, 2004, Bruening 2010), and they also show that weak crossover is not uniformly triggered by A-bar movement.

1 Introduction

A major point of contention in the literature on English locative inversion, exemplified in (1), is the question of what the subject in Spec-TP is. There are basically two schools of thought. One holds that the fronted PP is the subject in Spec-TP (although most analyses add that it subsequently extracts to an A-bar position). The other school of thought holds that a null expletive like there is the subject in Spec-TP.

(1) Under the bridge lived a bloodthirsty troll.

Among those who argue that the PP is the subject are Bresnan (1994), Culicover & Levine (2001), Doggett (2004), Diercks (2017), while those arguing for a null expletive include Lawler (1977), Postal (1977, 2004), Bruening (2010), Diercks (2017), summarizing the arguments (and see that work for additional references), asserts that the crucial set of facts deciding in favor of the PP-as-subject analysis involves weak crossover (WCO). Culicover & Levine (2001) claimed that locative inversion contrasts with PP topicalization in that only the former permits a quantifier in the PP to bind a pronoun as a variable in the NP that agrees with the verb. Topicalizing a PP over a preverbal subject is claimed to result in weak crossover:

*Thanks to Amanda Payne, for running the experiments on Mechanical Turk.
(2)  a. * In every dog_{1}’s cage its_{1} collar hung. (topicalization, WCO)
    b. In every dog_{1}’s cage hung its_{1} collar. (locative inversion, no WCO)

According to Doggett (2004), with an overt expletive the fronted PP patterns with topicalization, not locative inversion:

(3) * In every dog_{1}’s cage there hung its_{1} collar.

These researchers take this to show that only in locative inversion does the PP occupy an A-position high in the clause, on the assumption that variable binding requires binding from an A-position, while A-bar movement always gives rise to weak crossover. This then supports the PP-as-subject analysis and argues against the null expletive analysis, since locative inversion is patterning differently from a comparable sentence with an overt expletive.

The judgment in (3) was disputed by Postal (2004) and Bruening (2010), who argue that any degradation in (3) is due to the definiteness effect with overt there rather than to the failure of variable binding. Diercks (2017), however, dismisses this claim, disagreeing with Postal’s and Bruening’s judgments on variant items.

Complicating the empirical picture further, I and other native speakers I have asked actually find variable binding acceptable in topicalization examples like (2a). Adding an additional modifier at the end makes the sentence more natural but should not affect crucial aspects of the structure:

(4) In every dog_{1}’s cage, its_{1} collar hung from a hook welded to the bars.

In agreement with this judgment, Pica & Snyder (1995) judge topicalization of NP quantifiers to permit variable binding, contradicting Postal (1993).

Given this dispute over judgments, it is important to ascertain what the empirical facts are using a method other than the introspective judgments of professional linguists who have a stake in the outcome. To this end I ran two large-scale acceptability studies on naive English speakers using the Amazon Mechanical Turk tool (see Gibson et al. 2011, Sprouse 2011). The first compares acceptability judgments on variable binding with locative inversion versus PP topicalization, as in (2). The second directly compares locative inversion and PP topicalization with the expletive there, as in (2b) versus (3). This experiment used a forced-choice task rather than an acceptability task. The results show that naive English speakers do not distinguish topicalization from locative inversion for variable binding, and they do not distinguish locative inversion from sentences with there. This removes one of the arguments for the PP-as-subject analysis of locative inversion, and illustrates another way in which locative inversion patterns with there-sentences, as I discuss in the conclusion. It also shows that weak crossover is not about A- versus A-bar movement, in agreement with Eilam (2011).

2 Experiment 1: Locative Inversion Versus PP Topicalization

Experiment 1 compared locative inversion and PP topicalization on the ability of a quantifier in the fronted PP to bind a pronoun in the NP that agrees with the verb.
### 2.1 Items

Minimal triplets were constructed like the following:

(5)  
   a. Base: Her lady in waiting stood to the left of every princess with an extra cape.  
   b. Top: To the left of every princess, her lady in waiting stood with an extra cape.  
   c. LocInv: To the left of every princess stood her lady in waiting with an extra cape.

All variants included an additional modifier, because modifiers were judged to make the sentences more natural, as mentioned above. Gendered quantified noun phrases were chosen so that there would be no question of the suitability of the pronoun covarying with the quantifier.

The task was a simple judgment of acceptability. Gordon & Hendrick (1997) showed that subjects rate sentences lower in acceptability if they cannot resolve the referent of a pronoun. The logic of Experiment 1 is that, if binding of the pronoun *her* by the quantifier is unacceptable in any of (5b–c), then that pronoun will lack a referent, and subjects will rate it lower in acceptability. Kush et al. (2017) used acceptability judgments on experiments involving strong and weak crossover with wh-questions, and showed that subjects do indeed rate sentences that violate weak crossover lower than sentences that do not. The Base sentence without fronting of the PP was included as a check on the logic of the task. A further check of the logic was provided by an additional pair, as follows:

(6)  
   a. Var: Every princess hopes that her lady in waiting will be nice.  
   b. NoVar: Her lady in waiting hopes that every princess will be nice.

In the Base sentence in (5a), it might be possible for the PP to take scope over the subject, leading to high judgments of acceptability. In (6b), in contrast, the theoretical literature is in general agreement that the quantifier should be unable to take scope over the matrix pronoun across a finite clause boundary (or should be able to only with great difficulty). The Var items in (6a), in contrast, should easily allow a bound variable reading. The Var and NoVar items then provide a check on the experiment: if the subjects are performing as expected, judgments of acceptability on the Var items should be significantly higher than those on the NoVar items. If this is indeed the finding, then we can legitimately compare the Base, Top, and LocInv items in (5). Note that absolute values of the acceptability judgments are meaningless and nothing will be made of them; all we can do is compare judgments on minimally different items to see if they are being treated differently.

In the present experiment, the crucial comparison is between Top and LocInv (5b vs. 5c). Since Var/NoVar are not minimally different from the set of Base/Top/LocInv, no comparison across these will be attempted.

Nine sets like those in (5–6) were constructed and divided into three lists so that no subject saw more than one item from each set of the triplet in (5). The Var and NoVar items in (6) were divided among the three lists so that no subject saw both members of any pair. The complete list of items appears in the appendix. Each list included three exemplars of each condition, for a total of 15 experimental items. Each list also included 33 filler items. 16 of these were items for an unrelated experiment involving adverb placement. 17 were simply fillers, six of which were acceptable and six of which were unacceptable, with the other five somewhere in between. The task was to rate how acceptable each sentence was on a scale of 1 to 7, 1 being “completely unacceptable” and 7 being “completely acceptable.”
### 2.2 Subjects

82 subjects were recruited using Amazon Mechanical Turk, limited to people with IP addresses in the United States. All reported being native speakers of English. Two of the subjects were thrown out because they gave the same rating of acceptability to all of the sentences and were therefore clearly not engaged in the task. This left 80 subjects whose data entered the analysis. All 80 gave judgments on the filler items in the expected pattern. Because the age of the speakers was important to the unrelated study involving adverbs, all of the subjects were over 40 years old. There is no reason to think that judgments on variable binding should differ by age, so this should not be an issue. The average age was 46. 40% were female, 60% male. Subjects were paid 50 cents for their participation. The entire experiment typically took subjects about six minutes to complete.

### 2.3 Results

The results of Experiment 1 are shown in Table 1 (raw and z-scores, mean and standard deviation).

Table 1: Results of Experiment 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Raw Mean</th>
<th>Raw SD</th>
<th>Z-Score Mean</th>
<th>Z-Score SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base (Her lady in waiting stood to the left of every princess with an extra cape.)</td>
<td>3.63</td>
<td>1.82</td>
<td>-0.53</td>
<td>0.88</td>
</tr>
<tr>
<td>Top (To the left of every princess, her lady in waiting stood with an extra cape.)</td>
<td>5.32</td>
<td>1.53</td>
<td>0.32</td>
<td>0.75</td>
</tr>
<tr>
<td>LocInv (To the left of every princess stood her lady in waiting with an extra cape.)</td>
<td>5.56</td>
<td>1.40</td>
<td>0.43</td>
<td>0.71</td>
</tr>
<tr>
<td>Var (Every princess hopes that her lady in waiting will be nice.)</td>
<td>5.80</td>
<td>1.13</td>
<td>0.58</td>
<td>0.56</td>
</tr>
<tr>
<td>NoVar (Her lady in waiting hopes that every princess will be nice.)</td>
<td>5.02</td>
<td>1.70</td>
<td>0.18</td>
<td>0.83</td>
</tr>
</tbody>
</table>

As can be seen, average judgments of locative inversion (LocInv) and topicalization (Top) are very similar to each other, but both differ from the Base sentence where the PP follows the pronoun. The difference between the Var and NoVar items confirms that the logic of the experiment is sound; that is, subjects rate sentences lower where variable binding fails and hence a pronoun ends up lacking a referent.

Statistical analysis was run using R ([R Core Team](https://www.R-project.org) 2012). Z-scores were analyzed by means of linear mixed-effect modeling using the R-package lme4. In the model, Condition was a fixed effect and subjects and items were included as random intercepts. Reported p-values were extracted from the fitted model objects using the Satterthwaite approximation implemented by the *lmerTest* package. Pairwise comparisons were conducted using the `diffmeans()` function in *lmerTest*. Pairwise comparisons indicate that LocInv is significantly different from Base (p=4.393e-16) and Top is significantly different from Base (p=2.610e-14), but LocInv and Top are not significantly different from each other (p=0.1221416). Var and NoVar are also significantly different from each other (p=3.461e-06), as expected. (As stated above, comparisons between Var/NoVar and any of Base, Top, LocInv are meaningless because they are not minimal pairs.)
2.4 Discussion

Experiment 1 found that subjects do not distinguish PP topicalization from locative inversion in the ability of the fronted PP to bind a pronoun in the NP that agrees with the verb. A quantifier in a topicalized PP can bind a pronoun inside the subject as a variable. This contradicts the judgments reported by Culicover & Levine (2001), Doggett (2004), Diercks (2017). However, it is in line with the judgments of this author and Pica & Snyder (1995). It is also in line with Eilam (2011), who argues that weak crossover is not about the A- versus A-bar status of the position occupied by the quantifier. Eilam (2011) argues that for a quantifier to bind a pronoun as a variable, the quantifier has to be construable as a topic, while the pronoun has to be contained in an XP that can be construed as a focus. This is clearly possible with locative inversion, where the fronted PP can be topical while the postverbal NP is focal, but it is also possible with a topicalized PP and a preverbal subject. In such a case it is possible to take the preverbal subject to be a focus. Adding modifiers to the sentence may help to make this possible, which may be why (4) sounds more natural than (2a) (examples repeated below).

(7) a. In every dog’s cage its collar hung. (repeated from 2a, grammaticality judgment removed)
   b. In every dog’s cage, its collar hung from a hook welded to the bars. (repeated from 4)

In my judgment, simply adding focal stress to collar also helps in (7a), in line with Eilam (2011).

To summarize the findings of Experiment 1, naive subjects do not distinguish PP topicalization from locative inversion in variable binding, at least as far as can be determined from a simple judgment of acceptability. This removes one of the arguments in favor of the PP-as-subject analysis of locative inversion. Experiment 2 directly compares locative inversion with PP topicalization plus an overt there. It also uses a different task, namely, selecting a referent for the pronoun.

3 Experiment 2: Locative Inversion Versus an Overt Expletive

Since the dispute in the literature on locative inversion is about sentences that differ only in the presence of an overt expletive there, Experiment 2 compared those directly. However, because sentences with there are degraded with definite postverbal NPs, including possessed ones, an acceptability judgment task was not appropriate. Sentences with there would probably be rated lower for a reason other than the availability of variable binding. Experiment 2 therefore included a forced-choice judgment on the referent of the pronoun rather than a judgment of acceptability.

3.1 Items

Items were constructed in triplets like the following, with a question that would go with each item in the triplet:

(8) Paradigm for Experiment 2
   a. There: The old king said that beside every knight there stood his squire.
   b. LocInv: The old king said that beside every knight stood his squire.
c. Base: The old king said that his squire stood beside every knight.

*Question for all three:* Whose squire is it? A: the old king’s B: every knight’s

The definiteness restriction was violated in the There condition, but this was judged to only make the sentences slightly awkward, not unacceptable. Subjects were given a forced choice task asking for the referent of the pronoun. This is a question that subjects should be able to answer even if they find the There condition degraded compared to the LocInv condition. The two possible answers to the question were the matrix subject and a quantificational phrase in a PP in the embedded clause. The clauses of interest (those with the fronted PP) were always embedded under a verb like *say* or *think* that permits locative inversion and PP topicalization in its complement. The purpose of this was to provide a second possible referent for the pronoun, in the form of the matrix subject. The logic of the experiment is that if there is a grammatical difference between the There and LocInv conditions in the possibility of variable binding, we should see this difference reflected in fewer choices of the quantificational antecedent in the There condition. If A-bar movement like topicalization never enables variable binding, we ought to expect to see the There condition pattern with the Base condition. However, there could be extragrammatical reasons why those two might differ (preferences or processing heuristics based on linear order, for example). The crucial comparison is the There-LocInv one. If there is a grammatical difference in variable binding, as [Doggett (2004) and Diercks (2017)] claim, responses to these two conditions should differ; if there is no difference in variable binding, as proponents of the null expletive analysis of locative inversion assert [Postal (2004) Bruening (2010)], and as we might expect given the results of Experiment 1, then responses to these two conditions should not differ.

Six sets like those in (8) were constructed and divided into three lists so that no subject saw more than one item from each set. The complete list of items appears in the appendix. Each list included two exemplars of each condition, for a total of six experimental items per subject. Each list also included twelve filler items. Six of these were items for an unrelated experiment (also involving adverb placement). Six were simply fillers. This time subjects were instructed to answer different questions for each item. The items for this experiment asked for the referent of the pronoun, as did two of the fillers (where one choice should have been excluded by Binding Condition C, and subjects did indeed never select that choice). The items for the unrelated adverb experiment asked subjects to rate how acceptable each sentence was on a scale of 1 to 7, 1 being “completely unacceptable” and 7 being “completely acceptable.” Four of the fillers also asked subjects to rate acceptability. Subjects were expected to find one of these acceptable, and three unacceptable.

### 3.2 Subjects

Once again, 80 subjects were recruited using Amazon Mechanical Turk, limited to people with IP addresses in the United States. All reported being native speakers of English. None of the subjects were thrown out, as they all answered as expected on the filler items. Because the age of the speakers was important to the unrelated study involving adverbs again, all of the subjects were over 40 years old. There is no reason to think that judgments on variable binding should differ by age, so this should not be an issue. The average age was 45.65. 33.75% were female, 62.5% male (the others did not answer). Subjects were paid 60 cents for their participation.
3.3 Results

Results are shown in Table 2. Table 2 shows for each condition the percentage of answers where the quantifier is chosen as the antecedent for the pronoun.

Table 2: Results of Experiment 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>Quantifier %</th>
</tr>
</thead>
<tbody>
<tr>
<td>There (The old king said that beside every knight there stood his squire.)</td>
<td>83.125</td>
</tr>
<tr>
<td>LocInv (The old king said that beside every knight stood his squire.)</td>
<td>75.0</td>
</tr>
<tr>
<td>Base (The old king said that his squire stood beside every knight.)</td>
<td>21.25</td>
</tr>
</tbody>
</table>

As can be seen, subjects choose the quantifier as antecedent very rarely in the Base condition, as would be expected. In contrast, in both the There and LocInv sentences, they choose the quantifier as antecedent most of the time. They actually do so more in the There condition than in the LocInv condition, contrary to what Doggett (2004) and Diercks (2017) would expect.

Statistical analysis was run using R (R Core Team 2012). Results were analyzed by means of linear mixed-effect modeling using the R-package lme4. In the model, Condition was a fixed effect and subjects and items were included as random intercepts. Since the task was a forced-choice one, glmer with family binomial was used rather than lmer. Reported p-values were extracted from the fitted model objects using a Tukey’s post-hoc test implemented with the glht function from the multcomp package. Pairwise comparisons indicate that LocInv is significantly different from Base ($p < 1e-04$) and There is significantly different from Base ($p < 1e-04$), but LocInv and Top are not significantly different from each other ($p=0.351$).

3.4 Discussion

It is clear that judgments from naive English speakers do not accord with the judgments reported by Doggett (2004) and Diercks (2017). There is no difference between locative inversion and sentences with a fronted PP and overt there in the ability of a quantifier inside the fronted PP to bind a variable in the agreeing NP. This is in line with the judgments reported by proponents of the null expletive analysis of locative inversion (Postal 2004, Bruening 2010). Experiment 2 is also consistent with Experiment 1 in that subjects in both experiments treat fronted PPs identically regardless of whether the agreeing NP was preverbal or postverbal. In both experiments, quantifiers in topicalized PPs could bind pronouns as variables. This means that topicalizing a PP does not give rise to weak crossover in English.

4 Conclusion

In this investigation, experiments conducted on naive English speakers using two different tasks reached the same conclusion: PP topicalization does not give rise to weak crossover in English. A quantifier in a topicalized PP can bind a pronoun in the subject as a variable. This is true whether the subject is preverbal or postverbal. Importantly for the debate regarding locative inversion, locative inversion sentences do not pattern differently from sentences with an overt expletive there as subject. This contradicts judgements reported by Culicover & Levine (2001), Doggett (2004),
Diercks (2017), but agrees with judgments reported by Postal (2004) and Bruening (2010). This finding removes one of the arguments in favor of the PP-as-subject analysis, and argues in favor of the expletive subject analysis, since variable binding is yet another way in which locative inversion patterns with sentences with an overt there. For a long list of ways in which they pattern the same, see Postal (2004), Bruening (2010), and also Bruening (2016), where locative inversion and there sentences pattern together but behave differently from quotative inversion sentences for a number of grammatical phenomena.

This study also joins a growing list of cases where judgments from some professional linguists have diverged from those of the population at large. For one case involving reconstruction for Binding Principle C, see Adger et al. (2016) and Bruening & Khalaf (2019). Other cases include multiple questions (Clifton et al. 2006), adjectival passives of raising to object verbs (Bruening 2014), and nominalizations of raising verbs (raising to subject and raising to object; see Bruening 2018). It is becoming increasingly important for linguists to support any judgments that they report in their work using multiple sources of evidence, such as corpus evidence and survey results. It should no longer be acceptable practice for one linguist to simply assert that the judgments of another are faulty; it is incumbent upon anyone who cares about the validity of data to ascertain what the facts actually are using every available source of data.

Appendix A: Items for Experiment 1

1. (a) Base: Its collar hung from a hook in every dog’s cage.
   (b) Top: In every dog’s cage, its collar hung from a hook.
   (c) LocInv: In every dog’s cage hung its collar from a hook.
   (d) Var: Every actress thinks that only her agent is honest.
   (e) NoVar: Her agent thinks that every actress is talented.

2. (a) Base: Its diminutive rider sat on every horse waiting for the starting bell.
   (b) Top: On every horse, its diminutive rider sat waiting for the starting bell.
   (c) LocInv: On every horse sat its diminutive rider, waiting for the starting bell.
   (d) Var: Every queen believes that her guards are loyal to her.
   (e) NoVar: Her guards believe that every queen is safe from harm.

3. (a) Base: Its guard stood beside every door, impassively watchful.
   (b) Top: Beside every door, its guard stood impassively watchful.
   (c) LocInv: Beside every door stood its guardian, impassively watchful.
   (d) Var: Every king commands his subjects to celebrate his birthday.
   (e) NoVar: His subjects refuse to celebrate every king’s birthday.

4. (a) Base: Her lady in waiting stood to the left of every princess with an extra cape.
   (b) Top: To the left of every princess, her lady in waiting stood with an extra cape.
   (c) LocInv: To the left of every princess stood her lady in waiting with an extra cape.
(d) Var: Every princess hopes that her lady in waiting will be nice.
(e) NoVar: Her lady in waiting hopes that every princess will be nice.

5. (a) Base: Her pet crow perched on every witch’s shoulder with an evil eye.
(b) Top: On every witch’s shoulder, her pet crow perched with an evil eye.
(c) LocInv: On every witch’s shoulder perched her pet crow with an evil eye.
(d) Var: Every witch claims that her magic potion is the most powerful of all.
(e) NoVar: Her magic potion proves that every witch is the most powerful of all.

6. (a) Base: Her partner sat beside every policewoman, manning the radio.
(b) Top: Beside every policewoman, her partner sat, manning the radio.
(c) LocInv: Beside every policewoman sat her partner, manning the radio.
(d) Var: Every cat likes to scratch its owner’s skin.
(e) NoVar: Its owner likes to scratch every cat’s ears.

7. (a) Base: His personal bodyguard lurked behind every prince menacingly.
(b) Top: Behind every prince, his personal bodyguard lurked menacingly.
(c) LocInv: Behind every prince lurked his personal bodyguard menacingly.
(d) Var: Every Jedi Master fears that his apprentice will go over to the dark side.
(e) NoVar: His apprentice fears that every Jedi Master will go over to the dark side.

8. (a) Base: His name and a serial number were tattooed on every prisoner’s wrist.
(b) Top: On every prisoner’s wrist his name and a serial number were tattooed.
(c) LocInv: On every prisoner’s wrist was tattooed his name and a serial number.
(d) Var: Every pop star wants her bodyguard to keep her safe from harm.
(e) NoVar: Her bodyguard wants to keep every pop star safe from harm.

9. (a) Base: His apprentice sat behind every warlock, stirring something in a cauldron.
(b) Top: Behind every warlock his apprentice sat, stirring something in a cauldron.
(c) LocInv: Behind every warlock sat his apprentice, stirring something in a cauldron.
(d) NoVar: Every dog hopes that its owner will enter it in the dog show.
(e) NoVar: Its owner hopes to enter every dog in the dog show.

Appendix B: Items for Experiment 2

1. (a) There: The old king said that beside every knight there stood his squire.
(b) LocInv: The old king said that beside every knight stood his squire.
(c) Base: The old king said that his squire stood beside every knight.
Whose squire is it? A: the old king’s B: every knight’s

2. (a) There: The TV anchorwoman reported that behind every congresswoman there sat her assistant.
(b) LocInv: The TV anchorwoman reported that behind every congresswoman sat her assistant.
(c) Base: The TV anchorwoman reported that her assistant sat behind every congresswoman.
Whose assistant is it? A: the anchorwoman’s B: every congresswoman’s

3. (a) There: The groundskeeper said that to every huntsman’s left there lay his dog.
(b) LocInv: The groundskeeper said that to every huntsman’s left lay his dog.
(c) Base: The groundskeeper said that his dog lay to every huntsman’s left.
Whose dog is it? A: the groundskeeper’s B: every hunterman’s

4. (a) There: The medium claimed that behind every woman at the seance there stood her long-dead ancestor.
(b) LocInv: The medium claimed that behind every woman at the seance stood her long-dead ancestor.
(c) Base: The medium claimed that her long-dead ancestor stood behind every woman at the seance.
Whose ancestor is it? A: the medium’s B: every woman’s

5. (a) There: The policewoman reported that under every victim there lay her unused gun.
(b) LocInv: The policewoman reported that under every victim lay her unused gun.
(c) Base: The policewoman reported that her unused gun lay under every victim.
Whose gun is it? A: the policewoman’s B: every victim’s

6. (a) There: The anthropologist noted that in front of every warrior there crouched his child.
(b) LocInv: The anthropologist noted that in front of every warrior crouched his child.
(c) Base: The anthropologist noted that his child crouched in front of every warrior.
Whose child is it? A: the anthropologist’s B: every warrior’s

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