Experiencers Do Not Categorically Block Long-Distance Control of PRO: Evidence from Naturalness Ratings and Eye Movements During Reading

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1. Introduction

One of the major challenges in the syntactic study of control has been to understand the nature of long-distance control (LD control), and to properly characterize locality effects such as intervention in this phenomenon. In this study, we critically examine the claim that experiencer co-arguments of control clauses in Super-Equi are absolute intervenors which block LD control (Landau 2001, *inter alia*). Our naturalness ratings study and eye-tracking study show no evidence in support of the experiencer intervention effect as a grammatical ban on LD control in the presence of a more local experiencer argument, but we do find support for the general tendency for local controllers to be preferred over long-distance ones. Our results motivate the removal of the constraint against LD control with experiencer intervenors from our theory of the grammar of English (at least), therefore eliminating the need for the theoretical machinery introduced to explain it.

1.1. Long-distance control, Super-Equi

LD control (1-a) is a type of non-obligatory control (NOC), which can be contrasted with local and obligatory control (1-b). In (1-b), *John* obligatorily controls PRO. In (1-a), an example of LD control, *Sam* controls PRO in the controlled clause across several intervening embedded clauses. LD control, for example *John* controlling PRO in (1-c), and arbitrary control, as in (1-d), are both types of non-obligatory control, occurring in environments that are 'syntactically opaque' like extraposed, subject, and adjunct clauses (Landau 2000, 2013, *inter alia*.). We find obligatory control, for example (1-b), by contrast in complement clauses.

There is debate and discussion in the literature about the nature of intervention effects, if they exist, in LD control. Specifically, the question of whether (and in what conditions) a more local controller like *Mary* blocks LD control of PRO in (1-c) by *John*.

(1) a. Sam$_i$ claimed that it was clear that it had turned out that it seemed likely that it would be impossible [PRO$_i$ to prepare himself for the exam in time.] (Grinder, 1970, cited in Landau, 2013:238)
b. John$_i$ tried PRO$_i$ to pass the exam.
c. John thought that it disturbed Mary PRO to fail the exam.
d. PRO$_{arb}$ Eating a multivitamin every day is good for you.

The literature on non-obligatory control and intervention has been particularly concerned with one type of construction called "Super-Equi", first described and analyzed by Grinder (1970). The examples below show two different configurations for Super-Equi, intraposition and extraposition:[1]

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[1] Note that in *Section 1* we provide examples with the judgments given in the literature; these do not necessarily coincide with our own judgments, and in this paper we challenge in particular the 'ungrammatical' judgment for LD control with a psych predicate in extraposition constructions, for example in (2-a), (3-a), and (4).

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(2) a. Mary thought that it disturbed John [PRO to speak his/*her mind.] *Extraposition*
b. Mary thought that [PRO to speak his/her mind] disturbed John. *Intraposition*

Grinder (1970) claimed that the crucial factor in determining the availability of LD control in the presence of a local intervenor is whether the controlled clause is in the subject position of the embedded clause (intraposition: (2-b)), or whether it is extraposed as an adjunct on the right periphery of the VP (extraposition: (2-a)). Subsequent work by Landau (2000, 2001) proposed that the crucial factor was actually whether or not the verb selecting the controlled clause was a psychological predicate that introduced an experiencer more local to the controlled clause.

(3) a. Mary thought that it disturbed John [PRO to speak his/*her mind.] *Psych predicate*
b. Mary thought that it helped John [PRO to speak his/her mind.] *Non-psych predicate*

John is an experiencer in (3-a) selected by the psychological predicate *disturbed*; whereas in (3-b), *John* is selected by the non-psych predicate *helped*, and is not an experiencer. We accept Landau's (2001:114) definition of a 'psychological predicate' in the case of examples like (3) as "[carrying] certain psychological entailments with respect to the mental state" of the direct object experiencer. As we will see in the section below, it is claimed in the literature that LD control with an intervening potential controller that is an experiencer is ungrammatical (4). Our results, however, as we will show below, do not provide support for this fact.

(4) *Mary$_i$ thought that it disturbed John [PRO$_i$ to speak her$_i$ mind.]

1.2. Landau (2001, etc.): experiencers block LD control in extraposition

One of Landau's significant contributions to the literature on LD control/NOC was to identify that the crucial factor in whether a direct object argument was an intervenor for LD control in Super-Equi was whether it was an experiencer or not. He argued that Grinder had not considered the full paradigm of Super-Equi, and that it was the psych vs. non-psych status of the predicate selecting the controlled clause, and not the syntactic position of the controlled clause, that determined this. Landau (2001)'s full paradigm is in (5) below; judgments are as reported in Landau (2001).

(5) a. Mary thought that it pleased John [PRO to speak his/*her mind.]
b. Mary thought that it helped John [PRO to speak his/her mind.]
c. Mary thought that [PRO to speak his/her mind] would please John.
d. Mary thought that [PRO to speak his/her mind] would help John.[2]

Examples (5-a) and (5-b) show the controlled clause extraposed; (5-c) and (5-d) are cases of intraposition, with the controlled clause in subject position. Both LD control and local control, indicated by feminine and masculine pronouns respectively, are demonstrated in the examples in (5). According to the judgments reported here, only LD control with extraposition, in the presence of a local intervening experiencer (i.e. the reading where *Mary* controls PRO in (5-a)), is ungrammatical.

Landau's explanation for this paradigm relies on the proposal that there are two LF-copies of the controlled clause in extraposition cases: one that is VP internal, and one that is extraposed to the right periphery of the VP. When the controlled clause is VP internal, obligatory control (OC) is forced (this is the structural configuration for OC); when it is extraposed, non-obligatory control occurs, which allows control by either the more local direct object, or LD control by the higher DP. The extraposition is unmotivated with psychological predicates because the experiencer argument is generated higher, allowing the controlled clause to already be VP-peripheral (a requirement in Landau's analysis). Therefore, there is no extraposed LF copy of the controlled clause, and no LD, non-obligatory control option available. Only the more local experiencer argument can control PRO, and thus it acts as an absolute intervenor.

[2] Note that (5-c) and (5-d) have modals, which are noted to sometimes improve acceptability; this is discussed further in 1.3 below.

1.3. Challenging the experiencer intervention effect

The present study takes as its starting point questions noted in the literature about the variability in judgments for the experiencer intervention effect. Landau (2001:148) acknowledges that the experiencer intervention effect can be neutralized, for some speakers, by the addition of a modal to the (psych or non-psych) predicate:

(6) Mary$_i$ thought that it would please John [PRO$_i$ to speak her$_i$ mind.]

Landau (2001:114) also notes that LD control in cases like (5-a) above improve with an intonational pause before the controlled clause, which he attributes to the possibility that speakers are assigning a different structure to the sentences. Similarly, for the modals, he suggests that those who find the modal sentences better might be projecting an alternative structure with a conditional clause instead of an infinitive.

While Landau gives an account for these variations, and a few other scattered reports of similar judgments occur in the literature (e.g. Kuno, 1975:33b, etc.), the unevenness of the judgments and their susceptibility to change, as well as our own intuitions about the sentences, lead us to question the robustness of this effect. We do not address the claim about modals improving the judgments, or the reported effect in other languages (see Landau 2001: 115-118), but focus on Grinder's/Landau's original paradigm of Super-Equi in the English examples.[3] Further study could investigate these other details.

1.4. The present studies and hypotheses: what's at stake?

Landau (2001:127) observes that a garden-path effect exists in Super-Equi constructions such that we would expect there to be a processing cost for the LD reading in extraposition. He attributes this to a Right Branch parsing strategy (Phillips, 1996): "consider [...] the substring, '*It helped John to buy...*'. Given no evidence to the contrary, the parser attaches the infinitive as a right-branching sister to the lowest VP-projection [...] But this immediately determines local [obligatory] control," rather than LD control. He speculates that the parser backtracks later at the site of the pronoun, to instead generate the controlled clause VP-peripherally, in the extraposed position, thus allowing LD control.

It is noted in the literature (Landau, 2001, 2013, Clifton & Frazier 1989) that local controllers are preferred over long distance ones, and this effect is attributed to parsing. Thus, in the absence of absolute experiencer intervention effects, we expect that both local and LD control options for Super-Equi will be available, although local controllers may be preferred.

However, Landau (2013:244) maintains that LD control with a psychological predicate is categorically ungrammatical: "Although it seems that closer and more prominent NPs are favoured as controllers over more distant and less prominent ones, it proves very difficult to formalize a precise notion of intervention in NOC. Other than local experiencer co-arguments, that force OC, no other NP in the vicinity of a NOC clause can be said to be an absolute intervenor."

The present studies aim to investigate the robustness of this reportedly 'absolute' experiencer intervention effect, as reported primarily by Landau, in English Super-Equi constructions, using a variety of methods. What we expect to find, in the absence of clear evidence for the categorical ungrammaticality of LD control with an experiencer intervenor, is a preference for local controllers, although LD control is still possible in Super-Equi.

If we fail to find evidence for the experiencer intervenor effect, then we will be able to eliminate this constraint as an extra grammatical constraint of the grammar, reflecting a real grammatical distinction, and can maintain a simpler theory where in Super-Equi both LD and local options are available, though local readings may be preferred.

[3] We also do not investigate the effect of semantic-pragmatic factors like logophoricity, on the availability of non-obligatory controllers in this paper, although such factors have been shown to be relevant.

2. Experiments

2.1. Design

Due to the equivocal linguist judgments in the literature (as well as those of linguists informally polled by the authors), we conducted two experiments to determine whether native English speakers who are naïve to the theoretical purpose of these comparisons show experiencer intervention effects. The first experiment tested native speaker intuitions through a test of sentence naturalness, and the second experiment tested for the presence of intervention effects during real-time processing through the study of eye movements during reading. In both experiments, we manipulated two variables: Predicate (*Psych predicate* versus *Non-psych predicate*), which is equivalent to the presence or absence of an experiencer intervenor, and Control (*Local control* versus *LD control*). We expect that if there is a categorical ban on LD control across an experiencer intervenor, we should find an interaction in the results such that the *LD control*, *Psych predicate* condition is rated as less natural than the other conditions, and causes difficulty in sentence processing as compared to the other conditions.

2.2. Materials

24 item sets as in (7) were created, with four conditions in total to reflect all combinations of our two independent variables, Predicate and Control. The location of PRO is marked in the examples for clarity, but was not visible to participants. The intended controller of PRO was indicated through the use of embedded predicates that are typically reflexive (e.g., one typically grinds one's own teeth rather than someone else's) with pronouns that matched only one potential controller in gender. In both experiments, the items were counterbalanced across lists in a Latin-square design. One item was ultimately removed from all analyses due to a coding error.

(7) a. *Local control, Non-psych predicate*
Becky knew that it disgraced Tim (PRO) to grind his teeth during the exam.
b. *LD control, Non-psych predicate*
Becky knew that it disgraced Tim (PRO) to grind her teeth during the exam.
c. *Local control, Psych predicate*
Becky knew that it angered Tim (PRO) to grind his teeth during the exam.
d. *LD control, Psych predicate (reported to be ungrammatical)*
Becky knew that it angered Tim (PRO) to grind her teeth during the exam.

2.3. Rating study

2.3.1. Participants

55 participants (30 female, median age 40, age range 22-68) were recruited over the web using Amazon's Mechanical Turk. The participants were all self-reported native speakers of English living in the United States.

2.3.2. Procedure

Participants were asked to rate sentences according to how natural they were to them as sentences of English, on a scale from 1 (*completely unnatural*) to 7 (*completely natural*). After each sentence, participants answered a comprehension question probing their interpretation of the subject of the embedded verb (e.g., *Who was doing the grinding?* with options *Becky*, *Tim* and *Someone else*). The subject of this verb is necessarily the controller of PRO, so these questions were intended to ensure that participants were getting the intended interpretations of our materials. Our experimental items were intermixed with 102 filler items from unrelated experiments.

2.3.3. Results

The comprehension question results showed that participants were largely getting the intended interpretations of our sentences. Participants answered with the LD controller of PRO when LD control

	Non-Psych	Psych
LD	4.68 (0.18)	5.40 (0.16)
Loc	5.16 (0.15)	5.80 (0.11)
Diff.	0.48	0.40

Table 1: Mean naturalness ratings from 1 (*completely unnatural*) to 7 (*completely natural*).

was required (89.5% for *Non-psych predicate* and 89.2% for *Psych predicate*), and with the Local controller of PRO when Local control was required (92.0% for *Non-psych predicate* and 94% for *Psych predicate*).

Naturalness ratings were analyzed using a Cumulative Link Mixed Model using the ordinal package (Christensen, 2015) in R (R Development Core Team, 2014). Our model included centered fixed effects of Predicate (*Psych predicate* versus *Non-psych predicate*) and Control (*LD control* vs. *Local control*), and random intercepts and slopes for the fixed effects for participant and item. Our results show main effects of each factor manipulated. *Psych predicate* conditions were rated as more natural than *Non-psych predicate* conditions ($\hat{\beta}$= 1.029 ($\pm$0.216), z = 4.766, $p < .001$), and *Local control* was rated as more natural than *LD control* ($\hat{\beta}$= -0.633 ($\pm$0.289), z = -2.188, $p < .05$). However, there is no interaction that would suggest a difference in grammaticality between Local and LD control only with experiencer intervenors. In fact, numerically the *Local control* versus *LD control* difference was larger for sentences with non-psych predicates, and therefore without potential experiencer blocking.

2.4. Eye movements

The results of our naturalness rating study show a clear pattern that participants judge LD control as less natural than local control of PRO. Participants also judge our psychological predicate conditions as more natural than the non-psychological predicates, which could either suggest a grammatical preference for the experiencer object or merely be an artifact of the specific verbs chosen and their overall effect on the plausibility of the sentences. While we cannot rule out the possibility of a grammatical preference based on our data, we believe that the latter explanation is more likely. However, we do not see evidence for a penalty specific to LD control with experiencer intervenors. We believe this evidence to be highly suggestive that there is no difference in grammaticality between LD control with and without experiencer intervenors. It could, however, also be the case that the considered, meta-linguistic judgments involved in rating sentence naturalness obscured an underlying interaction pattern. To test for this possibility, we conducted a second experiment recording eye movements during sentence reading. This method provides fine-grained information about the time course of sentence processing, allowing us to determine whether there is an initial stage during real-time processing at which participants show blocking of LD control with experiencer intervenors.

2.4.1. Participants

29 native English speakers with normal or corrected-to-normal vision from the University of Toronto community participated for their choice of $10 or linguistics course credit. Data from an additional 29 participants were collected but ultimately excluded due to excessive blinks, track losses or self-reported non-native English speaker status.

2.4.2. Procedure

Participants were tested individually using a head-mounted Eyelink II eye-tracker (SR Research: Mississauga, Canada) with a sampling rate of 250Hz. Sentence viewing was binocular, but only the movements of the right eye were recorded. After initial camera set-up and calibration, participants proceeded to the main experimental task. This task consisted of reading experimental sentences that were triggered by an eye movement to a marker on the lefthand side of the screen, indicating with a button press when they had completed reading the sentence, and answering a two-choice comprehension question after each sentence. These questions did not target the participants' interpretations of the control structure of the sentence, but rather were general to the sentence material. For example, the sentences

in (7) were followed by the question *Where were they?* with options *work* or *school*. Our experimental sentences were presented in a new random order for each participant along with 114 filler items from other unrelated experiments.

2.4.3. Results

Data analysis Participants had an average accuracy of 96% on comprehension questions. Prior to statistical analyses, trials with blinks or other track losses on our critical region were removed, eliminating 13.5% of trials. Reliability of effects was assessed using linear mixed-effects models using the lme4 package (Bates, 2005). Models included centered fixed effects of Predicate (*Psych predicate* versus *Non-psych predicate*) and Control (*LD control* vs. *Local control*), and random intercepts and slopes for the fixed effects for participant and item. Due to problems with model convergence, we eliminated random slopes for the interaction term and the correlation parameter between random effects where necessary.

Eye movement measures In studies of eye movements during reading, the dependent variables are the durations of fixations on a critical word or region, summed according to specialized criteria (see Staub & Rayner, 2007). Here, we report two eye movement measures: First-Pass Time, the sum of all fixations on a region from first entering it until leaving it to the left or to the right, and Right-Bounded Reading Time, the sum of all fixations on a region from first entering it until leaving it to the right. We will report statistical tests on our critical region containing the pronoun and following word (e.g., *his/her teeth*), however full patterns of First-Pass Time and Right-Bounded Reading Time across the entire sentence are shown in Figures 1 and 2 for the reader's inspection.

In First-Pass Time on the critical region, we find a marginal advantage for *Local control* over *LD control* conditions ($\hat{\beta}$ = -33.60 ($\pm$ 19.69), t = -1.707, $p < .1$). Consistent with our naturalness rating data, we also find a numerical processing advantage for *Psych predicate* over *Non-psych predicate*, however this difference was not reliable ($\hat{\beta}$ = 23.15 ($\pm$ 21.21), t = 1.092, p = 0.29). Critically, the pattern of First-Pass Times does not suggest an interaction such that only *Psych predicate* incur a processing penalty for *LD control* ($\hat{\beta}$ = -6.70 ($\pm$ 32.79), t = -0.204, p = 0.84).

Right-Bounded Reading Times on the critical region showed the pattern closest to an interaction, with a numerically greater difference between *LD control* and *Local control* for *Psych predicate* than for *Non-psych predicate*. However, this interaction was not significant ($\hat{\beta}$ = 2.586 ($\pm$ 7.93), t = 0.33, p = 0.74). On this region there was a significant main effect of *Local control* versus *LD control* ($\hat{\beta}$= -24.66 ($\pm$ 11.95), t = -2.063, $p< .05$). While the main effect appears to be mainly driven by the *Psych predicate* conditions, the pattern shows an advantage for the *Psych predicate*, *Local control* condition rather than a penalty for the *Psych predicate*, *LD control* condition. In fact, numerically the *Psych predicate*, *LD control* condition is no greater than the *Non-psych predicate*, *LD control* condition which has not been proposed to be ungrammatical.

3. Discussion

Overall, our experimental results do not suggest that native speakers of English as recruited in our experiments have a ban on LD control only with experiencer intervenors. Instead, what we find is that in ratings and in processing time as measured by eye movements, there is a suggestion of an advantage for sentences with our chosen psych predicates over our non-psych predicates as well as evidence for an overall penalty for LD control. However, grammatical LD control is attested (see example (3-b)), and no categorical grammatical ban on LD control has been proposed in the syntax literature to our knowledge. We do not, therefore, have reason to believe that participants in our experiments found our LD control sentences to be ungrammatical, either with or without experiencer intervenors. It is perhaps obvious to state that differences in grammaticality status are only one potential source of differences in naturalness ratings and reading times; these measures also capture whether incoming input is compatible or incompatible with the preferences and expectations of the sentence processor. The penalty for LD control could be interpreted with independent motivation as a psycholinguistic processing preference for a gap or PRO to be associated with the most recent filler possible (see e.g., Clifton & Frazier, 1989). Our

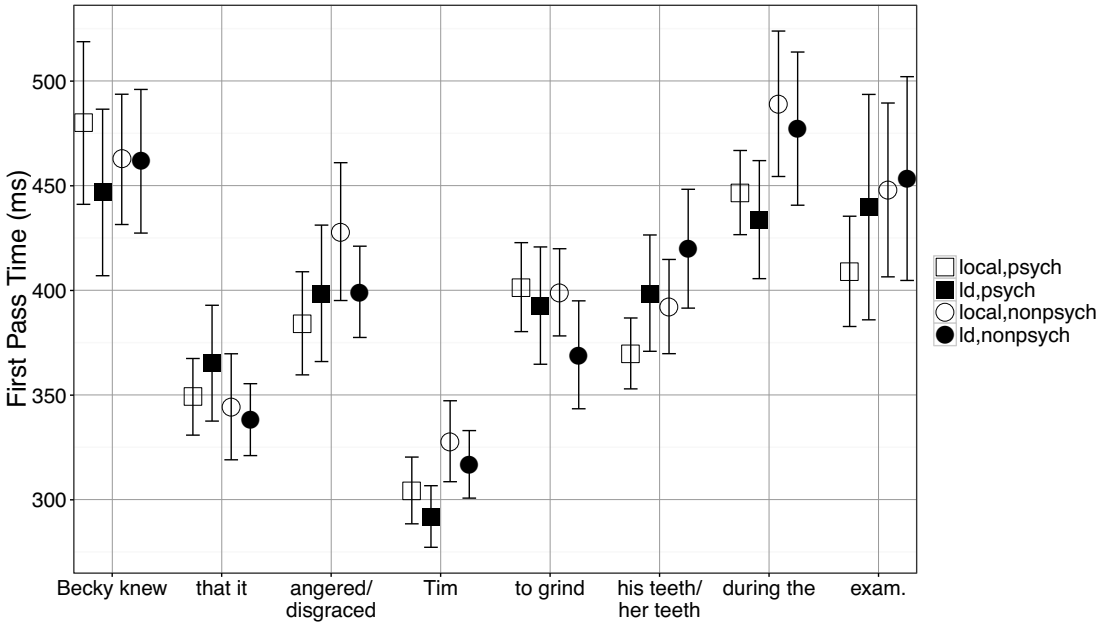

Figure 1: Mean First-Pass Time by participants over all sentence regions. Bars indicate standard errors.

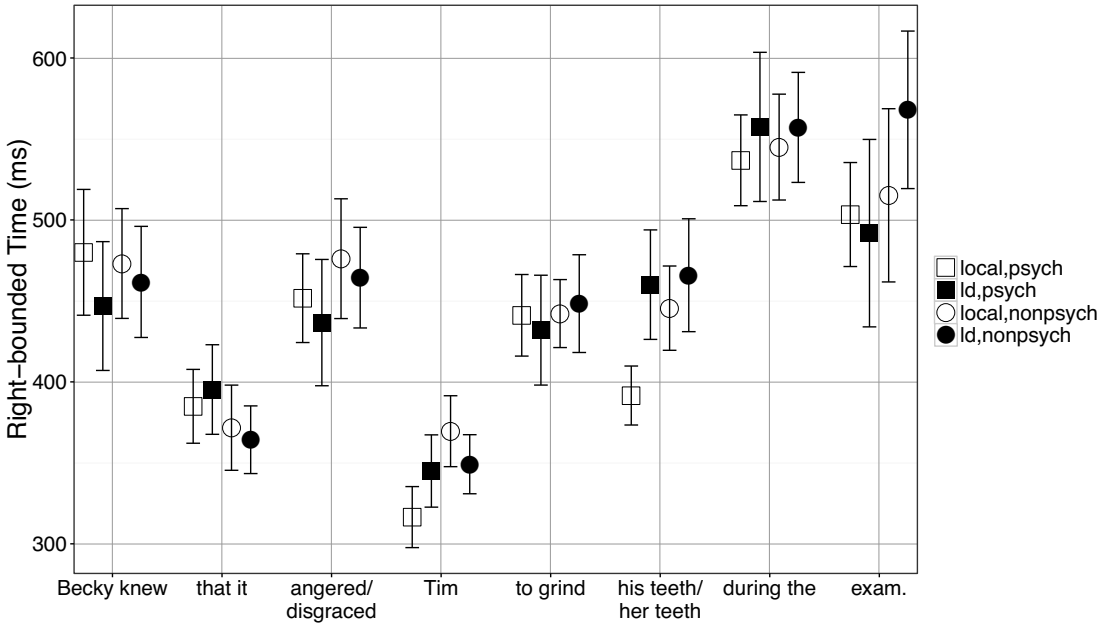

Figure 2: Mean Right-Bounded Reading Time by participants over all sentence regions. Bars indicate standard errors.

results are compatible with an account in which readers preferentially interpret PRO as having a local controller in both psych predicate and non-psych predicate conditions due to a processing pressure to select the closest potential controller.

Although our experiments show that the overall pattern for participant ratings and reading times does not support a categorical ban on LD control with experiencer intervenors, we cannot rule out the possibility that there is some subset of English speakers who do show such a pattern. However, the burden exists to show that this pattern is found in naïve native speakers selected from the general population.

Our results should also prompt a review of Landau's (2001) analysis of the experiencer intervention effect in Super-Equi, where he predicts experiencers should categorically intervene in extraposition Super-Equi constructions, although we do not undertake this critique here. The theoretical assumptions and apparatus that are introduced there to account for this effect thus need to be re-examined, and their utility questioned, with the goal of ascertaining if a simpler theory without those apparatus is preferable.

4. Conclusion

The claim that experiencers block LD control in Super-Equi extraposition constructions (Landau 2000, 2001) has been given much weight in the syntactic literature, despite some known variability in speakers' judgments. In this paper, we have provided evidence from two experiments, one study of naturalness ratings and one study of eye movements during reading, that further call into question the robustness of the experiencer intervention effect. In both of our studies, we find evidence for a similar preference for local control across predicate types, suggesting that the presence of a psychological predicate (and therefore an experiencer object) does not create a specific, categorical ban on LD control. Our results therefore suggest that a simpler theory of the syntax of LD control can be maintained when combined with known strategies in sentence processing, such as a preference for a recent controller over a more distant one.

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