Completion Tasks Reveal Misinterpretation of Noncanonical Sentences

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PIPP 2019 – Reykjavík, Iceland

Big Picture

The nurse remembered which doctor the patient had treated last week.

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The nurse remembered which doctor the patient had **treated** last week.

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- Our case study is looking at sentence-medial (pre-verbal) thematic role assignment.
- Using Cloze Completions and 2 Alternative Forced Choice Decisions we demonstrate that comprehenders entertain and sometimes prefer an illicit parse of unambiguous sentence fragments online.

Overview

1. Background
2. Experiments 1 and 2
3. Experiments 3a and 3b
4. Discussion

Background

Many others have investigated thematic role processing:

Ferreira 2003

Participants were presented sentences and asked "who was the {do-er / done to}" for sentences of the following types.

Accuracy for "Who was the do-er?" provided below

Sentence	Accuracy
The **dog** bit the man.	99
The **man** bit the dog.	99
The man was bitten by the **dog**.	88
The dog was bitten by the **man**.	74

Ferreira 2003

- This pattern was also observed when subject-clefts replaced active sentences and when object-clefts replaced passive sentences.
- Comprehenders are not guessing (50% accuracy), nor are they mistaking passives for actives (0%); **they occasionally misinterpret or misreport thematic roles in non-SVO clauses**

Bader & Meng 2018

Bader & Meng followed this up with the same task, but in German.
Separate participants provided plausibility judgments for the sentences.

Sentence	"Do-er" Accuracy	Plausibility Accuracy
Der **Koch** hat den Topf gereinigt. The **chef NOM** has the pan ACC cleaned.	95	92
Der **Topf** hat den Koch gereinigt. The **pan NOM** has the chef ACC cleaned.	76	90
Den Topf hat der **Koch** gereinigt. The pan ACC has the **chef NOM** cleaned.	87	91
Den Koch hat der **Topf** gereinigt. The chef ACC has the **pan NOM** cleaned.	61	87

Bader & Meng 2018

Participants' reading span (working memory measure) correlated with their thematic role question accuracy; not with plausibility judgments.

Bader & Meng claim that errors in a post-interpretive sentence retrieval cause the mistakes we see in the data; it is not *misinterpretation* per se.

Background

These previous experiments were offline and untimed tasks and allow for a post-interpretive mechanism to be blamed.

Semantic P600 / Lack of N400 literature (Chow et al 2016, Kuperberg 2007, Kim & Osterhout 2005) have used ERPs to investigate online thematic role processing.

We will use online completion tasks to show that during incremental interpretation thematic roles are frequently reversed in non-SVO clauses.

Experiment 1

120 Amazon MTurk workers continued 66 sentence fragments (36 from Chow et al., 2016) with the following configurations of preverbal arguments:

Condition	Sentence Fragment
Baseline	The man remembered which patient the doctor had … ____
Reversed	The man remembered which doctor the patient had … ____
Substitution	The man remembered which patient the seamstress had … ____

Experiment 1

Treated was the modal response in the baseline condition, and will be referred to as the target.

| Condition	Sentence Fragment
Baseline	The man remembered which patient the doctor had … ____
Reversed	The man remembered which doctor the patient had … ____
Substitution	The man remembered which patient the seamstress had … ____

Experiment 1

Experiment 1 Mean Cloze by Condition
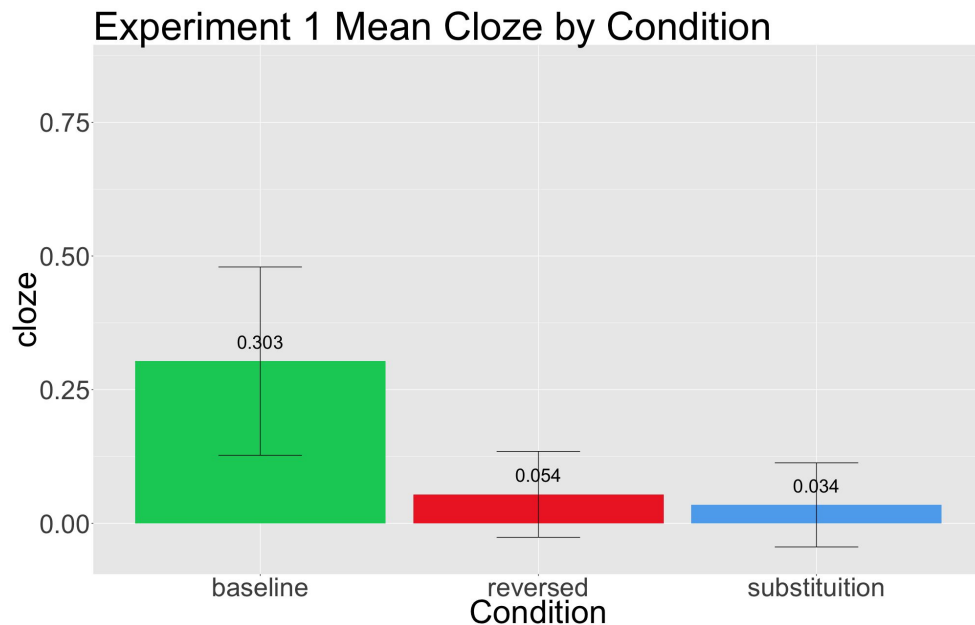
Logistic mixed effects model with repeated contrasts showed:

Reversal **β=-2.34, p < 2 e -16**
Substitution **β= -0.40, p = 0.0049**

Experiment 1

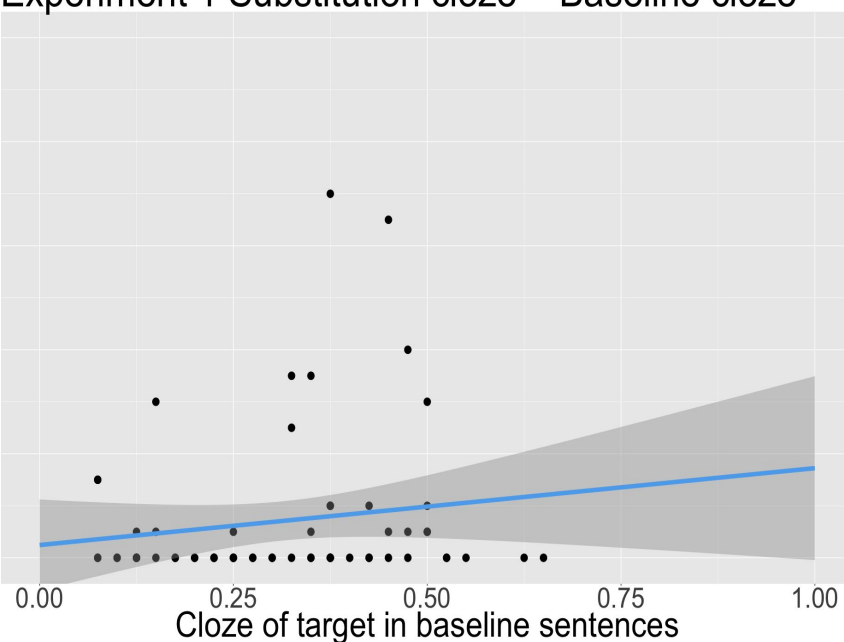Experiment 1 Reversal cloze ~ Baseline cloze
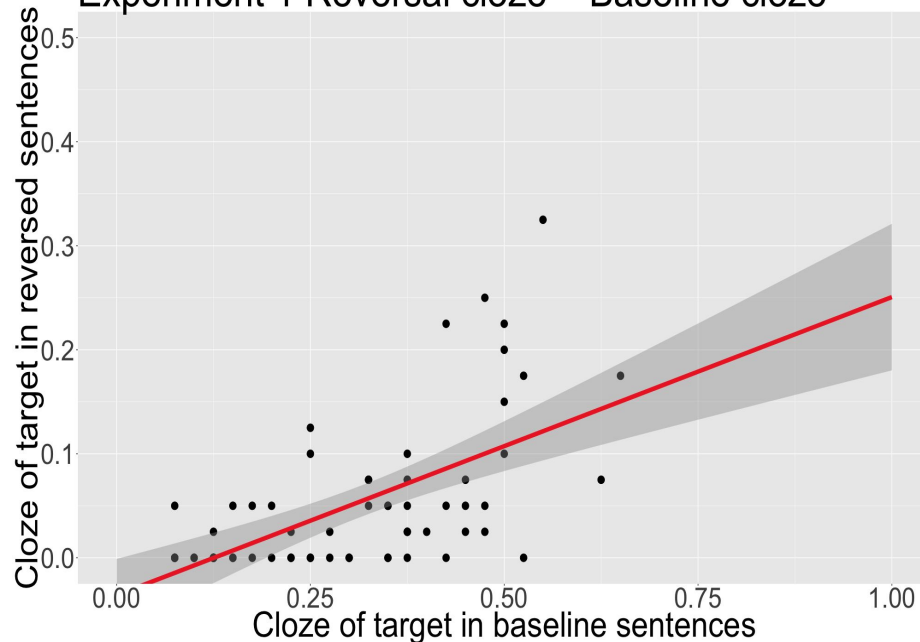
Experiment 1 Substitution cloze ~ Baseline cloze

$R^2 = $ **0.35**; **$\beta 1 = $ 0.29, p = 3.7 e -7**

$R^2 = $ 0.02; $\beta 1 = $ 0.07, p = 0.25

Experiment 1

Experiment 1 Reversal cloze ~ Baseline cloze
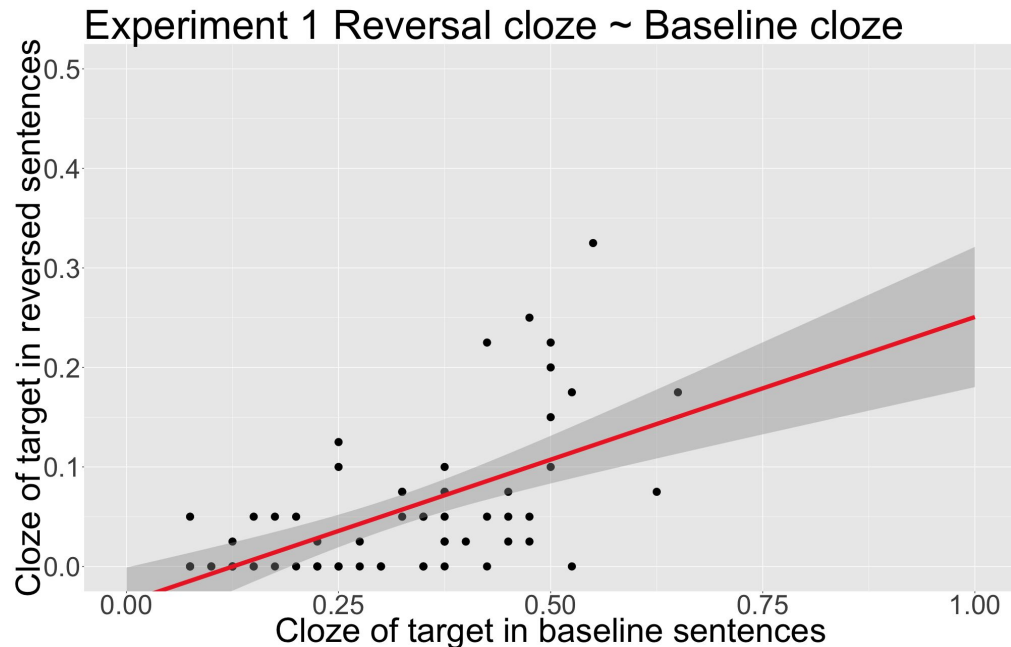
Anomalous verbs show up in predictable places.

The more productions of a specific verb in the canonical argument–role mapping, the more productions in the reversed mapping.

Experiment 2

Producing *treated* creates an <u>unlikely</u> event under the reversed argument order, however it does not create an <u>impossible</u> event.
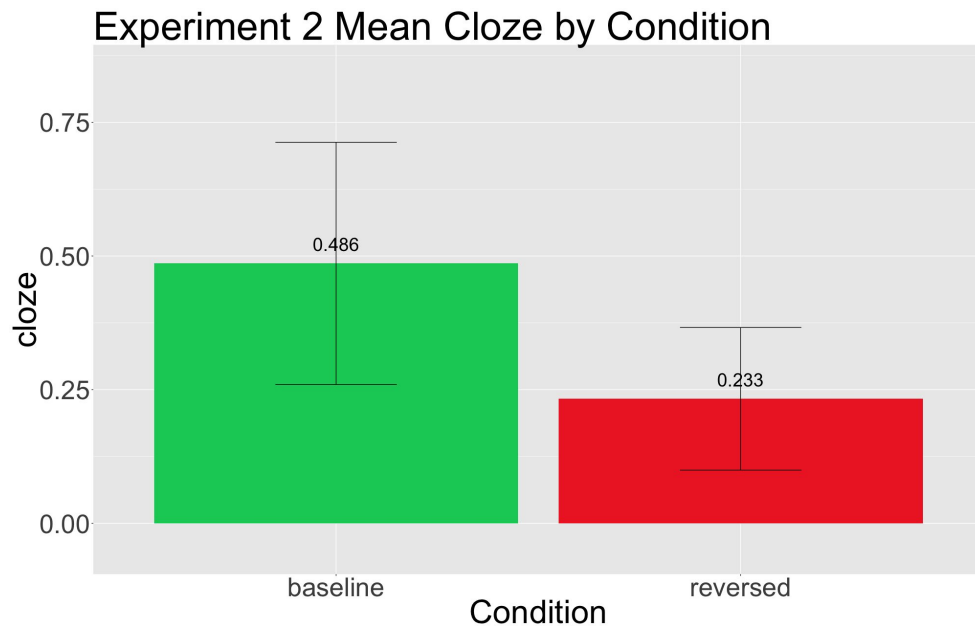
Experiment 2

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We manipulated the animacy of the arguments for 55 sentence fragments in Experiment 2 (80 participants):

Condition	Sentence Fragment
Baseline	The teacher saw which pencil the student had *<u>sharpened</u>*
Reversed	The teacher saw which student the pencil had _____

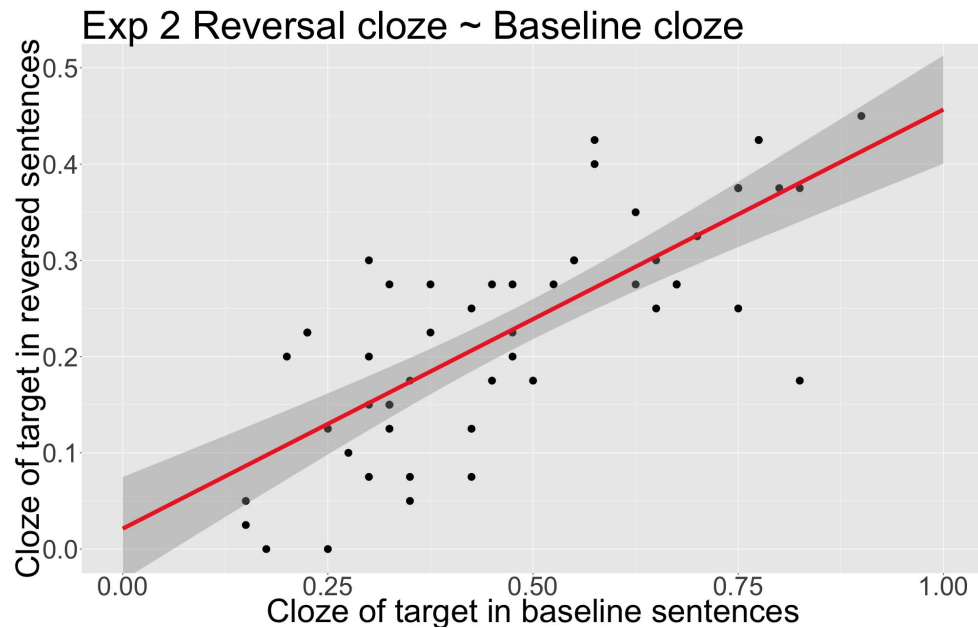# Experiment 2

Experiment 2 Mean Cloze by Condition

Logistic mixed effects model showed:

Reversal   **β=-1.34,   p < 2 e -16**

Experiment 2

Exp 2 Reversal cloze ~ Baseline cloze

$R^2 =$ **0.59**

$\beta 1 =$ **0.44**, p = 1.5 e -11

Experiments 1 and 2 Discussion

Participants frequently produce verbs that are consistent only with a reversal of the thematic roles.

This is consistent with the results of Chow et al 2016 a.o. who observed a reduced N400 for "target" verbs in role reversed sentences.

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In the following experiment, we investigated whether participants would provide these anomalous responses if there was an available alternative.

Experiment 3a

We again presented participants with sentence fragments but gave 2 options for completing them (cf. Sikos, Duffield, & Kim, 2016)

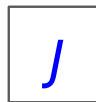The man saw which patient the doctor had been …

treating   F   J   *treated by*

Experiment 3a

Patient Agent

The man saw which patient the doctor had been …

treating *F* *J* treated by

Experiment 3a

Agent   Patient

The man saw which patient the doctor had been …

treating   F   J   treated by

Experiment 3a

96 MTurk workers provided completions for 48 sentence fragments (from Exp 1) using the voicing of their choosing for the following conditions of sentence fragment / answer option pairings:

Experiment 3a

Sentence Fragment	Answering Options
The man remembered which patient the doctor had been ...	**treating** / **treated by**
^	**treating** / hugged by
^	hugging / **treated by**
^	hugging / hugged by

In every condition, there is at least one sensible option.

Bold options are high cloze verb roots from Experiment 1.

Bold passive options <u>always</u> generate an implausible sentence.

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Sentence Fragment	Answering Options
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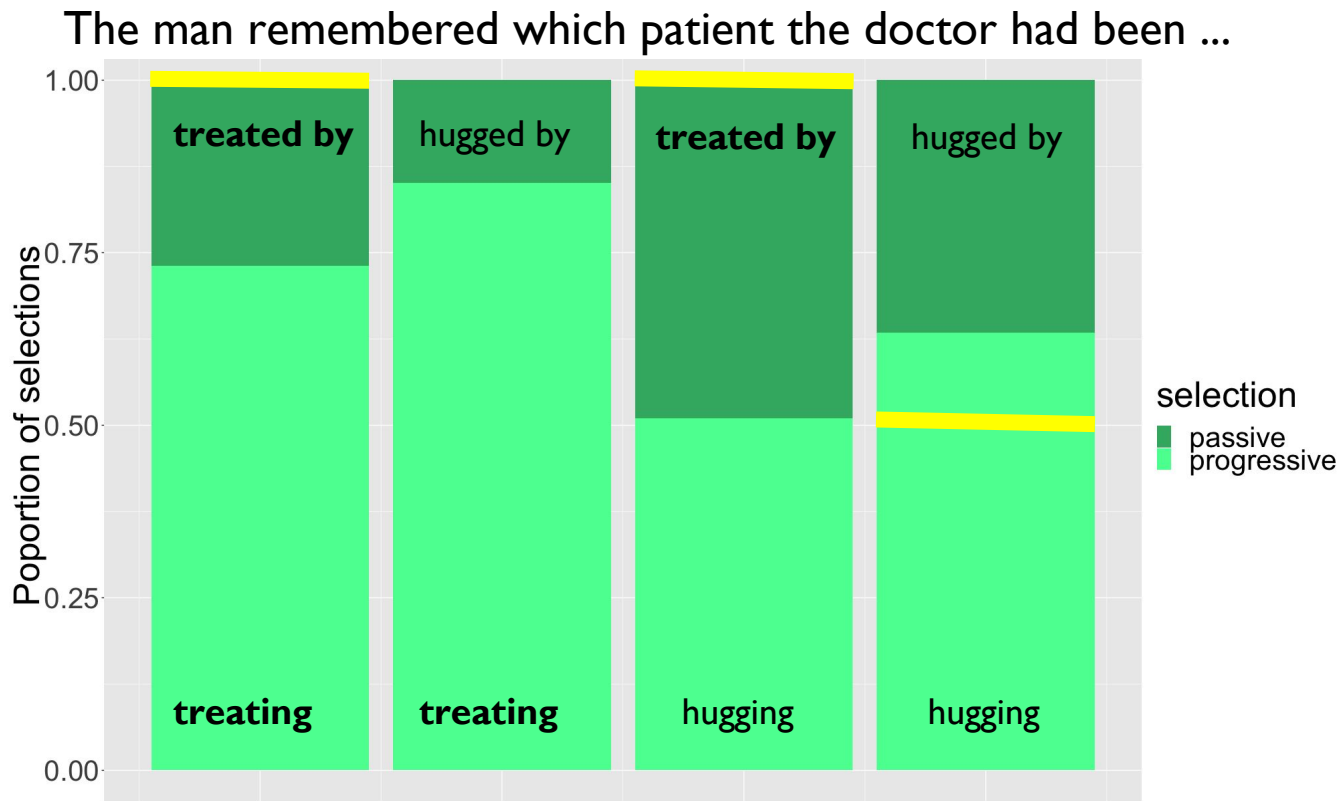Bold passive options <u>always</u> generate an implausible sentence.

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Logistic Mixed Effects Model showed that all main effects were significant:

- **Fewer progressive responses when the argument order was reversed**
- **Fewer progressive responses when the progressive option was low cloze**
- **Fewer progressive responses when the passive option was high cloze**

2-way interactions were significant (except Progressive Option x Passive Option); the 3-way interaction did not reach significance.

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Experiment 3a

When a verb root is high cloze, participants select it, regardless of if it's in the wrong voice, and regardless of what the other option is.

This further suggests that there is genuine sentence-medial misinterpretation of the role to argument mapping in these partial sentences.

Experiment 3b

Does misinterpreting who the agent is affect which person is treated as the syntactic subject?

Experiment 3b

The same participants from Exp 3a provided completions that required making a subject-verb agreement judgment

The man saw which doctors the patient …

were hugging F   J was hugging

Experiment 3b

Agreeing with the wrong argument indicates retrieval of that argument as the subject of the sentence.
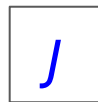
The man saw which doctors the patient …

were hugging F   J *was hugging*

Experiment 3b

The man saw which <u>doctors</u> the patient …

were hugging F   J *was hugging*

Experiment 3b

The man saw which doctors the <u>patient</u> …
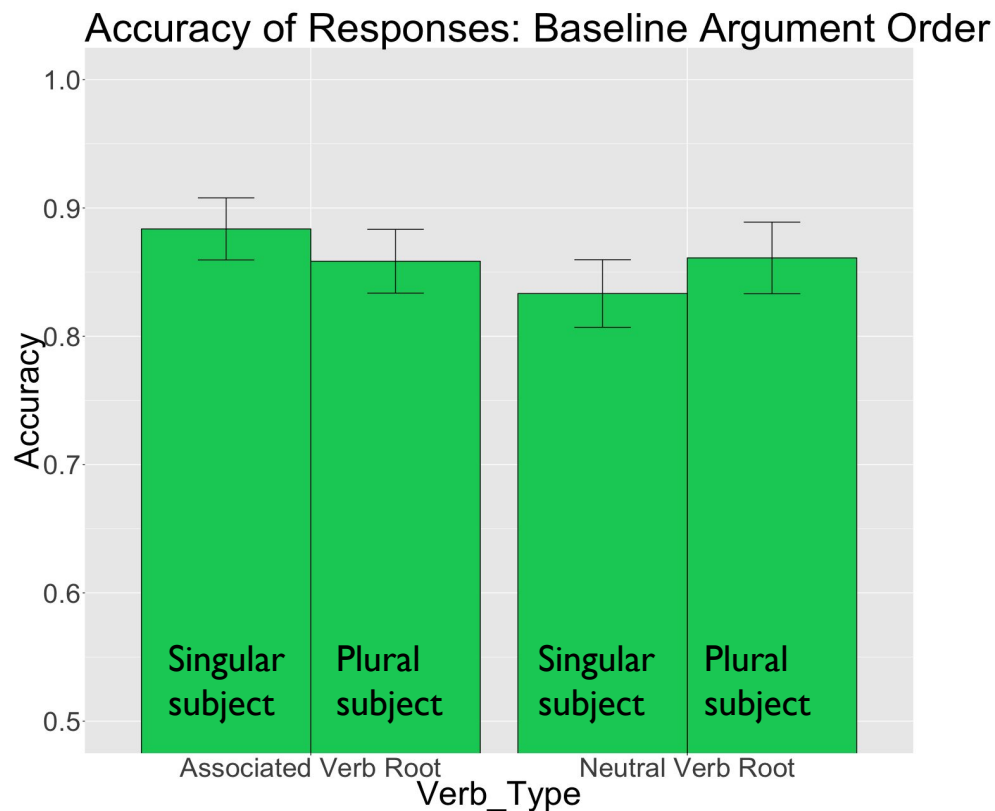
were hugging F   J *was hugging*

Experiment 3b

| Sentence Fragment	Answering Options
The man remembered which patients the doctor …	**was** treating / were treating
The man remembered which patient the doctors …	was treating / **were** treating
The man remembered which patients the doctor …	**was** hugging / were hugging
The man remembered which patient the doctors …	was hugging / **were** hugging

Experiment 3b

Accuracy of Responses: Baseline Argument Order

Experiment 3b

Sentence Fragment	Answering Options
The man remembered which patients the doctor ...	**was** treating / were treating
The man remembered which patient the doctors ...	was treating / **were** treating
The man remembered which patients the doctor ...	**was** hugging / were hugging
The man remembered which patient the doctors ...	was hugging / **were** hugging
The man remembered which doctors the patient ...	**was** treating / were treating
The man remembered which doctor the patients ...	was treating / **were** treating
The man remembered which doctors the patient ...	**was** hugging / were hugging
The man remembered which doctor the patients ...	was hugging / **were** hugging

Experiment 3b

Accuracy of Responses:Reversed Argument Order
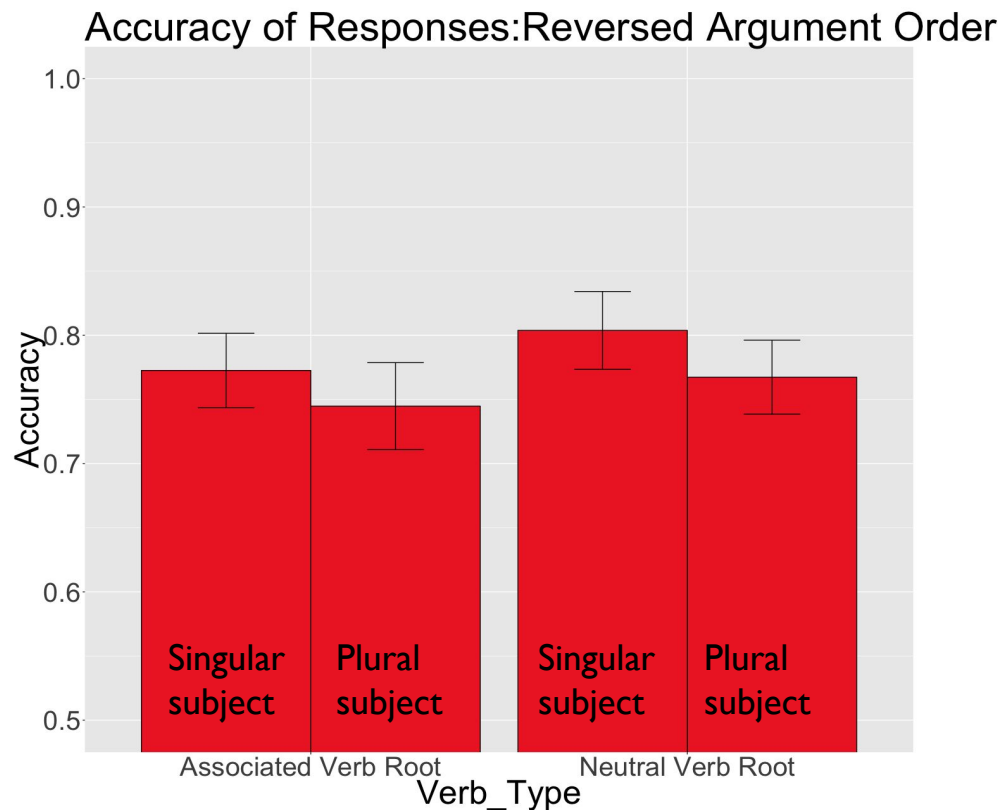
Experiment 3b
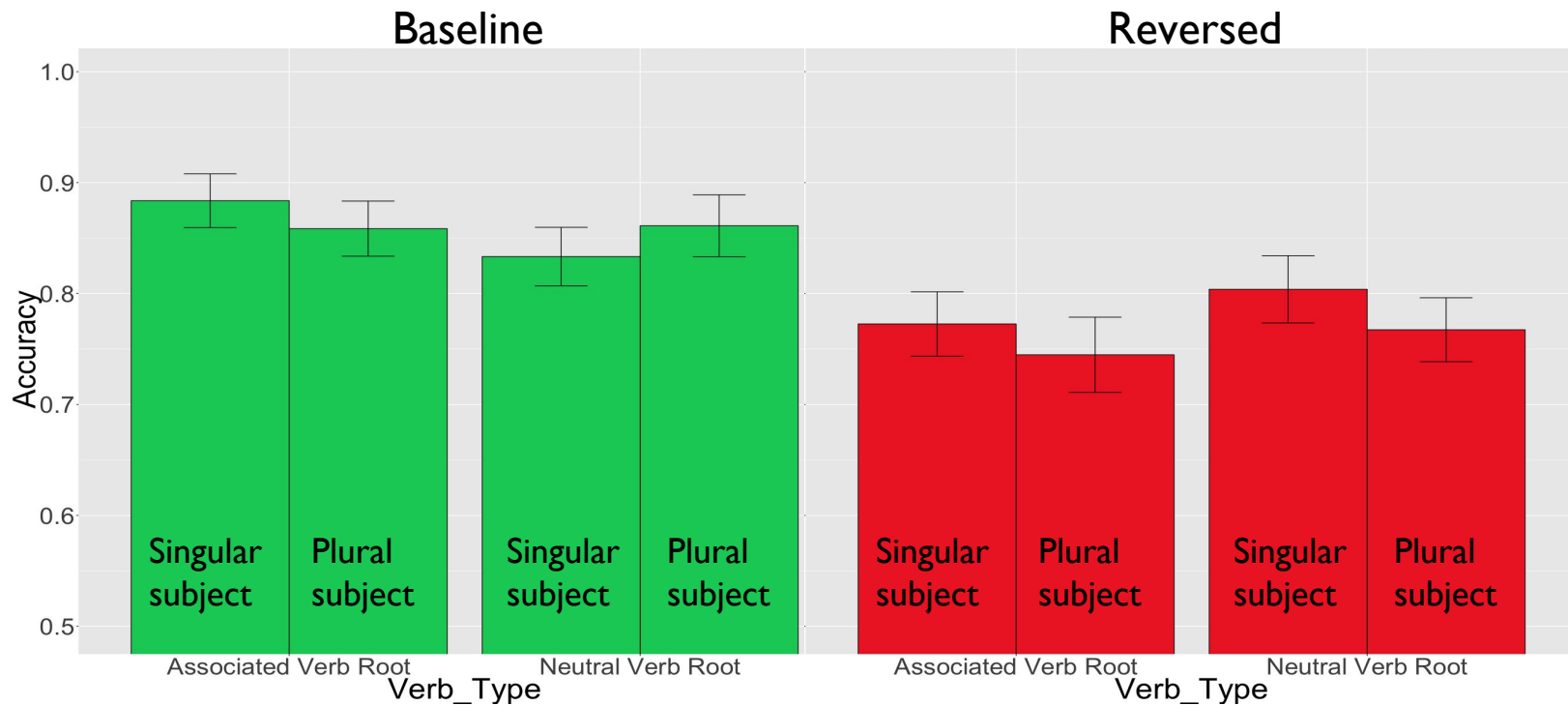
Experiment 3b

Logistic Mixed Effects Model showed that **only the main effect of argument order was significant.**

Cloze of the verb root may not have mattered as an agreement task effect.

All interactions were insignificant.

Experiment 3b

Participants erroneously agreed with the number of the canonical agent (the typical agent of the high cloze verb root).

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Bock & Miller 1991 suggest that subject-verb agreement errors in ORCs arise from confusion about the identity of the syntactic subject.

Ettinger 2018 found that Chow et al's items are asymmetrical; the baseline agent has a closer relation (cosine) to the verb than the reversed agent does.

The propensity to agree with the baseline agent suggests something similar.

Discussion

In Experiments 1 and 2, participants completed sentences containing embedded wh-questions (OSV) with any verb of their choosing.

Their choices frequently necessitated misassigning the thematic roles to the arguments to make sense.

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Their choices frequently necessitated misassigning the thematic roles to the arguments to make sense.

In Experiment 3a, participants were provided with a plausible (but low-cloze) alternative verb root.

Still, they frequently chose the verb that makes sense only with a reversed mapping of roles to arguments.

Discussion

Experiment 3b revealed that the baseline subjects / agents are more likely to be agreed with.

This suggests the items may be naturally asymmetric (*symmetry* was controlled in Ehrenhofer 2018).

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In sum:

At the point of the verb, comprehenders frequently have an illicit parse of the input such that the extracted object is the agent of the verb, and sometimes its syntactic subject.

Discussion

An open and important question is how exactly the parser has misrepresented the input.

Are the misassigned roles "lingering" remnants of a previous (SVO) parse?

Are roles assigned only after encountering the verb and the process underlying verb prediction / selection uninformed by preverbal role information?

Is there low confidence in these reversals of roles / are they driven by error detection?

Thank you!!

Works Cited

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Supplemental Slides