A discourse-based analysis of animacy effects on VP ellipsis interpretation

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Bound variable vs. coreferential (i.e. sloppy vs. strict identity)

John likes his apartment, and Bill does, too.

**Bound Variable:**
\[
\text{John likes John's apartment, and Bill likes Bill's apartment, too.}
\]
John \([\lambda x(x \text{ likes } x's \text{ apartment})]\) and Bill \([\lambda x(x \text{ likes } x's \text{ apartment})]\)

**Coreference:**
\[
\text{John likes John's apartment, and Bill likes John's apartment, too.}
\]
John \([\lambda x(x \text{ likes John's apartment})]\) and Bill \([\lambda x(x \text{ likes John's apartment})]\)

**Coreference #2:**
\[
\text{John likes Fred's apartment, and Bill likes Fred's apartment, too.}
\]
John \([\lambda x(x \text{ likes Fred's apartment})]\) and Bill \([\lambda x(x \text{ likes Fred's apartment})]\)
Bound variable vs. coreferential (i.e. sloppy vs. strict identity)

John likes his apartment, and Bill does, too.

Bound Variable: “John likes John’s apartment, and Bill likes Bill’s apartment, too.”
John [\(\lambda x(x \text{ likes } x’s \text{ apartment})\)] and Bill [\(\lambda x(x \text{ likes } x’s \text{ apartment})\)]

Coreference: “John likes John’s apartment, and Bill likes John’s apartment, too.”
John [\(\lambda x(x \text{ likes } \text{John’s apartment})\)] and Bill [\(\lambda x(x \text{ likes } \text{John’s apartment})\)]

Coreference #2: “John likes Fred’s apartment, and Bill likes Fred’s apartment, too.”
John [\(\lambda x(x \text{ likes } \text{Fred’s apartment})\)] and Bill [\(\lambda x(x \text{ likes } \text{Fred’s apartment})\)]
Resolving BV/coreferential ambiguity

*John likes his apartment, and Bill does, too.*

Bill likes John’s apartment? Bill likes his own apartment?

What influences the choice between bound variable and coreferential interpretations for this elliptical utterance?
Roadmap

- Background literature
- Previous experiments by Storbeck & Kaiser
- A theoretical model and its predictions
- Current experiments addressing model predictions
- Conclusions
Resolving BV/coreferential ambiguity

*John likes his apartment, and Bill does, too.*

Bill likes John’s apartment? Bill likes his own apartment?

What influences the choice between bound variable and coreferential interpretations for this elliptical utterance?

- Context
- Innate bound variable bias
- Lexical semantics (of verb and possessed noun)
Innate bound variable bias

- A number of studies have claimed that the bound variable interpretation is innately preferred and/or computationally easier

- Evidence from child language studies for early bound variable bias and increase in coreferential interpretations over development (Foley et al., 2003; Guo et al., 1997)

- Evidence from studies of agrammatic Broca’s aphasia that coreferential interpretations are disproportionately impaired (Vasić et al., 2006)

- Evidence from studies of unimpaired adults also confirms bound variable preference (e.g. Frazier & Clifton, 2000; Koornneef et al., 2011)
Lexical semantics

- Properties of lexical items within the sentence may affect BV preference
  - Verbs
    - Self-directed verbs (e.g. *scratch*) boost BV preference vs. other-directed verbs (e.g. *move*) (Foley et al., 2003; Guo et al., 1997)
    - Implicit causality (Ong & Brasoveanu, 2014)
  - Nouns
    - Inalienable possessions (e.g. *his arm*) boost BV preference vs. alienable (ownership) possessions (e.g. *his apple*) (Foley et al., 2003; Guo et al., 1997)

(NB: this was L1 acquisition work with children)
Typology of possessives

● Previous work has shown that the possessed noun’s alienability matters
  ○ Inalienable possessions boost BV bias relative to alienable possessions

● Possessives can also express relationships other than ownership and part/whole
  ○ Kinship (e.g. *her father*)
  ○ Non-kinship relations between animates (e.g. *her friend*)

● Many languages encode different possessive relationships with different morphosyntactic mechanisms (Haspelmath, 2017)
  ○ Maltese:
    * id ‘hand’ → id-i [hand-1SG.POSS] ‘my hand’
The effect of possessions’ animacy

● A possession’s animacy (and therefore possession type) may affect BV/coreferential preference in non-ellipsis contexts (Dahl & Fraurud, 1996)

(a) John sent his paycheck to his mother, and Bill sent it to his wife.
   (biases BV interpretation: Bill sent his own paycheck)

(b) John sent his daughter to his mother, and Bill sent her to his wife.
   (biases coreferential interpretation: Bill sent John’s daughter)

● Dahl & Fraurud (1996:57): “It seems plausible that this has to do with differences in individuation between animates and inanimates.”
Our prior work
(Storbeck & Kaiser, 2018 LSA Proceedings)

- Effect of possession type not systematically examined in VP ellipsis literature
- Do different possession types modulate preference for bound variable vs. coreferential interpretations?
- Previous research with children identified alienability as an important factor
  - How does alienability’s effect of compare to animacy’s?
Our prior work (Storbeck & Kaiser, 2018 LSA Proceedings)

- Effect of possession type not systematically examined in VP ellipsis literature
- Do different possession types modulate preference for bound variable vs. coreferential interpretations? Yes
- Previous research with children identified alienability as an important factor
  - How does alienability’s effect of compare to animacy’s? Animacy matters more
Storbeck & Kaiser (2018)

- 2AFC ellipsis interpretation task (n = 48)
  - Participants select the answer choice more compatible with their interpretation
- Manipulated possession type
  - Part-whole (e.g. nose, reputation, haircut)
  - Ownership (e.g. bicycle, shoes, newspaper)
  - Relational (e.g. classmate, opponent, partner)
  - Kinship (e.g. father, aunt, cousin)
- 24 targets, 40 fillers

*Helen chabbled her [noun], and Amanda did, too.*

  (a) *Amanda chabbled her own [noun].* (bound variable)

  (b) *Amanda chabbled Helen's [noun].* (coreferential)
Storbeck & Kaiser (2018)

Jason jolfed his bicycle, and Ronald did, too.

- Ronald jolfed his own bicycle.
- Ronald jolfed Jason’s bicycle.
Predictions for our original study

- Basic prediction: Possession type modulates BV/coreferential preference
  - Differing hypotheses based on prior work:

<table>
<thead>
<tr>
<th>Possession type</th>
<th>Alienability hypothesis</th>
<th>Animacy hypothesis</th>
</tr>
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<tbody>
<tr>
<td>Part-whole</td>
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Results of our original study

**Part-whole:** [inanimate, inalienable]
Helen chabbed her *nose*, and Amanda did, too.

**Ownership:** [inanimate, alienable,]
Helen chabbed her *jacket*, and Amanda did, too.

**Relational:** [animate, inalienable(?)]
Helen chabbed her *boss*, and Amanda did, too.

**Kinship:** [animate, inalienable]
Helen chabbed her *son*, and Amanda did, too.
Results of our original study

**Part-whole:** [inanimate, inalienable]
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Helen chabbed her **boss**, and Amanda did, too.

**Kinship:** [animate, inalienable]
Helen chabbed her **son**, and Amanda did, too.

Proportion of bound variable interpretations by possession type

![Bar chart showing proportions of bound variable interpretations by possession type.](chart.png)

- **Part-Whole**
- **Ownership**
- **Relational**
- **Kinship**

USC Dornsife
Department of Linguistics
Results of our original study

**Part-whole:** [inanimate, inalienable]
Helen chabbed her **nose**, and Amanda did, too.

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Helen chabbed her **boss**, and Amanda did, too.

**Kinship:** [animate, inalienable]
Helen chabbed her **son**, and Amanda did, too.

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Proportion of bound variable interpretations by possession type

- **Part-Whole**
- **Ownership**
- **Relational**
- **Kinship**

Results: n.s.
Results of our original study

**Part-whole**: [inanimate, inalienable]
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Helen chabbed her *boss*, and Amanda did, too.

**Kinship**: [animate, inalienable]
Helen chabbed her *son*, and Amanda did, too.
Summary of original study results

- Part-whole and ownership nouns produce similar rates of BV interpretation.
- Part-whole and ownership nouns produce more BV interpretations than relational and kinship nouns.
- Relational nouns produce more BV interpretations than kinship nouns.
These results replicate (other studies w/ similar stimuli)

What we just saw:

Later replications:
Our original results support the animacy hypothesis

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An alternative analysis

● BV/Coreferential preference determined simply based on real-world plausibility?

  “John likes his jacket, and Bill does, too.”

  ○ Bill is likely to have his own jacket → variable binding
  ○ Bill is less likely to have his own jacket → coreference

● Interpretation may be influenced by high-level assumptions about the likelihood of an average person possessing the relevant noun

● Our earlier work (Storbeck & Kaiser, 2018 LSA Proc.) shows this is not the case
Noun possession likelihood norming

- 28 adult native speakers of American English recruited via MTurk
- Rated “how likely an average person is to have at least one” of nouns from original study (and others, 65 total items)
  - Ratings were on a 1-to-6 scale
    - 1 = an average person is not likely at all to have at least one
    - 6 = an average person is extremely likely to have at least one
Noun possession likelihood norming

How likely is the average person to have at least one:

father

Not likely at all
1  2  3  4  5  6

Extremely likely
Real-world plausibility does not explain results

No correlation between a noun’s likelihood of possession and the rate of bound variable responses \((r = 0.13, p = 0.38)\)

BV/Coref preference is not influenced by real-world knowledge about possession likelihood
Noun norming analysis

- People have high-level knowledge/assumptions that certain nouns are more likely to be possessed by the second “character” in target items
- We found no evidence that these assumptions influence rates of bound variable interpretation
A discourse-based model

- A working proposal [in the spirit of file change semantics (Heim, 1982)]
  - Animate possessions more likely to receive fully independent discourse representations (cf. “file card”)
  - Inanimate possessions less privileged; more likely processed/conceptualized as parasitic/dependent on the representation of the possessor
  - Independent discourse entities are available for coreference
  - Dependent discourse entities not available for coreference → BV interpretation
A potential model (offline decision)

“John likes his jacket, and Bill does, too.”

<table>
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<tr>
<th>Syntax/Semantics</th>
<th>Bound variable</th>
<th>Coreferential</th>
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<tr>
<td>John (\lambda x(x \text{ likes } x^\prime s \text{ jacket})) and Bill (\lambda x(x \text{ likes } x^\prime s \text{ jacket}))</td>
<td>John (\lambda x(x \text{ likes } \text{ John's jacket})) and Bill (\lambda x(x \text{ likes } \text{ John's jacket}))</td>
<td></td>
</tr>
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</table>

Discourse

- John
  - jacket
- Bill
  - jacket

- John
  - John's jacket
- Bill
Ownership

“John likes his jacket, and Bill does, too.”

**Bound variable**

John [$\lambda x(x \text{ likes } x\text{'s jacket})$
and Bill [$\lambda x(x \text{ likes } x\text{'s jacket})$]

**Coreferential**

John [$\lambda x(x \text{ likes John's jacket})$
and Bill [$\lambda x(x \text{ likes John's jacket})$]
Ownership

“John likes his \textit{jacket}, and Bill does, too.”

Bound variable

John $[\lambda x(x \text{ likes } x\text{’s jacket})]$  
and Bill $[\lambda x(x \text{ likes } x\text{’s jacket})]$  

Coreferential

John $[\lambda x(x \text{ likes } \text{John’s jacket})]$  
and Bill $[\lambda x(x \text{ likes } \text{John’s jacket})]$  

Bound variable more likely  
(Bill likes his own jacket)
### Ownership

“John likes his jacket, and Bill does, too.”

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<tr>
<td>John (x(x \text{ likes } x'\text{'s jacket})) and Bill (x(x \text{ likes } x'\text{'s jacket}))</td>
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- **John's jacket**
- **Bill's jacket**

Bound variable more likely (Bill likes his own jacket)

### Kinship

“John likes his father, and Bill does, too.”

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<td>John (x(x \text{ likes } x'\text{'s father})) and Bill (x(x \text{ likes } x'\text{'s father}))</td>
<td>John (x(x \text{ likes John's father})) and Bill (x(x \text{ likes John's father}))</td>
</tr>
</tbody>
</table>

- **John's father**
- **Bill's father**

Ownership and kinship are illustrated in the diagrams.
Ownership

“John likes his jacket, and Bill does, too.”

Bound variable

John [\(\lambda x(x \text{ likes } x's \text{ jacket})\)]
and Bill [\(\lambda x(x \text{ likes } x's \text{ jacket})\)]

Coreferential

John [\(\lambda x(x \text{ likes John's jacket})\)]
and Bill [\(\lambda x(x \text{ likes John's jacket})\)]

Bound variable more likely
(Bill likes his own jacket)

Coreference more likely
(Bill likes John’s father)

Kinship

“John likes his father, and Bill does, too.”

Bound variable

John [\(\lambda x(x \text{ likes } x's \text{ father})\)]
and Bill [\(\lambda x(x \text{ likes } x's \text{ father})\)]

Coreferential

John [\(\lambda x(x \text{ likes John's father})\)]
and Bill [\(\lambda x(x \text{ likes John's father})\)]

Bound variable more likely
(Bill likes his own jacket)

Coreference more likely
(Bill likes John’s father)
Ownership

“John likes his jacket, and Bill does, too.”

Bound variable
John $[\lambda x(x \text{ likes } x\text{'s jacket})]$ and Bill $[\lambda x(x \text{ likes } x\text{'s jacket})]$

Coreferential
John $[\lambda x(x \text{ likes John’s jacket})]$ and Bill $[\lambda x(x \text{ likes John’s jacket})]$

Bound variable more likely
(Bill likes his own jacket)

Coreference more likely
(Bill likes John’s father)

This is probabilistic, not deterministic!

Kinship

“John likes his father, and Bill does, too.”

Bound variable
John $[\lambda x(x \text{ likes } x\text{'s father})]$ and Bill $[\lambda x(x \text{ likes } x\text{'s father})]$

Coreferential
John $[\lambda x(x \text{ likes John’s father})]$ and Bill $[\lambda x(x \text{ likes John’s father})]$

Bound variable more likely
(Bill likes his own father)

Coreference more likely
(Bill likes John’s father)

This is probabilistic, not deterministic!
A prediction of the model

- What if building an independent discourse representation is impossible?
- Quantified NPs assumed not to introduce a discourse referent (e.g. Reinhart, 2000)
  - John likes his father, and Bill does, too.
    - Possible independent representation for [John’s] father → Coreference
  - Every man likes his father, and Bill does, too.
    - No independent representation for [every man’s] father → BV

- **Testable prediction:** Possession type should make no difference if the matrix subject is a QuNP
Experiment 1: design

- Same procedure and possession type conditions as our original study
- Target sentences were the same except the matrix clause subject was a QuNP
  - Male names were replaced with *Every man*
  - Female names were replaced with *Every woman*

- Example target:
  - **Part-whole:** Every woman chabbed her *nose*, and Amanda did, too.
  - **Ownership:** Every woman chabbed her *jacket*, and Amanda did, too.
  - **Relational:** Every woman chabbed her *boss*, and Amanda did, too.
  - **Kinship:** Every woman chabbed her *son*, and Amanda did, too.

- Same fillers and target-to-filler ratio as our original study
Experiment 1: participants

- 32 adult native speakers of American English
  - Self-identified as native English speakers born in the US
  - Normal vision and hearing
  - Recruited through Amazon Mechanical Turk
Experiment 1: predictions

Ex. Every woman chabbed her [noun], and Amanda did, too.

- When the matrix clause subject is definite, the possessed noun may (or may not) get an independent discourse representation, according the model
- However, a QuNP matrix clause subject establishes no discourse referent
- Consequently, no independent representation for possessed noun
- Therefore, the interpretation should always be BV, no effect of animacy
- All noun conditions should get ceiling rates of BV interpretation
Experiment 1: results

For all comparisons, $p > 0.05$ (glmer)

Kinship may show marginal effect depending on random effects structure, further analysis warranted

No effect of animacy as observed in prior work

Ex. Every woman chabbed her [noun], and Amanda did, too.
Experiment 1: analysis

- Our model’s prediction is confirmed
- Possession type effects are wiped out by matrix clause QuNP
- Implicates lack of independent discourse representation → obligatory-ish BV
- But what if the QuNP is the subject of the elided clause?

Ex. *Every woman chabbed her [noun], and Amanda did, too.*
Experiment 2: design

- Target sentences were the same except the elided clause subject was a QuNP
  - Male names were replaced with *every man*
  - Female names were replaced with *every woman*

- Example target:
  - **Part-whole:** Helen chabbled her *nose*, and every woman did, too.
  - **Ownership:** Helen chabbled her *jacket*, and every woman did, too.
  - **Relational:** Helen chabbled her *boss*, and every woman did, too.
  - **Kinship:** Helen chabbled her *son*, and every woman did, too.

- Same fillers and target-to-filler ratio as our original study
- \( n = 32 \), English native speakers from Mturk
Experiment 2: predictions

Ex. Helen chabbed her [noun], and every woman did, too.

- Matrix clauses are the same as in the original study
- We predict the same influences on discourse encoding for the matrix clause
- We should see the same animacy effect observed in the original study
  - Animate possessions result in fewer BV interpretations, due to availability of an independent discourse representation for coreference
Experiment 2: results

Inanimate conditions do not differ; nor do animate conditions
\( p > 0.05 \) (glmer)

Inanimate conditions differ from animate
\( p < 0.001 \)

Confirms animacy effect as observed in prior work

Ex. Helen chabbed her [noun], and every woman did, too.

Proportion of bound variable interpretations by possession type (QuNP in elided clause)
Experiment 2: analysis

- Our model’s prediction is confirmed
- Possession animacy effect is left intact by elided clause QuNP
- Failure to replicate relational/kinship difference is topic for further analysis
A possible critique of Experiments 1 & 2

● All Exp. 1 items have a possible confound which could bias BV responses

  *Every woman chabbèd her nose, and Amanda did, too.*

● Given that Amanda is a woman, the matrix clause entails BV interpretation (i.e. that Amanda chabbèd her own nose)

● Maybe this entailment, not discourse representation of the possessed noun, is driving the strong BV bias across conditions

● We address this concern in Experiment 3
Experiment 3: design

- Same targets as Experiment 1, except *Every man* and *Every woman* were exchanged
- Matrix clause subject and elided clause subject always mismatch in gender

- Example target:
  - **Part-whole:** Every man chabbed his *nose*, and Amanda did, too.
  - **Ownership:** Every man chabbed his *jacket*, and Amanda did, too.
  - **Relational:** Every man chabbed his *boss*, and Amanda did, too.
  - **Kinship:** Every man chabbed his *son*, and Amanda did, too.

- Same fillers and target-to-filler ratio as original study
- *n = 24*, English native speakers from Mturk
Experiment 3: predictions

Ex. Every man chabbded his [noun], and Amanda did, too.

- If Exp. 1 results were due to lack of an independent discourse representation, as our model predicts, we should see the same results (uniformly high BV rate).
- However, if Exp. 1 results were due only to a pragmatic confound, we should see similar possession type effects as in the original study.
  - e.g. Every man chabbded his nose, and Amanda did, too.
    (no entailment that Amanda chabbded her own nose)
Experiment 3: results

For all comparisons, $p > 0.05$ (glmer)

No effect of animacy as observed in prior work

Results mirror Exp. 1

Ex. Every man chabbed his [noun], and Amanda did, too.

Proportion of bound variable interpretations by possession type (QuNP in matrix clause)
Experiment 3: analysis

- Our model’s prediction is confirmed
- Supports claim that results of Experiments 1 & 3 were due to lack of an independent discourse representation for the possessed noun

Ex. Every man chabbled his [noun], and Amanda did, too.
Experiment 4: design

- But will the animacy effect observed in Exp. 2 persist with gender mismatch?
- Same targets as Experiment 2, except *Every man* and *Every woman* were exchanged
- Matrix clause subject and elided clause subject always mismatch in gender

- Example target:
  - **Part-whole:** Helen chabbed her *nose*, and every man did, too.
  - **Ownership:** Helen chabbed her *jacket*, and every man did, too.
  - **Relational:** Helen chabbed her *boss*, and every man did, too.
  - **Kinship:** Helen chabbed her *son*, and every man did, too.

- Same fillers and target-to-filler ratio as original study
- n = 24, English native speakers from Mturk
Experiment 4: predictions

Ex. Helen chabbed her [noun], and every man did, too.

- Matrix clauses are the same as in the original study
- We predict the same influences on discourse encoding for the matrix clause
- As in Exp. 2, we expect same animacy effect observed in the original study
  - Animate possessions result in fewer BV interpretations, due to availability of an independent discourse representation for coreference
- Model makes no prediction about effect of gender-mismatch
Experiment 4: results

Inanimate conditions do not differ; nor do animate conditions
p > 0.05 (glmer)

Inanimate conditions differ from animate
p < 0.001

Confirms animacy effect we observed in prior work

Proportion of bound variable interpretations by possession type (QuNP in elided clause)

Ex. Helen chabbed her [noun], and every man did, too.
Experiment 4: analysis

- Model prediction confirmed, but there is a clear effect of gender mismatch
- Gender mismatch effect presents opportunity for future work

Ex. Helen chabbed her [noun], and every man did, too.
Summary of current experimental results

<table>
<thead>
<tr>
<th>Gender match</th>
<th>QuNP matrix clause subject</th>
<th>QuNP elided clause subject</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Experiment 1</td>
<td></td>
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Conclusions

The core proposal:

- Animate possessions → independent discourse status → weaker bound variable bias
- Inanimate possessions → dependent discourse status → stronger bound variable bias
Conclusions

● We confirm our model’s prediction that a QuNP as matrix-clause subject will result in uniformly high rates of BV interpretation.

● When an independent representation for the overt possession is possible, its animacy is an important factor in resolving the elided possessive pronoun.

● We confirm that animacy seems to contribute more strongly than alienability, since we find no differences among conditions differing in alienability; nevertheless, animacy is still only one of multiple contributing factors in ambiguity resolution.
Thank you for listening!

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Selected References


