Thematic Role and Event Structure Biases in Pronoun Interpretation
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LSA Annual Meeting
January 6, 2006
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I. INTERPRETING AMBIGUOUS PRONOUNS

- **Goal preference**
  - Stevenson et al. (1994; see also Arnold 2001) tested strategies for pronoun interpretation using story completions like (1):

    (1) John handed a book to Bob. He ________.

    SOURCE (matrix subject)  \( \uparrow \)  TRANSFER VERB  \( \uparrow \)  AMBIGUOUS PRONOUN PROMPT  \( \downarrow \)  GOAL (to-phrase)

  - Results: overall preference for non-subject Goal

- **Existing models predict the wrong interpretation**

  - *Subject preference* (Crawley, Stevenson, & Kleinman 1990, *inter alia*): predict resolution to subject \( \rightarrow \) Source
  - *Grammatical parallelism* (Smyth 1994, Chambers & Smyth 1998): predict subject pronoun resolves to subject antecedent \( \rightarrow \) Source

- **Stevenson et al. considered two explanations:**
  1. Thematic-role-level preference for Goals over Sources
  2. Event-level bias for focusing on end state of transfer

- **Event Structure Hypothesis**
  - Stevenson et al. claim a bias towards focusing on the end state of an event
  - End state of transfer events make the Goal salient – hence a preferred referent for a pronoun.

II. DISTINGUISHING BETWEEN THE TWO EXPLANATIONS

- **Our proposal: manipulate end state focus through verbal aspect**
  - *perfective* – event is completed, compatible with end-state focus
  - *imperfective* – event as ongoing, incompatible with end-state focus

  **Experiment:** story completions following transfer-of-possessions introducing verbs in the perfective (2) or imperfective (3).

  (2) COMPLETED EVENT (PERFECTIVE):
  
  John\textsubscript{SOURCE} handed a book to Bob\textsubscript{GOAL}. He ________.

  (3) INCOMPLETE EVENT (IMPERFECTIVE):
  
  John\textsubscript{SOURCE} was handing a book to Bob\textsubscript{GOAL}. He ________.

  Equivalent thematic role relations with different verbal aspect

**Predictions:**

- **Thematic Role Preference**
  \( \rightarrow \) Goal preference for (2) and (3)

- **Event Structure Hypothesis**
  \( \rightarrow \) Larger percentage of Source interpretations for (3)
III. METHODOLOGY FOR STORY COMPLETION TASK

Subjects: monolingual English speakers (N=48)
Task: writing continuations for 21 passages similar to (2) and (3)
Stimuli: transfer-of-possession intro sentences with ambiguous pronoun prompt
Each participant saw half the sentences in the perfect and half in the imperfect.
Distractors: 29 non-transfer verbs for intro sentences; adverbs, proper names, and
gender-unambiguous pronouns as prompts
Evaluation: judges determined the participants’ pronoun interpretations in
light of the story context and the elicited continuation.

IV. RESULTS: MANIPULATING ASPECT CHANGES INTERPRETATION

- Imperfective intros yielded significantly more Source resolutions (71%)
  than perfective intros (48%; F(1,48)=51.597, p<0.0001)

![Effects of Verbal Aspect on Pronoun Resolution](image)

Fig. 2

- Results support Event Structure Hypothesis: pronoun interpretation changes
  as the structure of the event changes.

- Sample continuations from participant responses:
  (4) Miriam sent a fruitcake to Rachel. She told Miriam she doesn’t like fruitcakes.
  (5) Miriam was sending a fruitcake to Rachel. She forgot Rachel was allergic to nuts

- 11% were ambiguous and set aside, but either interpretation for these still
  results in a significant effect.

Conclusion:
- Imperfective aspect results in increased percentage of Source interpretations.
- Participants’ interpretations of ambiguous pronouns appear to reflect deeper
  event-level biases rather than surface-level thematic role preferences.

V. ADDITIONAL RESULTS: VERB CLASSES

Verbs were classified prior to the experiment along two dimensions:
- co-location of event participants & guarantee of successful transfer

<table>
<thead>
<tr>
<th>Verb Class 1</th>
<th>Verb Class 2</th>
<th>Verb Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>co-located</td>
<td>co-located</td>
<td>not co-located</td>
</tr>
<tr>
<td>guaranteed transfer</td>
<td>no guaranteed transfer</td>
<td>no guaranteed transfer</td>
</tr>
<tr>
<td>hand</td>
<td>throw</td>
<td>send</td>
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<tr>
<td>give</td>
<td>kick</td>
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<td>bring</td>
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<td>give</td>
<td>roll</td>
<td>fax</td>
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<td>transmit</td>
</tr>
<tr>
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<td>wire</td>
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</tbody>
</table>
Pronoun interpretation differs across verb classes (F(2,98)=15.058, p<0.0001)  
No preference for perfective: Class 1

- Class 1 verbs with co-located participants and guaranteed transfer
- Ex. hand, give, pass
- Perfective intros yield similar percentage Goal interpretations as Source interpretations ($\chi^2=0.54$, p<0.5)

Goal preference for perfective: Class 2

- Class 2 verbs with co-located participants but no guaranteed transfer
- Ex. kick, roll, throw
- Perfective intros yield more Goal interpretations than Source ($\chi^2=5.34$, p<0.02)

Source preference for perfective: Class 3

- Class 3 verbs without co-located participants and no guaranteed transfer
- Ex. mail, fax, send
- Perfective intros yield more Source interpretations than Goal ($\chi^2=18.85$, p<0.0001)

In all classes, the imperfective always yields more Source interpretations

VI. Effects of Coherence

- Pronoun interpretation strategies are side effects of the types of inference processes used to establish discourse coherence (Kehler 2002)

- Goal preference is compatible with narration – Occasion coherence relations connect the end state of one event with the initial state of the next event.
  Occasion Relation: infer a change of state for a system of entities from $S_1$, inferring the initial state for this system from the final state of $S_2$.
  (adapted from Hobbs 1990)

  Sample continuation from experiment
  (6) Matt passed a sandwich to David. He said thanks and ate it.
     → Occasion: Goal

  No reason to expect Goal preference for other types of coherence relations

  Sample continuations from experiment
  (7) Matt passed a sandwich to David.
     (a) He didn’t want David to starve.
        → Explanation: Source
     (b) He put fruit on his plate too.
        → Parallel: Source
     (c) He did so carefully.
        → Elaboration: Source

Superficial heuristics cannot explain these patterns – need a model of discourse to capture event-level mechanisms like coherence for pronoun interpretation (see Wolf et al. 2004 and Kertz et al. in preparation).
VII. Future Work

- **Referring expressions** – preferences emerge when participants can choose to use either a pronoun or a name (Stevenson et al. 1994; Arnold 2001)
  - In interpretation, pronouns are resolved preferentially to the Goal
  - With free choice in production, pronouns are not associated with Goals
  
  (8) John gave the book to Mary. __________

  1st mentioned individual (Source) – repeated as pronoun
  2nd mentioned individual (Goal) – repeated as name

- **Our distractors confirmed preferred referring expressions:**

  Each of 48 participants saw 10 sentences with active Agent-Patient verbs. Choice of referring expression with no pronoun prompt shows effect of referent’s sentence position (F(1,94)=50.798, p<0.0001)

  (9) Keith poisoned Sally with cyanide. Next __________

  (a) Next he destroyed the evidence.
  (b) Next Sally collapsed on the floor.

  1st mentioned individual of intro: repeated as pronoun 66% of the time
  2nd mentioned individual of intro: repeated using name 72% of the time

- **Repeated name effect for subjects** (Gordon et al. 1993)
  - Although proper names disambiguate, their use can create reading time penalties in certain situations.
  - Gordon et al. show that in cases where a pronoun would refer preferentially to the subject, using a full name induces reading time penalty.

- **Proposed reading time experiment**: test for repeated name effect in cases where a non-subject Goal is the preferred referent

  (10) Sarah served chili to Emily.

  (a) She<sub>SOURCE</sub> warned that it was hot.
  (b) She<sub>GOAL</sub> said thanks.
  (c) Sarah<sub>SOURCE</sub> warned that it was hot.
  (d) Emily<sub>GOAL</sub> said thanks.

**QUESTION 1**: Is there still a repeated name effect for the subject, given the existence of another potential antecedent that is at least as, if not more, salient than the subject?

**QUESTION 2**: Does the repeated name effect extend to the non-subject Goal?

**Summary**

- Our results support the conclusion that preferences for Goal interpretation are the result of event structure biases.
- Pronoun interpretation must be addressed within a broader theory of discourse comprehension rather than by appeal to superficial heuristics.

**REFERENCES**


APPENDIX: STIMULI

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Sentence-completion passages:

(each participant saw perfective or imperfective, depending on verb)

1. Ben chucked/was chucking a wrench to Mark. He _________
2. Rebecca flung/was flinging a frisbee to Hannah. She _________
3. Nick kicked/was kicking a soccer ball to Justin. He _________
4. Charles lobbed/was lobbing a football to Jacob. He _________
5. Peter rolled/was rolling a toy truck to Jeremy. He _________
6. Jason threw/was throwing a hat to Andrew. He _________
7. Amanda tossed/was tossing a dish towel to Jenny. She _________
8. John brought/was bringing a glass of water to Robert. He _________
9. Brian faxed/was faxing a resume to Adam. He _________
10. Angela forwarded/was forwarding a gossipy email to Kelly. She _________
11. Heather mailed/was mailing a letter to Amy. She _________
12. Miriam sent/was sending a fruitcake to Rachel. She _________
13. Katherine shipped/was shipping a package to Laura. She _________
14. Jane transmitted/was transmitting a message to Nicole. She _________
15. Richard wired/was wiring money to Fred. He _________
16. Sarah carried/was carrying a tray to Brittany. She _________
17. Roger delivered/was delivering a subpoena to Joe. He _________
18. Elizabeth gave/was giving a sweater to Ruth. She _________
19. Mike handed/was handing a book to Josh. He _________
20. Matt passed/was passing a sandwich to David. He _________
21. Jessica served/was serving chili to Emily. She _________

Distractors:

22. Pamela was stabbed by Colleen at midnight. Next _________
23. Keith poisoned Sally with cyanide. Next _________
24. Kevin was complaining about school. Brad _________
25. Brett was startled by Dan at the dance. As a result _________
26. Allison was apporached by Tracy at a bar. Amazingly _________
27. Paul blinded Greg with a flashlight. As a result _________
28. Ryan hugged Alice after the game. He _________
29. Carl was escorted to court by Frank. Next _________
30. Bill amazed Ken with a double back flip. Next _________
31. Craig was beaten by Beth in the race. He _________
32. Casey was interviewed by Joel. Next _________
33. Melissa murdered George at midnight. She _________
34. Tina arrived home late. Candice _________
35. Sandra was attacked on the street by Jared. He _________
36. Alan surprised Clara with flowers. Later _________
37. Scott was hitting Zack with a pillow. As a result _________
38. Tom was waiting after class. Kristy _________
39. Dawn confused Neal with bad directions. Afterwards _________
40. Carolyn was worrying about finals. Henry _________
41. Ian found Jordan in an empty hallway. Quickly _________
42. Linda saw Becky through the window. Suddenly _________
43. Melanie helped Julia with the dishes. Next _________
44. Lisa was avoiding Mary after the party. As a result _________
45. Karen called Tiffany at home. Next _________
46. Margaret laughed out loud. Luis _________
47. Alyssa was deceived by Kim at a costume party. As a result _________
48. Katie answered Cindy with a smirk. As a result _________
49. Alicia was delayed by Monica on the way to school. As a result _________
50. Gina was followed by Susan. As a result _________

Rohde, Kehler, Elman (2006)