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Anticipating Upcoming Discourse Relations: Using Eye Movements To Measure Verb-Driven Pragmatic Expectation

Hannah Rohde & William S. Horton
Northwestern University

1. Question

Given existing evidence for expectation-driven processing at the levels of sounds, words, and syntactic structures, do we find that comprehenders also generate expectations at a pragmatic level?

2. Pragmatic Expectations

Testing ground: two relations taken from the wider inventory of implicit discourse coherence relations which are inferred to hold between clauses (Kehler 2002)

Explanations: infer that 2nd clause explains 1st
Theo congratulated Miriam. She had won the spelling bee.

Occasions: infer sequence of events
Heather bounced a basketball to Josh. He caught it.

Previous work: story continuations show verbs guide coherence expectations (Rohde et al. 2006, Kehler et al. 2008)

Implicit Causality (IC) Verbs → Explanations
(*congratulate*, *amuse*, *scold*, *detest*, etc.)
Transfer-of-Possession (TOP) Verbs → Occasions
(*bounce*, *give*, *hand*, *pass*, etc)

3. Discourse-Relation Classification Paradigm

Implicit learning with tube 'classifier' (McMurray & Aslin 2004)

Task: for each item in implicit learning phase, the participant …
… launches ball
… hears a two-sentence story
… guesses story classification (left or right)
… receives visual/auditory feedback for correct classification

Sample materials:

Explanation: *Leo takes the bus to work. He doesn't have a car.*
Occasion: *Melissa ran towards Trevor. They embraced.*

Goal: teach mapping of, e.g.: Explanation = left / Occasion = right (relation-region mapping reversed for half the participants)

Eyetracking hypothesis
- If verb-driven contextual guide coherence expectations
- And if comprehenders can learn a relation~region mapping

→ Then hearing a coherence-biasing cue in sentence1 should yield anticipatory looks to the region corresponding to the expected coherence relation *before* sentence2 is heard

IC verbs → *more looks to Explanation region*
TOP verbs → *more looks to Occasion region*

4. Experimental Design

Implicit learning training phase
Task: learn classification w/10 correct items in a row or all 60 items
Materials: half Explanations, half Occasions
Post-training quiz: 24 items with no feedback

Speeded-response task with eyetracking
Task: launch ball for sentence1, click emerging ball for sentence2

Instructions: use categories from training for speed
Design: sentence1 verb manipulation (IC vs. TOP)
sentence2 balanced for Explanation/Occasion

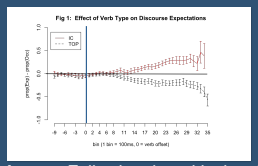
Sample Materials:

Explanation-biasing IC verb: *Burt amused Gwen.*
w/ Explanation sentence2: *He told her a joke about elephants.*
w/ Occasion sentence2: *She laughed out loud.*
Occasion-biasing TOP verb: *Caleb threw Claire a hat.*
w/ Explanation sentence2: *He was worried that she was cold.*
w/ Occasion sentence2: *They ran out the door into the snow.*

Goal: test whether verb type in sentence1 affects anticipatory looks left/right before participants hear sentence2

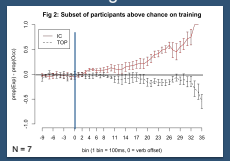
5. Results

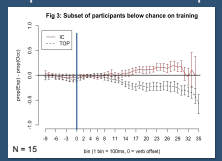
Critical measure: preference for looking to the Explanation region vs. Occasion region during sentence1, calculated as relative proportions of eye fixations in 100 ms 'bins'



Verb-driven biases: Following the critical verb, listeners begin showing a preference to look at the region associated with the appropriate discourse relation.

Training differences: Not all subjects were equally successful in learning relation-region pairings during training. This appears to affect the strength of verb-driven expectations in the test phase:



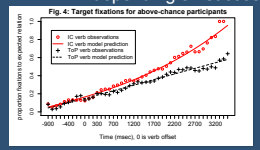


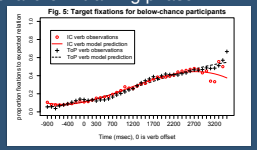
6. Analysis

T-Tests per 'bin'
Goal: identify points when relative proportions of Exp. vs. Occ looks are significantly different from zero for both IC/TOP
All Data:
- IC condition differs from zero 1600ms after verb
- TOP condition differs from zero 1000ms after verb

Effects for Training-Success Participants (n=7 of 22):
- IC condition differs from zero 400-600ms after verb and then consistently after 2000ms
- but, TOP condition differs from zero 2100ms after verb

Growth Curve Analysis (Mirman, Dixon, & Magnuson, 2008)
Goal: model looks to expected coherence region
Strategy: series of regression models to fit curves to data, first collapsed across participants and conditions, then with added variables to check for improved fit (avoid multiple analyses across discrete windows, as with t-tests)
Analysis: Adding verb type improves model fit, but differently depending on success/failure in training phase





Model	-2LL	Coefficient	p-value
Base	7581	-	
Intercept	7580	-115.254	=0.268
Linear	7569	-711.621	<0.001
Quadratic	7549	-276.642	<0.001

Model	-2LL	Coefficient	p-value
Base	14237	-	
Intercept	14237	12.244	=0.735
Linear	14236	207.855	=0.485
Quadratic	14225	162.812	<0.001

Interpretation: for training-success participants, better fit found (i.e., improvement over lower-order models) for both linear and quadratic models; for training-failure participants, better fit found only with quadratic model
- negative linear coefficient: slope in TOP condition is lower (reaching target later)
- negative quadratic coefficient: change in slope in TOP condition is lower (overall shape of curves is different)

→ IC cue is incorporated earlier and in a more meaningful way for those who learned the relation~region mapping

7. Summary

Findings:
- Psychological plausibility of Explanation/Occasion relations
- Evidence for expectations at discourse level (extends work on expectations at phonological/morphological/syntactic levels)
- Introduces new paradigm for testing comprehenders' intuitions about structure that is implicit in all coherent discourses

Open questions:
- How to interpret/evaluate early and late timecourse effects?
- How to interpret GCA results and verb type differences?
- What factors beyond verb type influence comprehenders' expectations about upcoming discourse relations? (A preceding Explanation? An open question in the discourse?)