The state of our inquiry –

Representing context for Negation

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Joint Work with…

Ye Tian,
Université Paris Diderot
Outline

• Context in incremental processing
  – A role for QUDs?

• Projecting context when processing negation
  – Positive and negative QUDs?

• Relation between QUD and data?
Anticipation in Incremental Interpretation
Altmann & Kamide (1999)

• ‘Look and listen’ paradigm

"The boy will move the cake"

"The boy will eat the cake"
Ingredients of Incremental Interpretation: Compositional Semantics
Altman & Kamide (2007)

(1) The man will drink all of the beer.
(2) The man has drunk all of the wine.

• Results show semantic composition in incremental interpretation – over and above simple associations.
Background –
A Role for QUDs in Language Processing?

• Quantity Implicatures
  • Breheny et al. (2013) show incremental access to Particularised Implicatures.
The woman put a fork into box A and a fork and a spoon into box B
Interim Summary

• We find immediate access to Particularised Implicatures on-line

• Access not only constrained by linguistic cues.
  • Ignorance condition had same prosody.

• PCI access integrated into cue-based probabilistic comprehension systems.
Discussion

• Cue-based/Probabilistic automatic comprehension systems cannot simply associate forms with all contextual inferences (e.g. PCIs)
  – Models of automatic processing set up to select decision from pre-determined options
  – Implicatures are generated in context.

• Pragmatic theory can provide a guide to what is monitored
  – For QIs, this is
    • likely source of relevance,
    • alternatives,
    • speaker’s epistemic state regarding these etc.
Incremental Dynamics
Dynamics meets incremental interpretation

- Interpretation is an information update process.
- Rich shared information structures
- Includes not only information to satisfy presuppositions but also information about likely *source of relevance* of utterance.
  - Describe using ‘Question Under Discussion’ (QUD).
  - No commitment to specific rhetorical structure in dialogue (cf Ginzburg 2012).
Dynamics meets incremental interpretation

- Incrementalism says that automatic processes take linguistic input together with information in utterance situation to yield (anticipatory) hypotheses about interpretation.

- Interpretation involves updating shared information.
Dynamics meets incremental interpretation

• Incrementalism says that automatic processes take linguistic input together with information in utterance situation to yield (anticipatory) hypotheses about *shared information update*. 
A History of Negation Research

• Negation is difficult but easier in context
  – For decades, psycholinguistic research has shown that processing negation is hard (takes longer, more errors) but it gets easier with context
  – Wason (1967), Clark & Chase (1972),…

• Processing widely assumed to proceed via the argument of negation:
  – John didn’t cook the spaghetti
A History of Negation Research

• Negation is difficult but easier in context
  – For decades, psycholinguistic research has shown that processing negation is hard (takes longer, more errors) but it gets easier with context
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• Processing seems to proceed via the argument of negation:
  – John didn’t cook the spaghetti

  ➜ [John cooked the spaghetti]
A History of Negation Research

• Negation is difficult but easier in context
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  – Wason (1965), Clark & Chase (1972),…

• Processing seems to proceed via the argument of negation:
  – John didn’t cook the spaghetti
    ➢ Not [John cooked the spaghetti]
A History of Negation Research

• Truth-functional approaches to negation (Clark & Chase 1972; Kaup et al 2006, 2007) seek to account for cost/delay in terms of extra step of embedding under negation.
  – First represent the argument of negation, then 'negate' it.

• ‘Contextualist’ approaches seek to account for cost/delay in terms of the need for a context for negation (Wason 1965, etc.)
<table>
<thead>
<tr>
<th>Sentence</th>
<th>Picture match</th>
<th>Picture mismatch</th>
<th>Picture unrelated</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) “The eagle was flying”</td>
<td><img src="image1.png" alt="Eagle" /></td>
<td><img src="image2.png" alt="Bird" /></td>
<td><img src="image3.png" alt="Umbrella" /></td>
</tr>
<tr>
<td>(2) “The eagle was flying”</td>
<td>Yes!</td>
<td>Yes!</td>
<td></td>
</tr>
<tr>
<td>(3) “The eagle was flying”</td>
<td>No!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Advantage for ‘matching’ image with positive sentences
Kaup et al 2006, 2007

- At short SOA, advantage for ‘mismatch’ image for negative sentences
- At longer SOAs, advantage for match image.
An Incremental-Dynamic Perspective
Tian, Breheny & Ferguson (2010)

• Incremental processes probabilistically establish QUDs for utterance

• Assume: Without any further contextual information, the most likely QUD for a negative sentence is the positive polar question.
An Incremental-Dynamic Perspective
Tian, Breheny & Ferguson (2010)

• I.e. for ‘The bird is not in the air’, the QUD is whether the bird is in the air.

Exceptions like, ‘John is not happy’ (vs. not sad) based on things like frequency.
A Dynamic Perspective
Tian, Breheny & Ferguson (2010)

• Assume: Situational representations (e.g. ‘simulations’) for context include source of relevance/QUDs.
  – I.e. some representation that means an answer to the QUD would be desirable.
Rejection or Context Accommodation?

<table>
<thead>
<tr>
<th>Clefted:</th>
<th>Match</th>
<th>Mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>It was Jane who didn’t cook the spaghetti</em></td>
<td>![Match]</td>
<td>![Mismatch]</td>
</tr>
<tr>
<td>Non-cleft:</td>
<td>![Match]</td>
<td>![Mismatch]</td>
</tr>
<tr>
<td><em>Jane didn’t cook the spaghetti</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rejection or Context Accommodation?

- Manipulate QUD using clefting. Keep assertive content the same.
  - For clefted items, presupposition is ‘Someone didn’t cook the spaghetti’, assume QUD is ‘Which person didn’t cook the spaghetti’

- Assume cleft items lead to accommodation of a negative presupposition/QUD.

- Predictions at short SOA (250ms):
  - Kaup et al: $RT_{\text{mismatch}} < RT_{\text{match}}$ for both conditions
  - Tian et al: Interaction. $RT_{\text{mismatch}} > RT_{\text{match}}$ for cleft condition

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<tr>
<td><em>Jane didn’t cook the spaghetti</em></td>
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<td></td>
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</tbody>
</table>
John didn’t iron his shirt.
SOA = 250ms
It was John who didn’t iron his shirt.
SOA = 250ms or
Tian et al (2010)

![Bar chart showing reaction times for NegCleft, NegNonCleft, AffmCleft, and AffmNoncleft conditions. The chart indicates that NegCleft and NegNonCleft have significantly longer reaction times compared to AffmCleft and AffmNoncleft. The data is from Tian et al (2010).]
Interim Summary

• We have some evidence that participants spontaneously accommodate source of relevance even for decontextualised experimental items.

• But positive context seems to be represented before negative state of affairs?

• Can negative content find representation in the same timecourse as positive?
Move to Visual World

• Minimise secondary cost of negative viz a viz affirmative.

• Infer what state of affairs supports a sentence:
  – For affirmative, access relevant properties of soa from an interpretation of sentence structure.
    • 'John ironed the shirt'
  – For negative, an extra step of inference:
    • 'John didn't iron the shirt'
Context accommodation on-line (Tian et al. 2016)

2 (polarity) by 2 (cleft) within design. 36 participants

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Affm</td>
<td>Matt has shut his dad’s window.</td>
<td>It is Matt who has shut his dad’s window.</td>
</tr>
<tr>
<td>Neg</td>
<td>Matt hasn’t shut his dad’s window.</td>
<td>It is Matt who hasn’t shut his dad’s window.</td>
</tr>
<tr>
<td></td>
<td>Simple</td>
<td>Cleft</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------</td>
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</tr>
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<td><strong>QUD</strong></td>
<td><em>Has Matt shut his dad's window?</em></td>
<td><em>Who has shut their dad's window?</em></td>
</tr>
<tr>
<td><strong>Neg</strong></td>
<td>Matt hasn’t shut his dad’s window.</td>
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QUDs, Negation and Clefting

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<tbody>
<tr>
<td><strong>Affm</strong></td>
<td>Positive sentence</td>
<td>Positive sentence</td>
</tr>
<tr>
<td><strong>QUD</strong></td>
<td>Positive QUD</td>
<td>Positive QUD</td>
</tr>
<tr>
<td><strong>Neg</strong></td>
<td>Negative sentence</td>
<td>Negative sentence</td>
</tr>
<tr>
<td><strong>QUD</strong></td>
<td>Positive QUD conflict</td>
<td>Negative QUD</td>
</tr>
</tbody>
</table>
Predictions

- For simple sentences, more interference from the competitor for negative compared to positive sentences. 
  - Due to positive QUD accommodation
- For cleft sentences, no more interference for negatives than positive sentences.
- Negation is incorporated incrementally: more looks to target before onset of noun, at least in the cleft case.
Target advantage: $\ln(p(\text{target})/p(\text{competitor}))$

Positive
Negative

Simple

Cleft
Discussion

• Cleft condition shows that when we control for QUD accommodation, the time course for processing negatives is the same as positives.

• Simple negatives take longer to process than their positive counterparts due to QUD interference.

• Our results show that QUDs are incorporated incrementally
  – Negation also! - Rather than after the argument is processed
A Role for Context in QUD accommodation
Verification Task
Clark & Chase (1972), Carpenter & Just (1975)

The star is above the cross

True Affirmative (TA)
Verification Task
Clark & Chase (1972), Carpenter & Just (1975)

The cross is above the star

False Affirmative (FA)
Verification Task
Clark & Chase (1972), Carpenter & Just (1975)

The cross is not above the star

True Negative (TN)
Verification Task
Clark & Chase (1972), Carpenter & Just (1975)

The star is not above the cross

False Negative (FN)
Verification Task
Clark & Chase (1972), Carpenter & Just (1975)

- All studies find ME of polarity

- Many studies find interaction effect:
  - TA < FA < FN ≤/≈ TN

- Insight: Pattern can be explained as joint effect of ‘negation time’ and ‘verification time’.
Verification Procedure - TN
Clark & Chase (1972), Carpenter & Just (1975)

- Translate sentence and picture into propositional format
- Set response at default, ‘True’
- Compare most embedded representation. Switch to ‘False’ if mismatch.
- Compare next most embedded operator, switch response if mismatch.
- RT reflects number of switches

- Image = A(s,c); S = ¬A(c,s)
- A(s,c) vs. A(c,s)____FALSE!
- Aff. vs. Neg______TRUE!
Verification Procedure - FN
Clark & Chase (1972), Carpenter & Just (1975)

- Translate sentence and picture into propositional format
- Set response at default, ‘True’
- Compare most embedded representation. Switch to ‘False’ if mismatch.
- Compare next most embedded operator, switch response if mismatch.
- RT reflects number of switches

- Image = A(s,c); S = ¬A(s,c)
- A(s,c) vs. A(s,c)___no switch
- Aff. vs. Neg_____FALSE!
Verification Procedure?

- No real reason why this should be the procedure.
- FA and FN have the same amount of switches but different latencies. (FA < FN)
- Need extra assumption that ‘negation time’ is longer than ‘falsification time’
  - No motivation for this.
  - In fact, it seems easier to compare polarities (1 bit) than embedded propositions (2-3 bits)
Doing Verification Task Straight

• Task QUD: $\text{True(utterance content)}$
• Assume extra costs to infer negative state.
• Assume there is a greater cost for falsification than verification.
  – Given data for positives.

• Predict only MEs of polarity and TV!
  – E.g. $\text{TA} < \text{FA} \neq \text{TN} < \text{FN}$
‘Classic’ Strategy?

• The classic interaction effect is not always obtained.

• In C&C and C&J and elsewhere, studies are very long and repetitive with very long training phases (training data not analysed).

• We conjecture that the interaction is the result of participant strategies.
‘Classic’ Strategy Results from Dynamic Pragmatic Processes

• Task QUD: ?True (utterance content)
  – So, participants need to interpret the utterance prior to task.

• As per above studies, assume that participants project positive polar question as most likely QUD.
  – I.e. ?S(s,c) for both ‘The star is above the cross’ and ‘The star is not above the cross’.
'Classic’ Strategy Results from Dynamic Pragmatic Processes

• We conjecture that there is an interference from the utterance QUD in this task.

• As a result, participants form a strategy to respond to utterance QUD and, in the case of negation, more or less consciously switch responses.
Verification Strategy for ‘Classic’ Interaction Pattern: TN

- ‘The cross is not above the star’
- Project QUD: ?A(c,s)
- Answer ‘no’ by inferring situation of image supports negative proposition. (Falsification time)
- Switch answer because sentence is negative (Negation Time).
Verification Strategy for ‘Classic’ Interaction Pattern: FN

- ‘The star is not above the cross’
- Project QUD: ?A(s,c)
- Answer ‘yes’ by inferring situation of image supports positive proposition. (Verification time)
- Switch answer because sentence is negative (Negation Time).
‘Classic’ Strategy?

- On our account, both TN and FN involve extra ‘negation time’ due to strategy.
- Assuming falsification time is longer than verification time, FA > TA and TN > FN.
- We explain both the ME of negation and the interaction in classic studies in terms of indirect strategy.
(Tian & Breheny, 2015, *in prep*)

- We predict that participants change their behaviour in the course of an experiment from simple ME pattern to interaction pattern.

- We predict that altering the utterance QUD will eliminate this strategy.
### Design

<table>
<thead>
<tr>
<th>Context</th>
<th>Sentence</th>
<th>Image</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Item</td>
<td>The banana is peeled</td>
<td><img src="image1.png" alt="Image of a peeled banana" /></td>
<td>TA</td>
</tr>
<tr>
<td></td>
<td>The banana isn't peeled</td>
<td><img src="image2.png" alt="Image of an unpeeled banana" /></td>
<td>TN</td>
</tr>
<tr>
<td>2 Item</td>
<td>The banana is peeled</td>
<td><img src="image3.png" alt="Image of a peeled banana" /></td>
<td>TA</td>
</tr>
<tr>
<td></td>
<td>The banana isn't peeled</td>
<td><img src="image4.png" alt="Image of an unpeeled banana" /></td>
<td>TN</td>
</tr>
</tbody>
</table>

2*2*2 Mixed design – Context a between groups factor
<table>
<thead>
<tr>
<th>Context</th>
<th>Sentence</th>
<th>Task QUD</th>
<th>Utterance QUD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Image</td>
<td>The banana isn’t peeled</td>
<td>Is it true that the banana isn’t peeled?</td>
<td>Is the banana peeled</td>
</tr>
<tr>
<td>2 Image</td>
<td>--------/-----------</td>
<td>----------/----------</td>
<td>Which one isn’t peeled</td>
</tr>
</tbody>
</table>
Methods and Results

• Sentence-picture verification (80 participants, 146 trials in total).
• Sentence presented first.
• Half the participants saw one-item pictures and had simple sentences as fillers, while the other half saw two-item pictures and had cleft sentences as fillers.
• Both groups had the same experimental sentences.
Methods and Results

- Overall we found a main effect of polarity and truth value in both 1-item and 2-item groups (Fs>16.85, ps<0.01).
- Combining 1 and 2-item groups, there was a significant 4 way (2(picture context) x 2(half) x2(polarity) x 2(truth value)) interaction (F(1,78)= 10.41, p=0.002).
- We found a training effect in the one-item group: interaction only emerged in the second half of the experiment (F (1,39) =6.70, p=0.01).
  - No differences in 2-item group between stages.
• The predicted change of behaviour occurred in 1-picture context.
  – Participants got relatively better at FN items.

• No change in 2-picture context.
Discussion

• In a verification task, there are two stages:
  i. interpret the sentence,
  ii. judge if it is true.

• QUD accommodation for stage (i) explains a lot of the difficulty in verification tasks.
  – Difficult to ignore or ‘turn off’ QUD accommodation in spite of the actual task demand.

• Suggests QUD accommodation ‘automatic’
Interim Summary from Negation Research

• QUD accommodation occurs in the same timecourse as inferring sentence content.

• QUD accommodation is automatic
Summary from Negation Research

- Different factors affect QUD accommodation
  - Sentence form/semantic properties
    - clefting, focus (watch this space)
  - Situational context
  - Frequency
    - Mary is not sad vs. Mary is not happy
QUDs in Language Processing

- QI and Negation studies show evidence for incremental access to inferences about likely source of Relevance.

- Do we really represent source of Relevance in terms of QUDs?

- What does it mean to represent a QUD?
- What do QUDs have to do with question interpretation?
  - What is the difference between:
    - Did Matt shut his dad’s window?
    - Did Matt not shut his dad’s window?
Aims

• Explore the time course of processing for positive and negative questions using visual world paradigm.

• Explore time course of response particles, ‘yes’ and, ‘no’.
Our experiment – visual world eyetracking

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Answer</th>
</tr>
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<tbody>
<tr>
<td><strong>Positive</strong></td>
<td>Has John ironed his father’s shirt?</td>
<td>Yes, he has.</td>
</tr>
<tr>
<td><strong>High-neg</strong></td>
<td>Hasn’t John ironed his father’s shirt?</td>
<td>No, he hasn’t</td>
</tr>
<tr>
<td><strong>Low-Neg</strong></td>
<td>Has John not ironed his father’s shirt</td>
<td></td>
</tr>
</tbody>
</table>
"Has John ironed his father's shirt?"
"Yes, he has."
"No, he hasn't."
Our experiment – visual world eyetracking

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<td>Low-Neg</td>
<td>Has John not ironed his father’s shirt</td>
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Our experiment – visual world eyetracking

- 42 experimental sentences (3 conditions, 14 each), plus 14 positive fillers.
- 1.5 second preview time. Then the audio starts. Between the question and the answer, there is a 1.5 second gap.
- Participants press a key that corresponds to the correct picture after they’ve heard the answers. The trial is terminated as soon as they press the response.
- The eye movements and responses are recorded.
Results – Question phase
Results – Question Phase

Polar Questions: Log (look to positive)/(look to negative)

- Has John
- Hasn’t John
- Ironed
- His
- Father’s
- Shirt
- [pə]_fist 750ms

Graph showing the logarithmic ratio of looking to positive over looking to negative over time in ms (resynchronized by word).
Results – Early timecourse
Comparison with positive assertion

Note: Different task for Assertion data! But same items

Tian, Ferguson and Breheny, (2016), Language Cognition and Neuroscience
• Delay in bias formation implies prolonged inspection of negative state of affairs for positive questions.
• Delay in bias formation implies prolonged inspection of positive and negative state of affairs for high-neg questions.
• Delay in bias formation implies prolonged inspection of positive and negative state of affairs for low-neg questions.
Results – Late timecourse
Question Phase: Positive

Positive polar question: Log ratios (look to positive)/(look to negative)
Question Phase: High neg

High neg polar question: Log ratios (look to positive)/(look to negative)

Time in ms (resynchronized by word)

[

( *)[n]

-0.4 -0.2 0.0 0.2 0.4 0.6

Hasn't John ironed his father's shirt

(*)
Question Phase: Low neg

Low neg polar question: Log ratios (look to positive)/(look to negative)

Time in ms (resynchronized by word)
Results for each condition

Mixed effect models on natural log ratios of looks to the positive and negative pictures. The looks are averaged per trial for a region. The random effects are subjects and item, the fixed effect is condition.

<table>
<thead>
<tr>
<th>Ln(positive/negative)</th>
<th>Period</th>
<th>Positive</th>
<th>High-neg</th>
<th>Low-neg</th>
<th>Pos</th>
<th>High Neg</th>
<th>Low Neg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noun</td>
<td>0.5</td>
<td>0.22</td>
<td>0.13</td>
<td>p&lt;0.001*</td>
<td>p=0.06*</td>
<td>n.s.</td>
</tr>
<tr>
<td></td>
<td>gap 0-750ms</td>
<td>0.5</td>
<td>0.21</td>
<td>0.02</td>
<td>p=0.01</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td></td>
<td>gap 750-1500ms</td>
<td>0.24</td>
<td>0.2</td>
<td>-0.08</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
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</table>
Results comparing three conditions
Results – Question Phase

![Graph showing polar questions: Log (look to positive)/(look to negative)]
Results – Question Phase

![Graph showing polar questions log (look to positive)/(look to negative)]
Results – comparing pos, high and low neg

Mixed effect models on natural log ratios of looks to the positive and negative pictures. The looks are averaged per trial for a region. The random effects are subjects and item, the fixed effect is condition.

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<th>Ln(positive/negative)</th>
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<th>pos vs. high</th>
<th>pos vs. low</th>
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</tr>
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<tr>
<td></td>
<td>Noun</td>
<td>0.5</td>
<td>0.22</td>
<td>0.13</td>
<td>p=0.10</td>
<td>p=0.049*</td>
<td>p=0.73</td>
</tr>
<tr>
<td></td>
<td>gap 0-750ms</td>
<td>0.5</td>
<td>0.21</td>
<td>0.02</td>
<td>p=0.09</td>
<td>p=0.01*</td>
<td>p=0.42</td>
</tr>
<tr>
<td></td>
<td>gap 750-1500ms</td>
<td>0.24</td>
<td>0.2</td>
<td>-0.08</td>
<td>p=0.71</td>
<td>p=0.09</td>
<td>p=0.18</td>
</tr>
</tbody>
</table>
Summary Q-Phase

- Experimental procedure allows for rapid discrimination of positive and negative states.
  - No cost of inferring negative soa.

- We show rapid attention to both positive and negative images in all question forms.

- Late bias to positive image for Positive and High Neg
  - Surprising given equal likelihood for upcoming 'yes'/‘no' answer
Follow up – control for task effect

• Experimental procedure allows for rapid discrimination of positive and negative states.
  – No cost of inferring negative soa.

• We show rapid attention to both positive and negative images in all question forms.

• Late bias to positive image for Positive and High Neg
Follow up – 'Look and listen' to control for task effect

• Same materials as the first study.

• Instead of having to click the picture corresponding to the answer, in the followup, the participants just listen to the question-answer pairs and look at the screen.

• A third of the trials are followed by a comprehension question to check that the participants are paying attention.
'Look and listen' follow up – similar results

Log ratios (look to positive)/(look to negative)

- time in ms (resynchronized by word)
- vertical axis: Ln(p(positive)/p(negative))
- horizontal axis: time in ms
- lines represent positive, high-neg, and low-neg
'Look and listen' follow up – similar results

<table>
<thead>
<tr>
<th></th>
<th>ironed</th>
<th>his</th>
<th>father’s</th>
<th>shirt?</th>
<th>gap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compared to zero</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>positive</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>positive bias, p&lt;.001</td>
<td>positive bias, p=0.01</td>
</tr>
<tr>
<td>high-neg</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>trending positive bias, p=.06</td>
<td>n.s.</td>
</tr>
<tr>
<td>low-neg</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>positive bias, p = .02.</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Pairwise comparison</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ln-ratio positive significantly higher than low-neg (p=.03)</td>
<td>Ln-ratio positive high/neg significantly higher than low-neg (p=.03)</td>
</tr>
</tbody>
</table>
'Look and listen' follow up – similar results

Log ratios (look to positive)/(look to negative)

-0.4 0.0 0.2 0.4 0.6

Has John Hasn't John Has John not

ironed his father's shirt

* [gap]

positive high-neg low-neg

-0.4 0.0 0.2 0.4

time in ms (resynchronized by word)
Summary Q- Phase

• Experimental procedure allows for rapid discrimination of positive and negative states.
  – No cost of inferring negative soa.

• We show rapid attention to both positive and negative images in all question forms.

• Late bias to positive image for Positive and High Neg
Discussion

• Evidence suggests processing question form can evoke representations of both positive and negative states

• Late positive bias for positive question in spite of equal likelihood of 'yes'/'no' in answer phase.

• Suggests positive questions strongly evoke representations of positive state of affairs.
Discussion

• Polar question study consistent with our conjecture that effects of negation in lab could be due to projection of positive 'QUD'.
But what could explain late bias?

• Frequency of response?

• Traditional taxonomy of usage (Gunlogson & Buring, 2000; Sudo, 2013)?

• State of inquiry
CORPUS STUDY
## Percentage of different polar Qs

### Polar Questions

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>3733</td>
<td>96.21%</td>
</tr>
<tr>
<td>High neg (outside reading)</td>
<td>132</td>
<td>3.40%</td>
</tr>
<tr>
<td>High neg (inside reading)</td>
<td>6</td>
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</tr>
<tr>
<td>Low neg</td>
<td>9</td>
<td>0.23%</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>3880</td>
<td>100%</td>
</tr>
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</table>

### Declarative polar questions

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<tbody>
<tr>
<td>Positive</td>
<td>1016</td>
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</tr>
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### All

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<td></td>
</tr>
</tbody>
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#### Declarative polar questions

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#### Total assertions:

- Total: 101,573
- Polar Q: 5006
- Non-opinion + Opinion: 75145
- Total statements: 101,573

Switchboard Dialog Act Corpus:
Polar Q

75145 statement non-opinion + 26428 statement opinion
# Probabilities of $P$ vs. $\neg P$ answers

<table>
<thead>
<tr>
<th></th>
<th>$P$</th>
<th>$\neg P$</th>
<th>Unsure</th>
<th>$P : \neg P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>54%</td>
<td>26%</td>
<td>20% *</td>
<td>2 : 1</td>
</tr>
<tr>
<td>High-neg Out</td>
<td>58%</td>
<td>8%</td>
<td>33%</td>
<td>6.6 : 1</td>
</tr>
<tr>
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<td>17%</td>
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<tr>
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<td>11%</td>
<td>44%</td>
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* Sample estimate
## Probabilities of $P$ vs. $\neg P$ answers

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Does not square with late bias results.

Difference not apparent in eye-gaze data
### Probabilities of $P$ vs. $\neg P$ answers

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</table>

Does not square with late bias results.

No negative bias in gaze data
What questions do we use?

<table>
<thead>
<tr>
<th>evidence</th>
<th>belief/opinion</th>
<th>NA</th>
<th>positive</th>
<th>negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>positive</td>
<td>High neg</td>
<td></td>
<td>Positive (marked ironic tone &amp;/or NPI)</td>
</tr>
<tr>
<td>positive</td>
<td>positive</td>
<td></td>
<td>positive</td>
<td>positive (marked by 'really', 'actually')</td>
</tr>
<tr>
<td>negative</td>
<td>Low neg</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

(Gunlogson & Büring, 2000), Sudo (2013)
## What questions do we use?

<table>
<thead>
<tr>
<th></th>
<th>belief/opinion</th>
<th>Neutral</th>
<th>positive</th>
<th>negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td><strong>positive</strong></td>
<td>High neg</td>
<td>Positive (marked ironic tone &amp;/or NPI)</td>
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(Gunlogson & Büring, 2000), Sudo (2013)
What questions do we use?

• Information seeking:
  – Have you been to Geneva before?

• No prior expectation, no evidence
**What questions do we use?**

<table>
<thead>
<tr>
<th>belief/opinion</th>
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<th>negative</th>
</tr>
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<td></td>
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</tbody>
</table>

(Gunlogson & Büring, 2000), Sudo (2013)
What questions do we use?

- Information seeking:
  - Have you been to Geneva before?

- Please confirm what I have inferred from positive evidence:
  - *(saw you after Christmas): Have you put on weight?*
What question do we use?

- High-neg where speaker has positive belief/opinion, neutral evidence (cf. Romero & Han, 2004).
  - Explains gaze bias?
- Unmarked positive questions in cases where speaker has neutral belief/opinion.
  - Epistemic stance does not always explain bias
What question do we use?

<table>
<thead>
<tr>
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</table>

- Unmarked positive questions in cases where speaker has neutral or positive evidence.
  - Sufficient to explain stronger positive bias?

- Neutral questions less marked
Speculation – State of Inquiry

• \(?P\) and \(?\neg P\) have same denotations.

• *Wondering about* \(P\) is different from *Wondering about not* \(P\)
  – Due to ‘confirmation bias’, we prioritise search for confirming evidence for the target of inquiry.
  – Search for disconfirming evidence has lower priority.

• Cf. Carnap on Questions vs. Topics
  • Russell (2006)
thanks to...

Heather Ferguson

Napoleon Katsos

Chao Sun
For simple positives, looks to target but not competitor rises after the verb.

For simple negatives, looks to both rises, and they only start to diverge in “dad’s” region.

In post-verb pause and “his” region, as well as “someone’s” region, there is a significant difference between simple positive and simple negative (paired t-test on Ln(p(target)/p(competitor)), all ts>2.8, all ps<0.01).
- cleft positive and negatives behaved the same immediately after the verb (all ps>0.4).
- Looks to both target and competitor rises, but start to diverge in “someone’s” region.
ANOVA shows a significant polarity * cleft interaction in a fixed post verb region.

\[ F_1(1,35)=8.19, \quad p=0.007. \]
\[ F_2(1,38)=6.16, \quad p=0.018. \]
Time course analysis: 100ms time slices post verb
Asterisks indicates that the value is significantly different from zero by both subject and item.
For simple, target bias became significant in the 9th time slice (trending in 7th and 8th).
• Time course analysis: 100ms time slices post verb
• For cleft target bias became significant in the 5th time slice for positives, and in the 6th for negatives (trending in the 5th).
• Importantly, target bias was formed faster in cleft negatives than simple negatives, despite the fact that cleft negatives are structurally more complex.
No ‘Inhibition’ in Looks to verb-able objects

Cf MacDonald & Just 1989