Scalar implicature processing: slowly accepting the truth (literally)

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Sinn und Bedeutung 19 - September 15-17, Göttingen
The overall project

• Comparing
  • Scalar implicatures
  • Presuppositions
The overall project

• Three perspectives
  • Processing
  • Acquisition
  • Language disorders
Today

• Zooming in on
  • Scalar Implicatures
  • Processing
Today

• *Measure*: Reaction Time
Today

• Investigating the processing of
  • Direct Scalar Implicatures (DSIs)
  • Indirect Scalar Implicatures (ISIs)
Today

- Comparing processing of
  - Direct Scalar Implicatures (DSIs)
  - Indirect Scalar Implicatures (ISIs)
- *terminological distinction treated uniformly*
Direct SIs

(1) John sometimes went to the movies

\( \sim \) John didn’t always go to the movies
Indirect SIs

(2) John didn’t always go to the movies
\[ \sim \text{John sometimes went to the movies} \]
The processing of SIs

• SIs and the 'experimental turn'
  (See Chemla and Singh 2014)

• Processing in particular
The processing of DSIs

• The literature has mostly focused on DSIs
• Reaction Time experiments
• DSIs found to be associated with a delay
  (Bott and Noveck 2004, Bott et al 2012, Chemla and Bott 2013, Cremers and Chemla 2014)
The processing of ISIs

- ISIs have been studied less
- Two studies with contrasting results
The processing of ISIs

- ISIs associated with a delay in RTs
  (Cremers and Chemla 2014 - C&C)

- ISIs not associated with a delay
  (Romoli and Schwarz 2014 - R&S)
Questions for today

(A) Do RTs yield uniform evidence for a delay of SIs?
(B) Are DSIs and ISIs uniform in processing?
Our experiment

• Investigating these two questions

• Comparing the processing of DSIs and ISIs
Our answers

(A) Do RTs yield uniform evidence for a delay of SIs?
Our answers

(A) Do RTs yield uniform evidence for a delay of SIs?

• NO!
(A) Do RTs yield uniform evidence for a delay of SIs?

• NO!

• it depends on whether we look at acceptance or rejection responses
Implications

This undermines the idea of SIs being associated with a delay in RTs
Our answers

(B) Are DSIs and ISIs uniform in processing?
(B) Are DSIs and ISIs uniform in processing?

• YES!
Our answers

(B) Are DSIs and ISIs uniform in processing?

• YES!
  • they yield the same pattern of responses
Implications

This supports uniform accounts of DSIs and ISIs
Today

- Scalar implicatures and their derivation
- Processing of DSIs and ISIs
- The contrasting results on ISIs
- Experiment
- Results, Implications, Further directions
Direct and Indirect Scalar Implicatures
Direct and indirect scalar implicatures

- (1) John sometimes went to the movies
  \( \sim \text{John didn’t always go} \)

- (2) John didn’t always go to the movies
  \( \sim \text{John sometimes went} \)
Cancellation

- Scalar implicatures can be cancelled
- One of the hallmarks of SIs
Cancellation

(1) John sometimes went to the movies... In fact, he always did!

(2) John didn’t always go to the movies... In fact, he never went!
Compare with entailments

(4) John and Mary went to the movies last week

\[\sim John \text{ went to the movies last week}\]
Compare with entailments

(4) John and Mary went to the movies last week…#In fact John didn’t go!
In sum

• Theoretical Goals:
  • explain how DSIs and ISIs arise
  • predict in what circumstances these inferences occur
  • Allow for cancellation
A sketch of SI derivation
Deriving SIs: the Gricean algorithm

- Hear an utterance
- Compare with an alternative utterance
- If competitor is stronger than the assertion, conclude that competitor is false
How do we obtain competitors?

- replace certain words in the assertion
  - <some, all>
  - <sometimes, always>
  - ...

Deriving direct SIs

• (1) John *sometimes* went to the movies
• (2) John *always* went to the movies

→ John didn’t always go to the movies
Deriving indirect SIs

• (1) John didn’t **always** go to the movies

• (2) John didn’t **sometimes** go to the movies

\[ \sim \text{It’s false that John didn’t sometimes go to the movies} \]
\[ = \text{John went sometimes} \]
A unified approach

• A scalar implicature algorithm
• A theory of competitors
• A unified account of direct and indirect SIs
Cancellation

• How do we allow for cancellation of SIs?
The data again

(1) John went to the movies sometimes...in fact he always went!
Cancellation

• The speaker uttered the competitor
• She cannot think that the competitor is false
• The scalar implicature is cancelled/not derived
In sum

• A unified account of direct and indirect SIs
In sum

- A unified account of direct and indirect
- How SIs can be absent
In sum

- A unified account of direct and indirect
- How SIs can be absent
- Expectation of uniformity
Processing
The processing of SIs

• Processing of SIs studied extensively

• DSIs found to be associated with a delay in Reaction Times (Bott and Noveck 2004, Chemla and Bott 2013, Bott et al 2012, Cremers and Chemla 2014)
Parenthesis

• Other methodologies (e.g., eye-tracking, self-paced reading) have given rise to more mixed results (Huang and Snedeker 2009, Breheny et al. 2006 vs. Grodner et al 2012, Degen and Tanenhaus 2011, Breheny et al 2013)
Parenthesis

• Other methodologies (e.g., eye-tracking, self-paced reading) have given rise to conflicting results (Huang and Snedeker 2009, Breheny et al. 2006 vs. Grodner et al 2012, Degen and Tanenhaus 2011, Breheny et al 2013)

• We focus on RTs for today

• Ultimately the question is how to integrate results from different methodologies
The processing of ISIs

- Two studies with RTs on ISIs
- Two (seemingly) contrasting results
The processing of ISIs

- ISIs associated with a delay in RTs (C&C)
- ISIs not associated with a delay (R&S)
What’s coming next

• Briefly review these two experiments
• Point to a crucial difference motivating the present experiment
Goal

- Comparing RTs of ISIs vs. DSIs
- Using and refining the classical Bott and Noveck 2004’s paradigm
Their main point

• Differences between DSIs and ISIs could be due to superficial differences
• The presence of negation
• Other confounds
First experiment

• Some elephants are mammals
   \( \sim \) not all elephants are mammals

• SI reading = False

• No SI/Literal reading = True

• Same methodologies as Bott and Noveck (2004) exp 3; also Chemla and Bott 2013, Bott et al 2012
First experiment

- *False* associated with a SI interpretation
- *True* associated with a Literal interpretation
First experiment

Comparing RTs of True/Literal vs False/SI responses
Replicate previous B&N’s finding that false responses are slower than true
Results

Interpretation: DSIs are associated with a delay
Results

However - they find the opposite pattern with ISIs
Interpretation: ISIs are not associated with a delay?
Discussion

• A potential conclusion
  • DSIs and ISIs’ processing profiles are different
Discussion

• C&C’s
  • The difference might have some other source
  • Go on to explore this in Experiment two
Second experiment

- Same type of sentences
- Effect of training of participants
- Bott and Noveck 2004 experiment 1
Second experiment

• A group of participants trained to literal interpretations (Literal/true)

• The other trained scalar interpretations (SI/false)
Second experiment

Literal Participants were **faster** than SI ones

**Interpretation:** SIs associated with a delay
Results

Replicating B&N’s effect for DSIs
Results

This time, same pattern for ISIs
Discussion

The effect of training is the same for DSIs and ISIs.

ISIs have the same processing profile as DSIs.
Discussion

Both DSIs and ISIs associated with a delay
Goal

• Comparing RTs of
  • ISIs
  • Presuppositions
Participants, material and Procedure

• Sentence picture matching task
• Pictures representing a character and her schedule
Participants, material and Procedure

- Participants chose among three pictures
- One target, one distractor, and one covered

(Huang et al 2013, Romoli et al 2011)
Instruction

one and only one picture matches the sentence
Design

• 2 x 2
  • Type of trigger
    • \textit{stop} vs. \textit{always}
  • Inference?
    • SI/Ps or Literal
Design

• 2 x 2
  • Type of trigger
    • stop vs. always
  • Inference?
    • SI/Ps or Literal
Always-SI condition

Distractor       Target

Jacob didn't always eat strawberries last week.
Emma didn't always go to the library last week.
Comparison

• Comparison

• **Target choices** in SI condition

• **Target choices** in Literal condition
Comparison

John didn’t always go to the movies

\[ \sim John \text{ sometimes went} \]
Results and discussion
Dependent variables

- Response rate
- Reaction times of target choices
Main effect of inference

(No interaction)
• Main effect of inference
• (No interaction)
Response Data

- Target choices much higher for SI targets
Response Data

% of Target Choices

Inference

always:Inf always:NoInf stop:Inf stop:NoInf

Loc
Inf
NoInf

SI
Response Data

- **% of Target Choices**
  - always:Inf
  - always:NoInf
  - stop:Inf
  - stop:NoInf

- **Loc**
  - Inf
  - NoInf

- **Inference**

- **Literal**
RTs

- Comparing RTs of Target choices
• Main effect of Inference
• (no interaction)
We used their model SI.
We used the TORCH library for inference.

Inference

RT for Target Choices

ms

10000

5000

Inf

NoInf

expression

- always

- stop

Literal
• Target choice in the SI condition was faster.
Results

• Computing ISIs does not appear to be associated with a delay

• (Same pattern for ISIs and Presuppositions)
Discussion

• C&C’s results
  • ISIs, like DSIs, associated with a delay

• R&S’s result:
  • ISIs not associated with a delay
Discussion

• How do we reconcile these results?
A difference

- C&C focuses on RTs for rejection responses based on SIs
  - as compared to acceptance of the literal
A difference

• R&S focuses on acceptance responses consistent with SIs
  • as compared to acceptance of literal
Next step

• Comparing DSIs and ISIs on both acceptance and rejection responses
Parenthesis

• In R&S and present experimental paradigm:
  • Rejection = Covered Picture
  • Acceptance = Target Picture
Acceptances comparison

Literal

\[ \text{John didn't always go to the movies} \]

\[ \sim \text{John sometimes went} \]
Rejections comparison

- A comparison related to B&N/C&C’s one
  - Rejection responses in Literal
  - Rejection responses in False
Rejections comparison

Literal

False

John didn’t always go to the movies

\[ \sim \text{John sometimes went} \]
Rejections comparison

Literal > False

Expectation based on B&N and C&C
In sum

- A novel set of comparisons
  - Acceptances comparison
  - Rejections comparison
Experiment
Goal

• Comparing ISIs and DSIs

• Both Target and Covered box choices
Participants

- 35 native speaker of English
- Macquarie University Undergraduates
Material and Procedure

- Similar design as R&S 2014
- But this time comparing ISIs and DSIs
- Looking at SI, Literal conditions and also false
Material and Procedure

- Participants chose among two pictures
- One target and one covered
Test trials

• 36 test trials
  • (18 always; 18 sometimes)
• 18 controls with always and no negation
  • 6 simple negation controls
• 12 fillers from another experiment
Design

- 2 x 3
- Type of scalar item
  - sometimes vs. always
- Status
  - SI vs Literal vs False
Sometimes-Sl

John sometimes went to the movies

→ John didn’t always go
Sometimes-Literal

John sometimes went to the movies

\[ \sim \text{John didn’t always go} \]
Sometimes-false

John sometimes went to the movies

→ John didn’t always go
John didn’t always go to the movies

~ John sometimes went
Always-Literal

John didn’t always go to the movies

\[ \sim John \text{ sometimes went} \]
Always-false

John didn’t always go to the movies

〜 John sometimes went
Results and discussion
Data Analysis

- Responses were coded as:
  - **Literal**: response justifiable based on literal meaning alone
  - **Scalar**: response compatible with the scalar implicature
Data Analysis

- This cuts across rejection (covered box) and acceptance (overt picture) responses
Sometimes Literal acceptance

John sometimes went to the movies

\(\sim \text{John didn't always go}\)
Sometimes Literal acceptance

John sometimes went to the movies

\[\sim\text{John didn’t always go}\]
Sometimes Literal rejection

John sometimes went to the movies


\rightarrow John didn’t always go
Sometimes Literal rejection

John sometimes went to the movies

\[ \sim John \text{ didn’t always go} \]
Sometimes scalar acceptance

John sometimes went to the movies

\( \sim John \ didn't \ always \ go \)
Sometimes scalar acceptance

John sometimes went to the movies

\(\sim \text{John didn’t always go}\)
Sometimes scalar rejection

John sometimes went to the movies

\( \sim \quad \text{John didn't always go} \)
Sometimes scalar rejection

John sometimes went to the movies

$\sim John \; didn't \; always \; go$
Always Literal acceptance

John didn’t always go to the movies

\[ \sim John \, sometimes \, went \]
Always Literal acceptance

John didn’t always go to the movies
Always scalar acceptance

John didn’t always go to the movies
Always scalar acceptance

John didn’t always go to the movies
Always Literal rejection

John didn’t always go to the movies
Always Literal rejection

John didn’t always go to the movies
Always scalar rejection

John didn’t always go to the movies
Always scalar rejection

John didn’t always go to the movies
Dependent variables

• for both DSI and ISI:
• Choice of Literal vs Scalar responses
• RTs of Literal vs. Scalar responses
Response rate

- Scalar responses for DSI = 77% of the time
- Scalar responses for ISI = 49% of the time
- Significant: DSI > ISI
A difference

- Overall proportion of Scalar interpretations lower for ISIs
- This replicates a similar effect found in R&S
• Main effect of implicature type
• 2x2 Interactions
• Simple effects of Rejection vs Acceptance
- Rejection based on ISIs and DSIs were slower
John didn’t always go to the movies
John didn’t always go to the movies.
- Rejection based on ISIs and DSIs were slower
- consistent with C&C and previous results
Acceptance responses based on scalar were faster for both ISIs and DSIs.
Acceptance SI
John didn’t always go to the movies

![Graph showing the comparison between always and sometimes for CB and Target. The graph includes two bars, one for SI and one for Literal. The SI bar is highlighted with a blue oval.]

![Image of a person and movie nights. The person is surrounded by movie posters and a calendar with days labeled from Monday to Friday.]

SI
Acceptance Literal
John didn’t always go to the movies

Literal
• For ISIs: same result as R&S
• For DSIs: novel result
In sum - the pattern

SI acceptance

<

Literal acceptance

John didn’t always go to the movies
In sum - the pattern

SI acceptance

Literal acceptance

John didn’t always go to the movies

False rejection

Literal rejection
Discussion

• Reconciling C&C and R&S
Discussion

**First result:** rejection choices in Literal conditions were *slower* than those in false condition
Discussion

First result: rejection choices in Literal conditions were slower than those in false condition

Second result: acceptance choices compatible with SI are faster than those only compatible with the literal meaning
We agree with C&C’s methodological point
Rather than playing with regressing factors
We look at the comparison between ISIs and DSIs from a different angle
Implications

Same pattern of delay/non-delay depending on whether we look at acceptance or rejection
Implications

However it is not clear that a SIs are delayed story can explain the full pattern of results
Discussion

**First result**: rejection choices in Literal conditions were slower than those in false condition

**Second result**: acceptance choices compatible with SI are faster than those only compatible with the literal meaning
Discussion

The second result appears incompatible with an account of the first result based on delay in the availability of the SI.
John didn’t always go to the movies

In both cases the literal meaning is true so why should you be faster in the SI-condition?
Back to the questions

(A) Do RTs yield uniform evidence for a delay of SIs?
(B) Are DSIs and ISIs uniform in processing?
Back to the questions

(A) Do RTs yield uniform evidence for a delay of SIs?
NO! - it depends on whether you look at acceptance or rejection responses
(B) Are DSIs and ISIs uniform in processing? YES! - they exhibit the same pattern of responses
Back to the questions

The uniformity between DSIs and ISIs consistent with uniform treatments
Back to the questions

But we need a different story than SIs are delayed for explaining the pattern in acceptance and rejection responses
Explaining the result
Two pragmatic principles

- Interaction between two pragmatic principles
Two pragmatic principles

• (Some version of a) Principle of charity: Construe utterances as true if possible

• Preference for scalar meanings
Hypothesis

• Delay occurs when these two principles conflict
The pattern

SI acceptance < Literal acceptance
In the Literal condition the charity principle is in conflict with the preference for the scalar interpretation.
The pattern

SI acceptance

In the SI condition no conflict between the two principles
The pattern

False rejection < Literal rejection
The pattern

In the Literal condition the charity principle is in conflict with the preference for the scalar interpretation

Literal rejection
The pattern

In the false condition no conflict between the two principles

False rejection
In sum

• The processing profile of SIs with RTs has to do more with a conflict between pragmatic principles

• Rather than a delay associated with SIs
Conclusions
The processing of SIs

- Processing of SIs studied extensively
- DSIs found to be associated with a delay in Reaction Times (Bott and Noveck 2004, Chemla and Bott 2013, Bott et al 2012, Cremers and Chemla 2014)
The processing of ISIs

- ISIs have been studied less and with conflicting results
Our experiment

• Comparing the processing of DSIs and that of ISIs

• looking at both acceptance and rejection responses
Conclusions

- Reconciling the conflicting results
- The difference appears to be in terms of acceptance and rejection
Conclusions

• Acceptance consistent with SI is faster than acceptance consistent only with literal meaning
Conclusions

• Rejection based on SI is slower than rejection based on the literal meaning alone
Implication

• DSIs and ISIs behave uniformly as expected by standard accounts
Implication

- But then no evidence that scalar implicatures are associated with a delay in RT
Proposal

- The delay arises because of conflict between pragmatic principles
Conclusions & further directions

- Remaining questions
  - explaining B&N and C&C effects with the conflicts of principles story
Conclusions & further directions

• Remaining questions
  • integrating these results with results obtained with other methodologies
Conclusions & further directions

- Comparing DSIs vs. ISIs
  - Other processing measures
  - acquisition
- language disorders
Conclusions & further directions

• Add back presuppositions to the comparison
Thanks!

COLLABORATORS

Others Rosalind Thornton, Kelly Rombough, Dorothy Ann, Emmanuel Chemla, Stephen Crain, Danny Fox, Lynda Kennedy, Clemens Mayr, Raj Singh, Benjamin Spector, Yasutada Sudo, Lyn Tieu