Broca’s Aphasia and Plurality Inferences

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LAGB October 2014, Oxford
Object of investigation

- Plurality Inferences in Broca’s aphasia
- Compared to typical adults and children
Object of investigation

(1) Emily fed pigs

-> Emily fed more than one pig
Preview

• Plural inferences are regarded as a type of SI
• Our previous experiment suggests that BAs can compute SIs
• **Expectation**: They will compute PIs too
Our findings suggest that indeed they do compute PIs (74%) and showed sensitivity to monotonicity.
The bigger picture

• It is not the case that BAs can compute *all* semantic/pragmatic inferences
Roadmap

• Background
• Previous experiment
• Current Experiment
• Main findings
• The ‘bigger picture’
• Conclusions
• Future research
Background
Broca’s aphasia

• Difficulties in comprehension and production

• **Comprehension**: difficulty with ‘complex’ syntactic constructions

• e.g. passives, object relatives, object clefts, pronominal binding (*e.g. Grodzinsky 2000, Avrutin 2006, Vasic et al. 2006*)
Broca’s Aphasia

• **Difficulties with ‘processing’**: Slowed lexical access and delayed priming effects *(Swinney et al. 1996, Swinney and Zurif 2001, Swinney et al. 2006)*
Acquisition and Aphasia

- (At least) superficial similarities in linguistic profiles
- A regression?
  - Later acquired = most vulnerable in BA
- Mostly syntax and more recently, syntax-discourse interface (e.g. Avrutin 2000, 2004, Vasic 2006)
Beyond syntax

- **Novelty**: looking at phenomena outside syntax that are:
  - Hard to process for typical adults
  - Acquired later by children
Beyond syntax

• Can help us further characterise the ‘processing limitation’ in Broca’s aphasia
Semantic/pragmatic inferences

- Scalar implicatures
  - The prototypical example of a type of inference we draw from utterances
  - Extensively studied
Semantic/pragmatic inferences

- Scalar implicatures

(1) **Some** giraffes have a scarf

\[ \sim \text{Not all giraffes have a scarf} \]

(2) **Not all** giraffes have a scarf

\[ \sim \text{Some giraffes have a scarf} \]
Hard to process

• Evidence suggests that SIs arise with a delay in typical adults (e.g. Huang and Snedeker 2009, Bott et al. 2012, Cremers and Chemla 2013)
Acquired later

• Children compute SIs less often than adults (e.g. Chierchia et al. 2001, Gualmini et al. 2001, Papafragou and Musolino 2003)
In sum

• Processing limitation in Broca’s aphasia

• Parallels in linguistic profiles in acquisition and aphasia

• SIs are **harder to process** for typical adults and are **acquired later** by children

**Expectation:** SIs will be hard for BAs
Previous experiment

Kennedy, Bill, Romoli, Schwarz, Crain and Folli (2014)
Bill et al. (2014)

- Scalar implicatures vs presuppositions
- Adults vs children
- Difference between the two groups on scalar implicatures and presuppositions
Scalar Implicatures in BA

- Adding to Bill et al. (2014)
- Comparison of:
  - Scalar implicatures and Presuppositions
- Adults vs children vs BAs
The Experiment

• **Participants:**
  - Adults with Broca’s aphasia (n=9)
  - Typical adults (n=22)
  - 7 yr old children (n=14)

• BAs showed difficulty processing ‘complex syntactic constructions’ on language screening
Design

• We compared our 3 groups (BAs vs 7yo children vs typical adults) on ‘classical’ scalar implicatures

• Some giraffes have a scarf $\Rightarrow$ \textit{Not all giraffes have a scarf}

• Not all giraffes have a scarf $\Rightarrow$ \textit{Some giraffes have a scarf}
Methods and Materials

• Sentence to picture matching task (e.g. Huang et al. 2013, Romoli and Schwarz 2014)
Some - target

Literal interpretation minus inference

‘Some or all giraffes have a scarf’
Some - target

Inference interpretation

‘Some but not all giraffes have a scarf’
not all - target

Literal interpretation minus inference

‘not all or no giraffes have a scarf’
not all - target

Inference interpretation

‘some giraffes have a scarf’
Results

CB choice = inference interpretation
• Adults vs BA: No significant difference on SIs
Results

• **BAs vs children**: Significant difference on SIs
Results

Main finding:

- Adults with $BA =$ typical adults on SIs and different from children
Current experiment
Motivation

• BAs can compute classical scalar implicatures

• Recent arguments to suggest plurality inferences are a type of scalar implicature (Sauerland 2003, Spector 2007)

-> **Expectation**: BAs should compute PIs
Arguments for a scalar implicature approach

- Plural morphology triggers a ‘more than one’ inference in positive sentences

(1) Sue picked apples

(2) Sue picked more than one apple
Plurality Inferences

• This inference generally disappears under negation (and DE contexts more generally)

• (3) Sue didn’t pick apples

  -/-> Sue didn’t pick more than one apple

  -> Sue didn’t pick a single apple
Plurality Inferences

• The disappearance of inferences in DE contexts is the hallmark of SIs

• Treating PIs as a kind of SI can account for this very naturally
SI approach to plurality inferences

• Moreover, the SI approach can successfully account for a second property of PIs

• A marked “more than one” reading of the plural can be forced in DE contexts

• Emily didn’t feed pigs, she fed only one!
SI approach to plurality inferences

• This is again similar to SIs more generally
In sum

- Two arguments for a SI approach to PIs
  - The pattern in UE vs DE contexts
  - The possibility of forcing a marked reading in DE contexts
Further support from acquisition

• **Prediction**: The acquisition profile of PIs should mirror that of other SIs

• **Experimental support**: Sauerland et al. (2005), Tieu et al. (2014)
Tieu et al. (2014)

- Comprehension of plural and singular sentences in upward entailing (UE) and downward entailing (DE) contexts

- Children vs typical adults

- **Prediction tested:**
  - If PIs = SIs then they should be difficult for children
Tieu et al. (2014)

- Prediction borne out
  - Children computed PIs significantly less than adults (42% vs 92%)
Plurality inferences and Broca’s aphasia

- Comprehension of plural morphology in UE and DE contexts by typical adults vs children vs Individuals with BA
Expectation

• BAs can compute SIs
• PIs are a type of SI
• BAs should compute PIs
The Experiment

- **Participants:**
  - Adults with Broca’s aphasia (n=9)
  - Typical adults (n=22)
  - Children (n=14)
Design

- **3x2** with group (typical vs BAs vs children) and monotonicity (UE vs DE) as factors

- Truth Value Judgement task
Design

• 2 training items

• 6 test items (3 UE, 3 DE)

• 8 control items: positive (x2) and negative indefinites (x2) and negation (x4)
Test items: UE context

‘Emily fed pigs’
Positive (UE) contexts

<table>
<thead>
<tr>
<th>Response</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO!</td>
<td>‘Emily fed *more than one pig’</td>
</tr>
<tr>
<td>YES!</td>
<td>‘Emily fed <em>one or more pigs</em>’</td>
</tr>
</tbody>
</table>
‘Emily didn’t feed giraffes’
### Negative (DE) contexts

<table>
<thead>
<tr>
<th>Response</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO!</td>
<td>‘Emily didn’t feed a <strong>single</strong> giraffe’</td>
</tr>
<tr>
<td>YES!</td>
<td>‘Emily didn’t feed <strong>giraffes</strong>, she only fed one!’</td>
</tr>
</tbody>
</table>
Control items

‘Sammy painted birds’ (YES)
Control items

‘Sammy didn’t draw dogs’ (YES)
Control items

(i) 'Emily didn’t eat the apple’ (Target: NO)

(ii) ‘Emily didn’t eat the chocolate’ (Target: YES)
Remember expectation

BAs will compute PIs:

- On par with typical adults
- Different from children
Results

All groups computed PIs more in UE contexts
Results

Adults compute PIs more than children and aphasics in DE contexts.
Results (Tieu et al)

Typical adults vs children

- Typical adults computed PIs significantly more often than children (42% vs 92%)
- Main effect of group ($p<.01$)
Our results

BAs vs typical adults

- BAs successfully computed PIs (74%)
- However not quite as often as adults (92%)
- Marginal main effect of group \( (p=.054) \)
Our results

2x2 BAs vs children

- BAs computed PIs more often than children
- Marginal main effect of group ($p = .074$)
Main findings

• BAs successfully computed PIs and showed sensitivity to monotonicity
Main findings

- Performance was in line with performance on classical SIs

BAs compute SIs
Main findings

- They did not compute PIs as often as adults but did so more than children.

**BAs performance was ‘in between’ typical adults and children**
The ‘bigger picture’
Beyond Syntax

• Part of a larger project on semantic/pragmatic inferences in BA
Beyond Syntax

• Refine the picture of what is spared/retained in BA

• Tell us more about the nature of semantic/pragmatic inferences and how they are processed

• Help us to better understand the similarities/differences between acquisition and aphasia
The bigger picture

- We found that BAs can compute classical SIs and PIs

- Can we conclude that they will be universally successful with all semantic/pragmatic inferences?
The bigger picture

- No!

- **Evidence:** Previous study on SIs also included comparison with presuppositions in BA
Presuppositions

- Another type of inference

- Difference between children and adults (e.g. Bill et al. 2014)

- ‘The bear didn’t win the race’

  -> The bear participated in the race
Presuppositions in literal contexts

‘The bear didn’t win the race’
Presuppositions in BA

- Presuppositions in literal contexts are hard (e.g. Chemla and Bott 2012, Romoli and Schwarz 2014)

- Acceptance requires suspending the presupposition

- In traditional approaches to presuppositions, this involves an extra mechanism
Presuppositions in BA

- Children struggle with the suspension of presuppositions (Bill et al 2014)
Presuppositions in BA

Suspension of PS
‘Bear didn’t participate and didn’t win’

PS interpretation
‘Bear participated and didn’t win’
Presuppositions and BA

- BAs performed on par with children and different from adults
The bigger picture

• BAs show a processing impairment outside of syntax
The bigger picture

• This can tell us something about what is spared and retained in Broca’s aphasia
The bigger picture

• It can also tell us something about the nature of these semantic/pragmatic inferences and how they are processed by different populations
Conclusions
Conclusions

• BAs can compute PIs

• They show sensitivity to monotonicity

• Consistent with findings of our previous study with classical SIs

• However, they are not universally successful on all semantic/pragmatic inferences
Further research

• Direct experimental comparison between SIs and PIs

• Develop a better understanding of the difference between SIs and Ps

• Bridging results on semantic/pragmatic inferences with other research in BA

• Ongoing project on syntax/semantics: scope ambiguity in BA
Acknowledgements

• **Participants**: members of StrokeNI
Acknowledgements

**Collaborators:** Jacopo Romoli, Lyn Tieu, Christina Sevdali, Cory Bill, Stephen Crain and Raffaella Folli

*also from Experiment 1:* Florian Schwarz
DSI vs IDSI

% Rejection

Group
- 7
- BA
- TA
Language Screening

- (agrammatic) Broca’s aphasia diagnosed on:
  1. Clinical impression of SLT
  2. Assessment on WAB (Kertesz 1982)
  3. Impaired on syntactically complex sentences on the VAST (Bastiaanse et al. 2001)
  4. Agrammatic speech production
  5. Left sided CVA
SI approach to PI

- Semantically, **plural = singular**
- Comparison with the singular which has been enriched with its own SI
  - \( \text{the negation of the enriched singular gives rise to the plural implicature} \)
SIs vs Ps: possible answers

(1) The processes underlying SI computation are spared in BA (but those underlying Ps accommodation are impaired)
SIs vs PS: possible answers

(2) SIs are **not costly** after all (e.g. Grodner et al. 2010, Breheny et al. 2013) and *contra* Huang and Snedeker (2009 a.o)

Assuming (2) ‘SIs are not costly’ how do we explain children’s persistent poor performance on SIs?
Hypotheses

1. Lexical knowledge *(e.g. Barner et al. 2011)*/access to *scalar alternatives*(e.g. Chierchia et al. 2001)

2. Pragmatic tolerance *(e.g Kastos et al. 2010)*
How do we explain our results showing BAs can compute PIs but performance is ‘in-between’ that of typical adults and children?
Hypothesis

- **Lexical access** is impaired in BA (e.g. Prather et al. 1997, Zurif 2003)

- **Lexical Knowledge** spared in BA but ‘impaired’ in children (Barner et al. 2011)