Effects of Syntactic Complexity in Discourse Comprehension

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Background

• There is considerable evidence that many persons with aphasia (pwa) have syntactic comprehension deficits when required to understand sentences in isolation.

  • (Thompson, Shapiro, Kiran & Sobecks, 2003, Caplan & Hildebrandt, 1988; Goodglass, Christiansen, & Gallagher, 1993; Grodzinsky, 1986; Saffran, Schwartz, & Marin, 1980).
Syntactic Complexity

- Canonical:
  - The man hugged the boy (active)
    - Agent Patient

- Non-canonical
  - The man was hugged by the boy (passive)
    - Patient Agent
Syntactic Complexity

- Passive vs. Active Voice
  - The boy chased the girl (active)
  - The boy was chased by the girl (passive)

- Reversible vs. Irreversible
  - The bone was eaten by the dog (passive, irreversible)
  - The boy was chased by the girl (passive, reversible)
Discourse Comprehension

- Several studies have investigated the correlation between discourse comprehension and sentence level comprehension in individuals with aphasia.

Syntactic Complexity in Discourse Comprehension

- Less clear whether pwa continue to have difficulty with **syntactic complexity** at the discourse level.

- Most clinical tests do not manipulate syntactic complexity.
Caplan & Evans (1990)

- Comprehension of more “complex passages” were, on average, no more difficult to understand than syntactically simple passage.

- Stimuli consisted of semantically irreversible sentences and syntactic complexity was assigned using only an active voice.
Purpose

1. Develop a discourse task which required patients to use a syntactic analysis for comprehension of some sentences.

2. Look at the effect of syntactic complexity on performance.

3. Compare performance of pwa on TESCD to performance on DCT-R
Stimuli

• Test of Syntactic Effects in Discourse Comprehension (TESDC)
  • Caplan, Levy, & Kiran, 2010

• Discourse Comprehension Test-Revised (DCT-R)
  • Brookshire and Nicholas (2008)
Nine pairs of passages about 100 words in length.

Each pair was comprised of a simple and a complex version.

Pairs were identical other than 2 or 3 semantically reversible sentences which differed in terms of syntactic complexity (target/non-target sentences).

Passages were equated across several measures using Coh-Metrix (Graesser et al, 2004)
## TSEDC Passages: Target Sentences

<table>
<thead>
<tr>
<th>Non-Target (Canonical)</th>
<th>Target (Non-Canonical)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active</strong></td>
<td><strong>Passive</strong></td>
</tr>
<tr>
<td>The man hugged the boy</td>
<td>The man was hugged by the boy.</td>
</tr>
<tr>
<td><strong>Subject relative</strong></td>
<td><strong>Object relative</strong></td>
</tr>
<tr>
<td>The man who hit the woman kissed the daughter</td>
<td>The woman who the man hit kissed the daughter</td>
</tr>
<tr>
<td><strong>Subject cleft</strong></td>
<td><strong>Object cleft</strong></td>
</tr>
<tr>
<td>It was the man who hit the woman</td>
<td>It was the woman who hit the man</td>
</tr>
<tr>
<td><strong>Transitive</strong></td>
<td><strong>Unaccusative</strong></td>
</tr>
<tr>
<td>The boy was shaking the girl</td>
<td>The boy was shaking</td>
</tr>
</tbody>
</table>
Last night was Sam’s first shift working as a train conductor. His job was to ensure that the train arrive at the station safely and without incident. Unfortunately, an incident occurred at a congested street crossing during rush hour. There was an electricity blackout. The train’s engine and all the streetlights shut down. The train blocked the traffic. A car and a bicycle tried to force their way through. Suddenly the electricity came back on. The train started moving and caused a collision. The train that the car had hit rolled over the bicycle. Sam is no longer a train conductor.
Discourse Comprehension Test-Revised

- Brookshire and Nicolas, 2008
- Contains five test stories of ~195-210 words in length.
- These stories are controlled for number of words, sentences, mean sentence length, number of subordinate clauses, number of terminal units (T-units), Ratio clauses to T-units, listening difficulty and number of unfamiliar words.
- Comprehension of each story is measured by eight yes/no questions:
  - Two test-stated main ideas
  - Two test-implied main ideas
  - Two test-stated details
  - Two test-implied details
Question (1)

• Do pwa have more difficulty than controls answering questions about a discourse when the discourse contains sentences that require a syntactic analysis?
Question (2)

- Do pwa have more difficulty than controls answering questions about a sentence in a discourse that requires a syntactic analysis?
What is the answer to questions (1) and (2) when patients who are known to have syntactic comprehension deficits are studied?
Question (4)

- How does the performance of pwa on the TESDC correlate with performance on the DCT-R?
## Participants

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Age</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWA</td>
<td>38</td>
<td>61 (25-83)</td>
<td>10-18 years</td>
</tr>
<tr>
<td>Healthy Controls</td>
<td>30</td>
<td>62.2 (27-82)</td>
<td>10-18 years</td>
</tr>
</tbody>
</table>
Procedure

• 38 pwa and 30 control subjects were tested on the TSEDC.

• Each subject was given a practice story and then presented with alternating versions of the nine passages, (complex, simple, complex, etc)

• Presentation order of passage type was alternated across subjects.

• A subset of 20 pwa were also tested using the Discourse Comprehension Test – Revised (Brookshire and Nicholas, 2008)
Results

Main Effects
TSEDC
Main Effect of Passage Type

Complexity; LS Means
Current effect: $F(1, 504) = 4.6962, p = 0.03070$
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals
Main Effect of Sentence Type

Target.non target sentences; LS Means
Current effect: F(1, 504)=8.8660, p=.00305
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals
Main Effect of Group

Group; LS Means
Current effect: F(1, 504)=93.213, p=0.0000
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

Accuracy

Controls   Patients

Group
Interaction of Passage Type* Sentence Type

Complexity*Target.non target sentences; LS Means
Current effect: $F(1, 504)=4.9925$, $p=.02590$
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

```
<table>
<thead>
<tr>
<th>Complexity</th>
<th>Complex</th>
<th>Simple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target sentences</td>
<td>0.52</td>
<td>0.54</td>
</tr>
<tr>
<td>Non target sentences</td>
<td>0.56</td>
<td>0.58</td>
</tr>
</tbody>
</table>
```
Interaction of Sentence Type

*Group*

Target non target sentences*Group; LS Means
Current effect: F(1, 504)=6.0513, p=.01423
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

<table>
<thead>
<tr>
<th>Sentence type</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non target sentences</td>
<td>0.7</td>
</tr>
<tr>
<td>Target sentences</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Group Controls
Group Patients
Selected Patients with Documented Syntactic Deficits
Interaction of Passage type * Sentence Type

Current Effect: F(1, 375)=6.27 ; p=0.013
17 Patients w/Syntactic Deficits & 30 Controls
Interaction of Sentence Type * Group

Interaction of Sentence Type * Group

Current Effect: $F(1, 375) = 4.26; p = 0.040$

17 Patients w/ Syntactic Deficits & 30 Controls

Accuracy

Sentence Type

Non-Target  Target

Group

Controls

Patients
Comparison of DCT-R and TSEDC
Correlation of DCT-R question accuracy with TSEDC simple, non-target question accuracy.

TSEDC vs. DCT-R Percent Correct
TSEDC: Simple, Non-Target Sentences Only
DCT-R = 0.32985 + 0.11959 * TSEDC
Correlation: r = 0.45521; p = 0.003

0.95 Conf.Int.
Correlation of DCT-R question accuracy with TSEDC complex, non-target question accuracy.
Summary

• Main effects were seen for group, passage type and sentence type

• Pwa performed significantly worse than their age-matched peers in comprehending both simple and complex passages.

• Pwa performed more poorly on questions related to complex sentence forms.
Summary

• Syntactic complexity does influence processing at the discourse level.

• Heuristic processing alone is not enough to compensate for complex syntactic processing demands in discourse.

• The TESDC is a sensitive measure of syntactic processing.
Conclusions

• Pwa do have more difficulty than controls answering questions about a discourse when the discourse contains sentences that require syntactic analysis.
Conclusions

- Pwa have more difficulty than controls answering questions about a sentence in a discourse that requires a syntactic analysis.
Conclusions

- Patients who are known to have documented syntactic comprehension deficits:
  - perform more poorly understanding sentences that require syntactic processing
  - Perform more poorly understanding passages that contain such sentences.
Conclusions

• Significant correlations were seen between the DCT-R and the non-target sentences. Non-significant correlations were seen between the DCT-R and the target sentences.

• The TESDC may be prove to be a useful tool for evaluating sentential comprehension deficits in discourse among pwa.
Next Steps

• Compare effects of syntax comprehension at a sentence level to the effects of syntax comprehension at the discourse level for pwa.

• Explore viability of a shorter version of TSEDC to increase clinical utility.
Thank you!

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Interaction of Passage Type*Sentence Type*Group;

Passage Type*Sentence Type*Group; Means
Current effect: F(1, 504)=.42386, p=.51531
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

Group: Controls

Group: Patients

Accuracy

Non-Target Sentences  Target Sentences

Non-Target Sentences  Target Sentences

Complex Passage
Simple Passage
### Controls & 21 Unselected Patients

**General Linear Model: Accuracy versus Passage Type, Sentence Type, Group**

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Type</td>
<td>0.006</td>
</tr>
<tr>
<td>Sentence Type</td>
<td>0.005</td>
</tr>
<tr>
<td>Group</td>
<td>0.000</td>
</tr>
<tr>
<td>Passage Type*Sentence Type</td>
<td>0.218</td>
</tr>
<tr>
<td>Passage Type*Group</td>
<td>0.085</td>
</tr>
<tr>
<td>Sentence Type*Group</td>
<td>0.072</td>
</tr>
<tr>
<td>Passage Type<em>Sentence Type</em>Group</td>
<td>0.855</td>
</tr>
</tbody>
</table>
### TSECD - Example of a Story

<table>
<thead>
<tr>
<th><strong>Factual: Non-target sentence</strong></th>
<th><strong>Inference: Non-target sentence</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What time of day does this take place?</td>
<td>Why is Sam no longer a train conductor?</td>
</tr>
<tr>
<td>a. Morning</td>
<td>a. There was a collision</td>
</tr>
<tr>
<td>b. Afternoon</td>
<td>b. the train blocked the traffic</td>
</tr>
<tr>
<td>c. Evening</td>
<td>c. the traffic blocked the train</td>
</tr>
<tr>
<td>d. Night</td>
<td>d. There was a blackout</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Factual: Target sentence</strong></th>
<th><strong>Inference: Target sentence</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What happened during the collision?</td>
<td>Why did a car and a bicycle try to force their way through?</td>
</tr>
<tr>
<td>a. the train hit the bicycle</td>
<td>a. There was a collision</td>
</tr>
<tr>
<td>b. the car hit the bicycle</td>
<td>b. the train blocked the traffic</td>
</tr>
<tr>
<td>c. the train rolled over the bicycle</td>
<td>c. the traffic blocked the train</td>
</tr>
<tr>
<td>d. the car rolled over the bicycle</td>
<td>d. There was a blackout.</td>
</tr>
</tbody>
</table>
Main Effect for Question Type

Question type; LS Means
Current effect: F(1, 248)=4.9285, p=.02732
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

Accuracy

Factual         Inference

Question type
Interaction of Passage Type* Question Type

Complexity*Question type; LS Means
Current effect: $F(1, 248)=4.9737$, $p=.02663$
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals
Interaction of Passage Type* Question Type* Group

Complexity*Question type*Group; LS Means
Current effect: F(1, 248)=1.4262, p=.23352
Effective hypothesis decomposition
Vertical bars denote 0.95 confidence intervals

Group: Controls
Question type:
- Factual
- Inference

Group: Patients
Question type:
- Factual
- Inference

Accuracy

- Complexity
  - Complex
  - Simple