B2: On the information conveyed by discourse connectives

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Discourse Relation Processing

Project B2 explores whether information-theoretic notion apply to language production and comprehension at the level of discourse relation processing.

New Perspective:
An incremental model of discourse relation processing

Research Hypotheses:

1. Discourse relation surprisal can account for processing difficulty in human text comprehension.

2. The occurrence of optional discourse markers can be explained by the uniform information density hypothesis.
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Discourse Relations

Discourse connective:
a cohesive device that contributes to making a text coherent.

Example
a. Peter stayed indoors, **although** it was sunny outside.
b. It was sunny outside, **but** Peter stayed indoors.
c. It was sunny outside. Peter stayed indoors.
Discourse Connectors

Relevant background on discourse connectors:
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- **ambiguity**

Diagram:

- but
- conjunction
- contrast
- concession
- pragm. contrast
Discourse Connectors

Relevant background on discourse connectors:

- ambiguity
- variation

**Concession**

- nevertheless
- although
- but
- still
- though
- however
Relevant background on discourse connectors:

- **ambiguity**
- **variation**
- **specificity**

**even though**

**but**

- contrast
- concession
- conjunction
- contrast
- concession
- pragm. contrast
Surprisal and Processing Difficulty

When do we predict processing difficulty?

**Figure:** large change in probability distribution of discourse relations before vs. after processing a connective.
Surprisal and Processing Difficulty

When do we predict processing difficulty?

Figure: large change in probability distribution of discourse relations before vs. after processing a connective.

In order to quantify this we need to know:

- What is the information conveyed by a discourse connective?
- How can we quantify this in a computational model?
Surprisal and Processing Difficulty

When do we predict processing difficulty?

**Figure:** large change in probability distribution of discourse relations before vs. after processing a connective.

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▶ How can we quantify this in a computational model?

**Case study:** two highly overlapping connectors *but* and *although*
Background

What do we know about discourse connectors and processing discourse relations?

- markers of contrastive and concessive discourse relations are more difficult to process than additive or causal connectors
  
  (Murray 1995; Drenhaus et al., 2014; Xiang and Kuperberg, 2014)

- connectives shape expectations online and therefore facilitate processing downstream
  
  (e.g., Köhne and Demberg, 2013)

- lack of research on processing of highly overlapping connectives
But vs. although

What do we know regarding *but* vs. *although*?

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><em>but</em></td>
<td><em>although</em></td>
</tr>
<tr>
<td>coordinating</td>
<td>subordinating</td>
</tr>
<tr>
<td><strong>P but Q</strong>: Q denies an accessible assumption of P.</td>
<td><strong>Q although P</strong>: Suspend an inference from P that would result in an unresolvable contradiction.</td>
</tr>
<tr>
<td>contrast</td>
<td>concession</td>
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(e.g., Iten, 2000)

**Examples**

- It’s raining **but** Peter is going out.
- Peter is going out **although** it’s raining.
- **Although** it’s raining, Peter is going out.
But vs. although

Despite these differences described in the theoretical literature, *but* and *although* often appear interchangeably:

- *but* is claimed to be the more general connective (Fraser, 1999)
- in translation, *although* is often rendered as the more general *but* (Swedish-English) (Altenberg, 2000)
- meaning of *although* order-independent; affects processing ease? (Iten 2000)

Examples

- It’s raining **but** Peter is going out.
- Peter is going out **although** it’s raining.
- **Although** it’s raining, Peter is going out.
What is the meaning of a discourse connective?

**Hypothesis 1:**
A highly ambiguous discourse connector like *but* only carries a core meaning, the rest is inferred by the content of the arguments.

(Fraser, 1999)

**Hypothesis 2:**
*But* and *although* come with different sets of processing instructions.

(Iten, 2000)

**Hypothesis 3:**
A discourse connectors meaning is defined by its distribution in text.

(Asr and Demberg, 2012b)
Corpus Statistics

Large resources like the Penn Discourse Treebank (PDTB) enable us to look at the distribution of *but* and *although*. 
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Experimental design:

- two clauses, such that both a contrast and a concession interpretation are possible.
- disambiguate contrast vs. concession reading on third sentence
- manipulate connective: but vs. although vs. sentence-initial although
- fully counter-balanced design
Comparing the interpretation of but vs. although

(1) After a busy day at the university and attending a lot of courses, Jane came home, made some tea, and started looking for something to eat.

(2a) She took some pizza from the fridge that was left from the day before, but she desired to have something sweet with her drink.

(2b) She took some pizza from the fridge that was left from the day before, although she desired to have something sweet with her drink.

(2c) Although she desired to have something sweet with her drink, she took some pizza from the fridge that was left from the day before.
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(3a) She had a piece of cake and went to bed early. → consistent with a contrast reading of 2

(3b) She had a piece of pizza and went to bed early. → consistent with a concession reading of 2
Comparing the interpretation of but vs. although

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   → consistent with a concession reading of 2
Two offline coherence judgment tasks via Amazon Mechanical Turk:

1) Norming first two sentences, excluding disambiguation
   ▶ 48 native English speakers (US American), 24 items
   ▶ Likert scale scoring between 1 and 7
   → first two sentences are matched for coherence

2) Full stories
   ▶ 48 native English speakers (US American), 24 items
   ▶ Likert scale scoring between 1 and 7
Results Acceptability Study

Statistics extracted from corpus data (PDTB)

- Contrast
  - Concession: arg1 but arg2
  - Concession: arg1 although arg2
  - Concession: Although arg2 arg1

Coherence scores by AMTurk participants

- Contrast: arg1 but arg2
- Concession: arg1 although arg2
- Concession: Although arg2 arg1

*** indicates statistically significant differences.
Conclusions:

- not consistent with Fraser’s account of “core” meaning
- not fully consistent with Iten’s account of differing processing instructions
- fully consistent with a distributional account for discourse connectors.
Eyetracking study

Are these results replicable in online processing?

Do readers slow down during first-pass reading of the critical region in the third sentence?

Stimuli (repeated)

(1) After a busy day at the university and attending a lot of courses, Jane came home, made some tea, and started looking for something to eat.

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- 32 native English speakers in Edinburgh, 24 items
- Stimuli same as above excluding the Although-initial conditions
Results Online Study

Corpus Statistics

Go-past times on critical region of third sentence.

MTurk Coherence Judgments

Coherence scores by AMT Turk participants

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Conclusions

- Discourse connectors which can mark the same relations but are differently distributed lead to different interpretations.
- Syntactic arrangement (P although Q vs. Although Q, P) affect inferred meaning.
- This information can be collected from discourse-annotated natural text corpora.
- Important result for B2’s goal of modelling discourse relation surprisal.
- Results can also inform other NLP tasks such as textual entailment.
End of Presentation

Thank you for your attention!

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