

Complementizers and Causality

“He said that X and (that) Y”

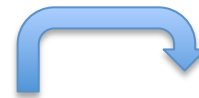
Did X cause Y?



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Coherence and Causality

- Discourses are structured, where discourse segments are linked via coherence relations (e.g. Kehler 2002; Asher & Lascarides 2003)
- Causal coherence relations are important to discourse structure
 - Result: *The mayor was elected. There was a riot.*
 - Explanation: *Max fell. John pushed him.*



Coherence and Causality

- What factors affect causal connections between propositions?
 - Lexical items (discourse markers like *because*; Implicit-causality verbs [congratulate vs. babysit])
 - World knowledge
 - John took a train from Paris to Istanbul. He has family there.
 - John took a train from Paris to Istanbul. He went from Istanbul to Budapest.
 - John took a train from Paris to Istanbul. He likes spinach.
 - Sentences' surface form? This project.

Optional complementizers in embedded contexts (Bjorkman 2010)

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 - the mayor was elected and there was a riot.
 - the mayor was elected and that there was a riot.



Causality blocked!

Or at least that's what we want to test.

Pilot 1

- Participants were shown an example sentence:
 - “At the basketball game, the referee observed that the fans were yelling and the star player missed his free throw”
 - The two meanings were explained.
- 14 target sentences with 12 fillers, all presented simultaneously in a matrix.
- Within-subjects design (counterbalanced for *that*)
- 40 subjects recruited through Amazon Mechanical Turk, all were native speakers of American English
- Participants rated the causal relatedness of the embedded clauses (1-5 Likert scale)

Pilot 1

Results	Mean Causality	1= definitely not causally related 5 = definitely causally related				
		1	2	3	4	5
...reported that [clause 1] and [clause 2]	3.30	42	56	40	61	81
...reported that [clause 1] and that [clause 2]	3.16	34	69	53	67	57

- This is not a significant difference. A mixed model, with random effects by subject and item, shows that the presence of the complementizer is not a significant predictor of causality ($\beta=-.10$, $t=-1.16$).

Pilot 2: Complementizers in bold

21 subjects recruited through Amazon Mechanical Turk

Results	Mean Causality	1= definitely not causally related 5 = definitely causally related				
		1	2	3	4	5
...reported that [clause 1] and [clause 2]	3.71	5	26	24	53	46
...reported that [clause 1] and that [clause 2]	3.23	8	39	37	50	20

Significant difference
($\beta = -.49$, $t = -2.51$).

Summary of Pilots: Mixed Results

- In plain font: not significant
- With complementizers in bold: significant
 - So, *noticing* the complementizer seems important. Seeing all sentences at once, in a matrix, may also affect results. Expanding set of target stimuli may help. → More studies

Experiment 1

- Expanded set of stimuli
 - 32 target sentences, 20 fillers
 - Target sentences involved a reporting verb with two embedded complement clauses
- 37 participants (MTurk)
- Questions presented one at a time, randomized, counterbalanced.

Example Sentences

In math class, the teacher remarked that half the class failed the test and (that) there was a mutiny.

During the interview, the politician claimed that not all votes were counted and (that) the wrong man won.

At the construction site, the architect estimated that the concrete was poorly prepared and (that) the building was unsafe.

After the wedding, the groom feared that his brother lost his car keys and (that) his dad missed his flight.

Experiment 1

- Results:

Results	Mean Causality	1= definitely not causally related 5 = definitely causally related				
		1	2	3	4	5
...reported that [clause 1] and [clause 2]	3.21	91	116	129	176	128
...reported that [clause 1] and that [clause 2]	3.08	113	135	105	165	122

Significant difference
($\beta = -.12$, $t = -2.12$)

Experiment 2

- Can we get the same effect with a less metalinguistic task?
 - Same design as Experiment 1, with cleaned up stimuli (n=28)
- *On the front page, the newspaper reported that the mayor was elected and there was a riot.*
 - Do you think there would have been a riot if the mayor hadn't been elected?
 - Definitely yes
 - Probably yes
 - Maybe
 - Probably not
 - Definitely not

Experiment 2

- 33 subjects (MTurk)

Do you think there would have been a riot if the mayor hadn't been elected?

Results	Mean	1= definitely yes 5 = definitely not				
		1	2	3	4	5
...reported that [clause 1] and [clause 2]	3.20	51	119	125	191	71
...reported that [clause 1] and that [clause 2]	3.27	37	120	131	198	72

Not significant
($\beta=.07$, $t=1.14$)

Experiment 3: Replicating Experiment 1

- Same as Experiment 1, but with cleaned up stimuli from Experiment 2.
- 42 subjects (MTurk)

Results	Mean Causality	1= definitely not causally related 5 = definitely causally related				
		1	2	3	4	5
...reported that [clause 1] and [clause 2]	3.30	70	104	126	155	132
...reported that [clause 1] and that [clause 2]	3.21	87	106	120	148	127

Not significant
($\beta = -.09$, $t = -1.58$)

Results so far

- Pilot 1 n.s.
- Pilot 2 ($\beta=-.49$, $t=-2.51$)
- Experiment 1 ($\beta=-.12$, $t=-2.12$)
- Experiment 2 n.s.
- Experiment 3 n.s.

- The effect only sometimes shows up, making follow-up experiments difficult.
- How about a forced-choice task?

Experiment 4: Forced Choice

Which of the two sentences below is more likely to mean that...

the mayor's election caused the riot?

the mayor's election and the riot were unrelated events?

1. *On the front page, the newspaper reported that the mayor was elected and there was a riot.*
2. *On the front page, the newspaper reported that the mayor was elected and that there was a riot.*

Experiment 4: Forced Choice

- 37 participants (MTurk)
- Results:
 - Question type predicts preferred sentence type ($\beta=.58, t=23.21$).

Which of the two sentences below is more likely to mean that...	the mayor's election caused the riot?	the mayor's election and the riot were unrelated events?
...reported that [clause 1] and [clause 2]	409 (79%)	106 (20%)
...reported that [clause 1] and that [clause 2]	109 (21%)	412 (80%)

Results Summary

- Pilot 1 n.s.
- Pilot 2 ($\beta = -.49$, $t = -2.51$)
- Experiment 1 ($\beta = -.12$, $t = -2.12$)
- Experiment 2 n.s.
- Experiment 3 n.s.
- Experiment 4 ($\beta = .58$, $t = 23.21$)
 - (forced choice)

Discussion

1. Experimental support for optional complementizer reducing causality (mixed for Likert scale, strong for forced choice)
2. Expands our ability to analyze discourse
3. Models of causal reasoning in discourse processing should incorporate cues from sentences' surface form, alongside cues from lexical, semantic, and pragmatic sources

Why does second complementizer affect causal interpretation?

- Bjorkman's analysis points out a syntactic contrast:
 - ...confirm [_{CP} that ...] and [_{CP} that ...]
 - ...confirm [_{CP} that [_{TP} ...] and [_{TP} ...]]
 - But note that without the second *that*, CP coordination is still possible. As a result, in English, there is still ambiguity between these two structures, and a need for a processing explanation.

Why does second complementizer affect causal interpretation?

- Preliminaries:
 - Semantic closeness
 - Causally connected clauses are closer semantically than logically conjoined clauses.
 - Asymmetry
 - Causal connections are asymmetric, while logically conjoined clauses are symmetric
 - Causal:
 - *The mayor was elected and there was a riot* ≠ *There was a riot and the mayor was elected.*
 - Non-causal:
 - *The mayor was elected and there was a riot* = *There was a riot and the mayor was elected.*

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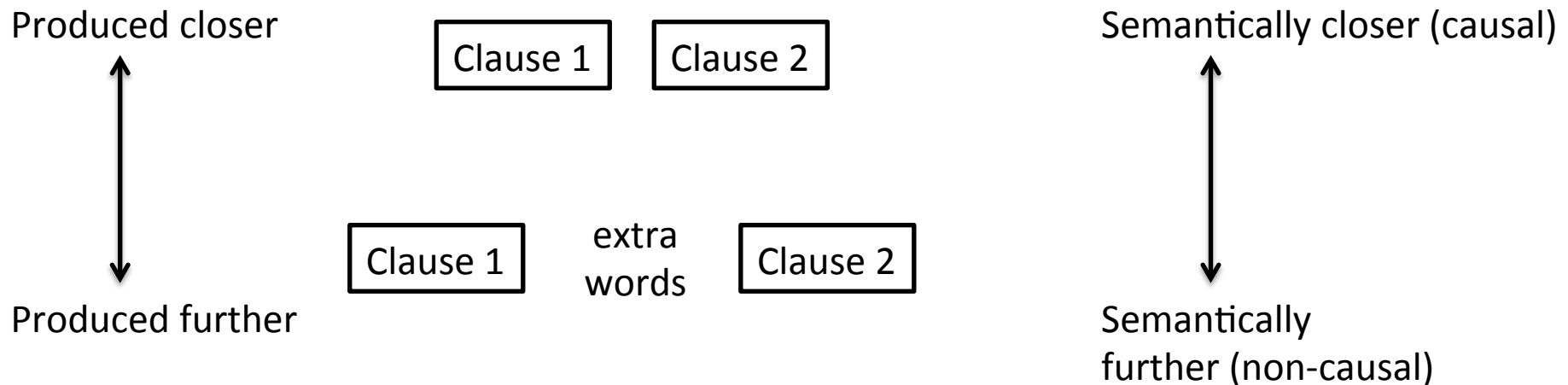
Boundary size explanation

- Clauses produced closer together (e.g. fewer intervening words) are interpreted as semantically closer
 - No optional complementizer makes clauses closer
 - Causal interpretation semantically links clauses closer
 - Therefore, no optional Comp → more causal

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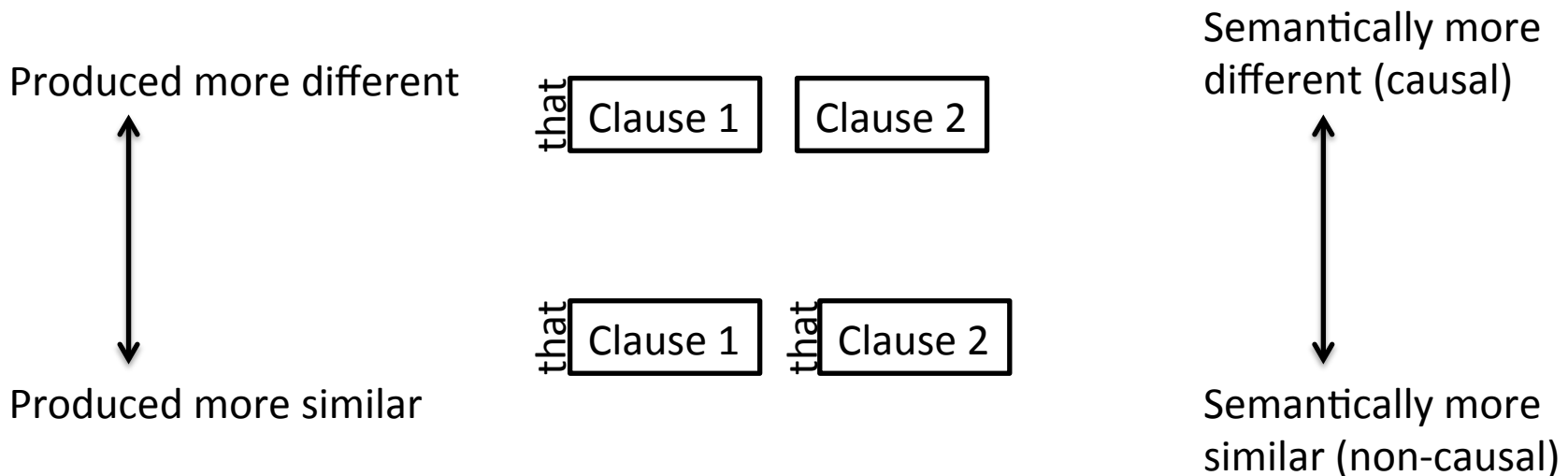
Parallel production explanation

- Clauses more similar in form are interpreted as semantically more similar
 - “that X and that Y” vs. “that X and Y”
 - Comp highlights connection to reporting verb
- Logical conjunction (non-causal) is symmetric, treating clauses as more similar than causal conjunction
- Therefore, optional second Comp → more non-causal

Why does second complementizer affect causal interpretation?

Parallel production explanation

- Clauses more similar in form are interpreted as semantically more similar



Additional insight from conditional conjunctions

You watch tv during dinner and you eat alone.

Gloss 1: If you watch tv during dinner, then you eat alone. (Cond Conj)

Gloss 2: Two things are true: 1) you watch tv during dinner, and 2) you eat alone. (Logical Conjunction)

- CondConj links clauses closer than LogConj
- *Boundary size explanation:*
 - bigger boundary → more LogConj
- *Parallel production explanation:*
 - clauses produced differently → more CondConj

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Tyler & Keshet (LSA 2015 poster) found evidence of both

Follow-ups

- Can the effect of complementizers on causality be achieved with prosodic contrasts?
 - Clause 1 {BIG PROSODIC BREAK} Clause 2
 - Clause 1 {little pros break} Clause 2
 - Like an optional complementizer, does a bigger prosodic break lead to less causality?
- Teasing apart the Boundary and Parallel explanations

Thank you!

- Comments welcome:
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