Psycholinguistic Evidence for Non-syntactic Dependencies in Coordinated-\(wh\) questions

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The goals of this talk

1) What and when will we eat?

To offer psycholinguistic evidence for those two different types of dependency

- syntactic
- semantic
Sharing dependencies

What and when did Ivy eat at the cafe?
Sharing dependencies

It can’t be:

\textbf{What}_i \textbf{and \textcolor{red}{when}}_j \text{ did Ivy \textbf{eat} at the café } t_i t_j \text{?}
Sharing dependencies

Nor can it be:

\[\text{What and when}\]_i \text{ did Ivy eat at the café } t_i?\]
Possible analyses

_Haida and Repp 2009: CWh is RNR_

2) Jo bought __ and Mary read __ [the book]

3) What __ and when __ [did Mary read]?
Possible analyses

Haida and Repp 2009: CWh is RNR

Movement
Ellipsis
Multidomiance
Something else entirely…
Possible analyses

_Haida and Repp 2009: CWh is RNR_

**Movement**
Ellipsis
**Multidomiance**
Something else entirely...
Movement

4) What and when did Ivy eat?

5) What $t_i$ and when $t_i [c, \text{ did Ivy eat}]_i$
Movement

4) What and when did Ivy eat?

5) What $t_i$ and when $t_i [c, \text{ did Ivy eat}]_i$?

Non-identical, non-maximal projections
Possible analyses

*Haida and Repp 2009: CWh is RNR*

Movement

*Ellipsis*

Multidomiance

Something else entirely…
Backwards Ellipsis

6) What and when did Ivy eat?

7) What did Ivy eat and when did Ivy eat?
Backwards Ellipsis

Problems:
8) When and what did Ivy fix?

9) *When did Ivy fix and what did Ivy fix?

And it can’t mean:
10) When did Ivy fix something and what did Ivy fix?
Backwards Ellipsis

Problems:
11) What and where did Ivy sing?

*doesn’t mean*

12) What did Ivy sing and where did Ivy sing?
Backwards Ellipsis

Problems:
11) What and where did Ivy sing?

rather, it means

13) What did Ivy sing and where did Ivy sing that song that she sang.
Backwards Ellipsis

Problems:
CWHs do not allow swiping (Gracanin-Yuksek 2007):

14) John was dancing, but I don’t know who with

15) *Who with were you dancing?

16) *Who with and when were you dancing?
Possible analyses

Haida and Repp 2009: CWh is RNR

Movement
Ellipsis
Multidomiance
Something else entirely…
Multidominance

Gracanin-Yuksek 2007, Ratiu 2009, others
Multidominance

Only optionally transitive verbs should be allowed.

Diagram:

```
To
  
  eat
  
  what
  
  when
```
## Multidominance

### Predictions

<table>
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<tr>
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Possible analyses

*Haida and Repp 2009: CWh is RNR*

Movement
Ellipsis
Multidomiance

*Something else entirely*
New Approach

What and when did Ivan eat?

Given this structure, the shared material 'the book' is c-commanded by elements from both conjuncts. This can easily be tested empirically. Elements from both conjuncts should show the effects of c-commanding the shared material. This turns out not to be the case. Shown in this section, only elements from the second conjunct show c-command effects while elements in the first conjunct do not.

(32) ta jekia ika da Ivana popravila? (Serbo-Croatian)

What and when Ivana repairs?

This extends to multiple wh-fronting languages generally.

(33) a. Mit és kinek adtál?

What and to whom did you give?

(34) b. Mit és hol javítottál meg?

What and where did you repair?

This suggests that both wh-words are actually undergoing movement.

(34) What and when Igor repairs?

But in Germanic, we seem to have this sort of pattern.

Verb-Type: eat

Verb-Type: fix

Wh-order: Arg first

Good

Wh-order: adj first

Good

Good

This is best accounted for with an analysis like the following:
New Approach

What and when did Ivan eat-x t?
New Approach

When the coordination should be licit.

✓ What and.. eat-x       *What and...fix
✓ When and...eat time-x   ✓ When and...fix time-x

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## Predictions

**Multidominance**

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**Our Theory**

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Experiment 1

• Speeded acceptability judgment

• Design:
  – **Verb Type:** optionally vs. obligatorily transitive
  – **WH Order:** argument-first vs. adjunct-first

• 24 participants (recruited on Mechanical Turk)
Experiment 1: Materials

OPTIONALLY TRANSITIVE VERBS

Given the busy filming schedule, the actor wanted to know…

Argument-first:
… what and where he could eat that day.

Adjunct-first:
… where and what he could eat that day.
Experiment 1: Materials

OBLIGATORILY TRANSITIVE VERBS

The most exciting thing about exploring in the attic is that you never know…

**Argument-first:**

…what and when you might **find** by surprise.

**Adjunct-first:**

…when and what you might **find** by surprise.
Experiment 1

Predictions:

• Optionally-transitive verbs: good regardless of WH order
  ✓ …what and where he could eat…
  ✓ …where and what he could eat…

• Obligatorily-transitive verbs: \textit{adjunct-first} better than \textit{argument-first}
  × …what and when you might \textbf{find}…
  ✓ …when and what you might \textbf{find}…
Experiment 1: Unfilled gaps

- **Optionally-transitive verbs**: good regardless of WH Order
- **Obligatorily-transitive verbs**: adjunct-first better than argument-first
Experiment 1: Unfilled gaps

- Expected asymmetries based on Verb Type and WH Order were observed.

- Results support the hypothesis that there is a non-syntactic dependency between the first wh-word and the verb.
Our theory states:

What and when will we eat?

- We will now provide evidence for this analysis using evidence from real-time comprehension
Questions

• We posit ‘full’ dependencies and merely semantic ones
• Is the gap-filling mechanism sensitive to the difference?
Active gap-filling

!! – Plausibility effects
Who will the professor eat lunch with?

!! – Filled gap effects

Plausibility effects: e.g. Tanenhaus et al. (1989), Boland et al. (1995), Traxler & Pickering (1996), Phillips et al. (2006)

Filled gap effects: e.g. Stowe (1986), Tanenhaus et al. (1989)
Filled gap effects

*What will we eat something?

*What and when will we eat something?

Do we get a filled-gap effect? If so, what is the timing?
Experiment 1

• Speeded acceptability judgment

• Design:
  – **Verb Type:** optionally vs. obligatorily transitive
  – **WH Order:** argument-first vs. adjunct-first
  – **What-Gap:** filled (‘something’) vs. unfilled

• 24 participants (recruited on Mechanical Turk)
Experiment 1: Filled gaps

Sentences with filled gaps:

- **Optionally-transitive verbs:**
  argument-first better than adjunct-first
  
  - …what and where he could eat something…
  - …where and what he could eat something…

- **Obligatory-transitive verbs:**
  bad regardless of WH Order
  
  - …what and when you might find something…
  - …when and what you might find something…
Experiment 1: Filled gaps

- Optionally-transitive verbs: argument-first better than adjunct-first

- Obligatorily-transitive verbs: smaller difference between argument-first and adjunct-first
Experiment 1: Filled gaps

• Asymmetry in filled gap effects based on order of WH words.
  ? What and when will we eat something?
  * When and what will we eat something?

• Suggests that the gap-filling mechanism is sensitive to whether a dependency is syntactically-mediated.
Experiment 2: Questions

• At least 2 possible explanations for the reduced filled gap effect in sentences like “What and when will we eat something?”
  – The active gap-filling mechanism only computes syntactic relationships, and thus does not detect the filled gap.
  – The gap-filling mechanism does detect the filled gap, but subsequent processes “repair” the sentence to get an interpretation.
Experiment 2: Design

• Self-paced reading

• Design:
  – **Verb Type:** optionally vs. obligatorily transitive
  – **What-Gap:** filled (‘something’) vs. unfilled
  – **WH type:** ‘what’ vs. ‘when’ vs. ‘what and when’

• 42 participants
Experiment 2: eat-type

No filler
The diplomat had to make a schedule of…
✓ what his lazy assistant would translate
✓ when his lazy assistant would translate
✓ what and when his lazy assistant would translate
...during the work week.

Filled gaps
✗ what his lazy assistant would translate something
✓ when his lazy assistant would translate something
✗ what and when his lazy assistant would translate something
...during the work week.
Experiment 2: Unfilled gaps

![Graph showing optionally transitive verbs, Unfilled gap]

- Mean RT (ms)
- Region: aux, verb, end1, end2, end3
- WhType: What and when, What, When
Experiment 2: Filled gaps

Optionally transitive verbs, Filled gaps

Mean RT (ms)

WhType
- What and when
- What
- When

Region
- aux
- verb
- filler
- end1
- end2
- end3
Experiment 2: eat-type verbs

• No cost for filled gap at or following the filler when the dependency is purely semantic.
  – Suggests that the gap-filling mechanism is only sensitive to syntactically-mediated dependencies
Experiment 2: fix-type

No filler
The busy executive was especially worried about…
✓ what his lazy assistant would **overlook**
✗ when his lazy assistant would **overlook**
✗ what and when his lazy assistant would **overlook**
   …during the important deal.

Filled gaps
The busy executive was especially worried about…
✗ what his lazy assistant would **overlook** something
✓ when his lazy assistant would **overlook** something
✗ what and when his lazy assistant would **overlook** something
   …during the important deal.
Experiment 2: Unfilled gaps

Obligatory transitive verbs, Unfilled gap

Mean RT (ms)

Region

WhType
What and when
What
When
Experiment 2: Filled gaps

Obligatory transitive verbs, Filled gaps

Mean RT (ms) vs Region

- aux
- verb
- filler
- end1
- end2
- end3

WhType
- What and when
- What
- When
Experiment 2: fix-type verbs

• In ‘what and when’ sentences with obligatorily transitive verbs, immediate sensitivity to the unavailability of any kind of dependency with ‘what’.
  – Earlier than sensitivity to lack of direct object in the simple ‘when’ sentences.
  
*What and when will we find at the conference?
*When will we find at the conference?
Conclusions

- Current accounts of CWh constructions have problems, a movement-less account for the first conjunct works better.
- Results from acceptability judgments support our hypothesis that the first conjunct in conjoined WH questions forms a purely semantic relationship with the verb.
- Results from self-paced reading suggest that active gap-filling mechanisms form dependencies over syntactic representations.
Acknowledgments

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A judgment study

Context: Jim was trying to lose weight. But he gave in and ate a doughnut at midnight last night.

Argument-first: What and when did Jim eat?
Adjunct-first: When and what did Jim eat?

Context: Rodney is a young mechanic. He fixed a limousine for the first time last week.

Argument-first: What and when did Rodney fix?
Adjunct-first: When and what did Rodney fix?
A judgment study

Argument-first

Adjunct-first
New Approach

Derivation Sketch

\[ [\text{TP} \text{ Ivy ate when}] \rightarrow [\text{CP} \text{ when [Ivy ate t]}] \]

\[ [\text{CP} \text{ what C}^0] \quad \& \quad [\text{CP} \text{ when [Ivy ate t]}] \]

\[ [\text{CP} [\text{CP} \text{ what C}^0] \quad [\& \& \text{CP} \text{ when [Ivy ate t]}]] \]
Filled-gap examples

- Now I know what and when to eat the correct food combinations.
- What and when was something done to stop this from happening?
- It allows you to basically pick what and when you want something to be inactive on your hard drive.
- They begin calling and emailing my friends and wanting to know what and when they told me something.
- I have always depended on God’s Holy Spirit to let me know what and when God desires something done by me.
- ...you need to tune in to what and how something is said and be alert for what is left unsaid.
- The projected shortfall could alter what and when things are built
- ...serving up an array of information that lets women choose what and when they want financial advice.
- The AAAS benchmarks provide guidance for what and when we teach certain content areas...
- You must stay on top of what and when seminars are offered.
- ...the garage is no longer there and not sure who and when it was removed.
- ...a number of questions that now have to be answered in terms of who and when they are going to turn over Elia Gonzalez to his father.
- The team will develop a plan ... to include ... who and when behaviors will be measured...
- What and where would this monitoring take place?
- ...it will specifically give the motorist the power to choose when, who, and where their car will be repaired
- ...In international affairs, what, when, and how you say something is important.