

CAS LX 522

Syntax I

Week 14b.
Phases, relative clauses, and LF
(ch. 10)

Islands

- There seem to be certain structures out of which you cannot move a *wh*-word. These are *islands*.
- **CNP (complex noun phrase) islands:**
A *wh*-word cannot get out of a DP.
 - *Who does Jack believe
[_{DP} the claim [_{CP} that the list does not include _]]?
- **Wh-islands:**
A *wh*-word cannot get out of an embedded question.
 - *Who did Pat ask [_{CP} who kidnapped <who>]?
- **Adjunct islands:**
A *wh*-word cannot get out of an adjoined modifier.
 - *What did Dr. Hibbert laugh [_{CP} when Homer lost <what>]?

Phases

- We can understand island constraints in terms of *phases*.
- The structure is built up from the bottom, but in *chunks (phases)*.
- C is a phase head. Once CP is finished, the complement of C is “spelled out”—frozen, inaccessible to further computation.
- **Phase Impenetrability Condition**
Feature matching reaches no further than the specifier of an embedded phase.

Wh-islands

- An embedded question forms an island: a **wh-island**.
- The embedded C already had a [**uwh***] feature, which was checked by moving the first *wh*-word into SpecCP.
- We can't move another *wh*-word to C before the lower CP phase is completed.
- By the time we get to the main clause C, it can no longer see a *wh*-word inside the embedded clause.
- *Who did Pat ask [_{CP} who kidnapped <who>]?
- Pat wondered [_{CP} Op if Hauptmann kidnapped the Lindbergh baby].
- *Who did Pat wonder [_{CP} Op if Hauptmann kidnapped <who>]?

Complex Noun Phrase islands

- Complex Noun Phrase islands: DP is also a phase. (Also: definite D cannot host a *uwh** feature)
- *Who does Jack believe
[_{DP} the claim [_{CP} that the list does not include _]]?
- *Who does Jack believe
[_{DP} the claim [_{CP} that the list does not include _]]?

Adjunct islands

- Adjoined modifiers constitute **adjunct islands**. (A *wh*-word cannot escape an adjoined modifier.)
 - Dr. Hibbert laughed [_{CP} when Homer lost a finger].
 - *What did Dr. Hibbert laugh [_{CP} when Homer lost]?
- We don't yet have a good explanation for this. So far, we predict these should be possible.

Adjunct islands

- To account for the islandhood of adjuncts in our system, we will add one further condition:
- **The specifier of a phase is only visible to feature matching if the phase gets a θ -role.**
 - Note: Adger makes this one step more complicated, to account for “subject islands” but we won’t do that here.
- Adjuncts differ from arguments in precisely this property.

In sum...

- Sentences are “chunked” into **phases** as they are built up. Phases are **CP** and **DP**.
- A feature outside of a phase cannot match a feature further inside the phase than its specifier.
- This leads to **island phenomena**, configurations in which a *wh*-word would be “trapped”:
 - **CNP islands:** A *wh*-word cannot get to the specifier of DP and so is not visible from outside.
 - **Wh-islands:** A *wh*-word cannot get to the specifier of an embedded question (that already has a *wh*-word, or *Op*, in its specifier).
 - **Adjunct islands:** Even the specifier is not visible if the phase did not get a θ -role.

“Island effects” are a property of movement

- 1) Jack believes [_{DP} the claim [_{CP} that the list does not include Ethan]]?
 - 2) *Who does Jack believe [_{DP} the claim [_{CP} that the list does not include _]]?
 - 3) Who believes [_{DP} the claim [_{CP} that the list does not include who]]?
 - 4) Dr. Hibbert laughed [_{CP} when Homer lost a finger].
 - 5) *What did Dr. Hibbert laugh [_{CP} when Homer lost _]?
 - 6) Who laughed [_{CP} when Homer lost what]?
- So long as the *wh*-phrase doesn’t *move*, it seems that there’s no problem with simply having a *wh*-phrase inside an island.

“Island effects” are a property of movement

- Japanese: a *wh*-in-situ language.
- Taroo-ga [_{DP} Hanako-ni **nani-o** ageta hito-ni] aimasita ka?
T-nom H-dat what-acc gave man-dat met.pol Q
*‘What did Taro meet [the man that gave _ to Hanako]?’
- Taroo-ga [_{CP} Hanako-ga **nani-o** yomu maeni] dekakemasita ka?
T-nom H-nom what-acc read before left.pol Q
*‘What did Taro leave [before Hanako read _]?’
- **Wh-words don’t move. Islands don’t matter.**

Why phases?

- One of the main motivations behind phases (conceptually—empirically, there is plenty of evidence) is that it makes computation easier.
 - That is, again, the system is lazy. It works in chunks, it never has to look too far to find a feature for checking.
- What happens when a phase is “committed”?
 - The standard idea is that the *phonological interpretation* and *semantic interpretation* of that chunk becomes fixed, and can’t be altered later. Terminology: “**Spell-out**”
- Terminology: The requirement that movement not go “too far” (not escape a committed phase) was known in the old days as **Subjacency**—you may still encounter this term when talking to linguists at parties (or reading older papers).

A word about interpretation

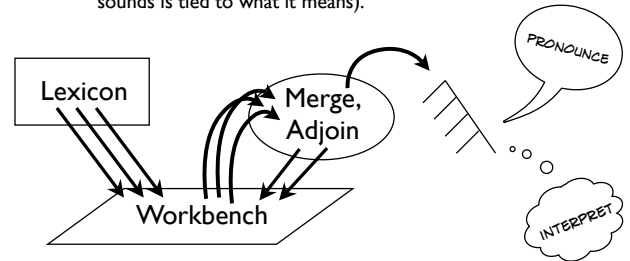
- Let’s think for a moment about what a *wh*-question means:
 - *Who did Pat meet?*
[_{CP} [_{DP} who]_i T_k+C [_{TP} Pat meet t_k]]
 - Something like (a ‘logical form’):
Tell me (a person) *x*
such that *Pat met x* is true.

Pronouncing & interpreting

- There are two things we need to do with the lexical items we assemble on the workbench:
 - Pronounce the sentence
 - Interpret the sentence
- We've mainly been concentrating on the pronunciation part (getting the words into the order we hear them), but the structure is also assumed to be the basis for interpreting the sentence as well.

Our model of grammar

- Here is the little picture of our model of grammar. The structure we end up with is used both to express the logical relations between participants and to pronounce the structure.
- (And of course it has to be that way, since how a sentence sounds is tied to what it means).



A word about interpretation

- *Who did Pat meet?*
 $[_{CP} [_{DP} \text{who}]_i T_k + C [_{TP} \text{Pat meet } t_k]]$
 Tell me (a person) x such that $\text{Pat met } x$ is true.
- If we need to get to a logical structure like *Tell me (a person) x such that Pat met x is true*, then it may well be that *this is what wh-movement is for*. The trace serves as the x variable, the moved *wh*-phrase sets the domain.
- Suppose that moving a *wh*-phrase (leaving a trace) is necessary for interpretation as a *wh*-question.

Wh-movement and interpretation

- Who bought what?
- Tell me a (person) x and tell me a (thing) y such that x bought y is true.
- Who gave what to whom?
- Tell me a (person) x and tell me a (thing) y and tell me a (person) z such that x gave y to z is true.
- How do we interpret those other *wh*-words?

The wh-typology

- **English: One *wh*-word** moves to the front.
 - What did Bill give to whom?
- **Japanese: No *wh*-words** move to the front.
 - Taroo-ga dare-ni nani-o ageta no?
 T-nom who-to what-acc gave Q
 'What did Taroo give to whom?'
- **Bulgarian: All *wh*-words** move to the front.
 - Kakvo na kogo Ivan dade?
 what to whom Ivan gave
 'What did Ivan give to whom?'
- **French: One *wh*-word or no *wh*-words** move to the front.
 - Qui as-tu vu? Tu as vu qui?
 Who have-you seen You have seen who
 'Who did you see?' 'Who did you see?'

The wh-typology

- Yet in all of these languages, the *meaning of What did Bill give to whom?* is the same...
- Tell me a (thing) x and tell me a (person) y such that Bill gave x to y .
- So, if the 'tell me an x ...such that... x ...' meaning arises from *wh*-movement (and, in fact, we can see the *wh*-movement in Bulgarian), it stands to reason that even in English and Japanese there is *wh*-movement for each *wh*-word—we just can't always hear it.

Phases again

- Remember that what's supposed to be true of phases is when they are "committed," we have locked in the pronunciation and interpretation.
- But what if we lock in the pronunciation first, move a little bit more, and then lock in the interpretation?
 - $[_{CP} \text{ what}_i T_k + C [_{TP} \text{ Pat } t_k \text{ give } t_i \text{ to whom }]]$?
 - Lock in pronunciation
 - $[_{CP} \text{ whom}_m \text{ what}_i T_k + C [_{TP} \text{ Pat } t_k \text{ give } t_i \text{ to } t_m]]$?
 - Lock in interpretation
- This will sound like: *What did Pat give to whom?*

Phases again

- Why would we lock in pronunciation first?
 - $[_{CP} \text{ what}_i T_k + C [_{TP} \text{ Pat } t_k \text{ give } t_i \text{ to whom }]]$?
 - Lock in pronunciation
 - $[_{CP} \text{ whom}_m \text{ what}_i T_k + C [_{TP} \text{ Pat } t_k \text{ give } t_i \text{ to } t_m]]$?
 - Lock in interpretation
- We said before: *Strong features* (generally) require movement because the strong feature must be local to the feature that checks it.
 - Viewed in light of different "timing" for locking in pronunciation and interpretation, we could now say that strong features need to be checked *before locking in pronunciation*. But since the system is lazy, it will wait until after that to check any remaining (weak) features.

Pros, cons

- If we imagine that there can be this type of "covert movement" we gain a strong benefit:
 - All languages have basically the same structure for the purposes of *interpretation*. Even if they seem to differ in terms of what visibly moves.
- But it raises a number of issues as well:
 - We must assume that once you covertly move something, you've left the phonological features behind—any further movement will also have to be covert.
 - We must assume that all *wh*-words accumulate in SpecCP (some covertly) but without losing the explanation of *wh*-island violations (there is only one SpecCP).
 - Covert movement seems not to obey islands: Strong features can't see inside committed phases, but *others* seem to be able to. Non-strong features won't affect the pronunciation, though—it's ok when the pronunciation is locked.

LF movement

- When syntacticians talk about this kind of "covert movement" at parties, they sometimes speak of it as **LF movement**.
- That is, movement that happens in order to construct the **logical form** of the sentence but doesn't affect the pronunciation.
 - We will not really seriously deal with LF movement in this class. We will not draw it in our trees. But it's worth having heard about it.

Wh-phrases binding pronouns

- There is an interesting property of the kind of operator-variable formation that we can see in *wh*-movement.
 - Who likes his roommate?
 - Pick the x such that x likes x 's roommate.
 - $\text{Who}_i [_{TP} t_i \text{ likes his}_i \text{ roommate}]$
- Notice that it is possible to have a pronoun bound by a *wh*-word.
 - And it is binding, like the binding we spoke of wrt Binding Theory. It's assignment of reference, both to the trace and to *his*, matching the reference of *who*.

WCO

- But now consider this:
 - Who does his roommate like?
 - Can this mean the same thing as *Whose roommate likes him?*
 - $*\text{Who}_i \text{ does his}_i \text{ roommate like } t_i ?$
- How is this different from
 - $\text{Who}_i t_i \text{ likes his}_i \text{ roommate?}$
 - $[\text{Whose roommate}]_i t_i \text{ likes him}_i ?$

Weak Crossover



- *Who_i does his_i roommate like t_i ?
- Who_i t_i likes his_i roommate?
- The difference lies in the fact that the *wh*-phrase had to **cross over** the coindexed pronoun on its way to SpecCP. This appears to be impossible, and we can state this as follows:
- **Weak Crossover (WCO):** A coindexed pronoun cannot intervene between an operator and its variable.

WCO

- We can also see this effect with *wh*-in-situ:
- Who introduced her advisor to whom?
- Who introduced whom to her advisor?
- Which girl told his parents to visit which boy?
- Which girl told whose parents to visit him?

Quantifiers

- We interpret *Bill saw everyone* as
- For every person *x*, Bill saw *x*.
- This is the meaning. This is the *logical form* of the sentence *Bill saw everyone*. In the notation of formal logic, this is written as $\forall x$. Bill saw *x*
'For all *x* (*x* a person), Bill saw *x*.'

Quantifiers

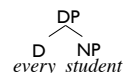
- Every boy hates his roommate.
- Notice that each boy hates a different roommate, the roommates are specific to each boy.
- For every boy *x*, *x* hates *x*'s roommate.
- This means that *every boy* doesn't just mean the group of boys; rather it goes through the set of boys and says something about each of them individually.

Quantifiers

- These phrases which don't refer to specific people/things in the world but rather seem to do things to sets of people/things (like state generalizations) are *quantifiers*. Examples:
 - most students
 - twelve angry men
 - fewer than half of the members
 - some custodian
 - nobody in their right mind

QP

- What is the category of a quantifier like *most students*?
- Well, it goes basically in all the same places a DP goes. Like *which student* or *what* or *who*.
- So, like what we said for *wh*-phrases, quantifier phrases are really DPs with an extra property (they're quantificational). Sometimes people write QP, but they mean 'a quantificational DP'.



Restrictions

- To reiterate, quantifiers are used to say something about *individuals in a set*.
- Most students like syntax.
- The set (sometimes, *restriction*) is the set of students.
- This says that, if you check *all* of the students individually to see if *each* likes syntax, you'll find that most (more than half) of the students you checked do.
- For each x in students, does x like syntax? Did we answer "yes" for most of the ones we checked?

Quantifiers

- To write the logical form (meaning) of a sentence with one of these, you put the quantifier first, and replace where it came from with a variable:
- Most students eat at Taco Bell.
For most students x , x eats at Taco Bell
- No administrators eat at Taco Bell.
For no administrator x , x eats at Taco Bell
- Mary likes every flavor of ice cream.
For every flavor of ice cream x , Mary likes x

Binding

- A quantifier is said to *bind* its variable. That is, the reference of the variable is assigned by the quantifier.
- Bill read every book.
For every book x , Bill read x
- Is this true? Well, let's go through the books. *Moby Dick*. Did Bill read *Moby Dick*? Yes. Ok, *War and Peace*. Did Bill read *War and Peace*? Yes. Ok, ...

Scope

- A student read every book.
- When is this true?
 - Mary, it turns out, has read all of the books.
 - Nobody has read everything, but Mary read half of the books and Bill read the other half. Every book was read by a student.
- There are two meanings here, the sentence is ambiguous between two logical forms.

Scope

- A student read every book
There is a student x such that
for every book y , x read y
or
For every book y , there is a student x
such that x read y
- It matters which quantifier comes first in the logical form.

Scope

- This is perfectly logical. A quantifier takes a set of individuals and checks to see if something is true of the individual members of the set.
- A student read every book. (Namely, Mary)
 - In the set of students, we find that it is true that for at least one student x : x read every book.
 - In the set of students, we find that it is true that for at least one student x : In the set of books, we find that it is true that for each book y , x read y .
 - There is a student x such that for every book y , x read y .
 - $\exists x \in \text{students} : \forall y \in \text{books} : x \text{ read } y$.

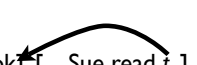
Scope

- A student read every book. (The books were all covered, though not necessarily by one student)
- In the set of books, we find that it is true that for each book x : a student read x .
- In the set of books, we find that it is true that for each book x : In the set of students, we find that it is true that for at least one student y , y read x .
- For every book x , there is a student y such that y read x .
- $\exists x \in \text{books}: \forall y \in \text{students}: y \text{ read } x$.

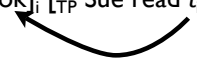
LF

- We think about this kind of ambiguity in much the same way we think about Mary heard a dog bark in the house.
 - (either Mary was in the house or the dog was)
- This (above) is a *syntactic* ambiguity, depending on where the PP *in the house* is attached.
- If there are two different interpretations, there are two different *structures*. Two different LFs.

QR

- Sue read every book.
For every book x , Sue read x .
- Covert movement again: the quantifier *moves* to a position above the sentence, so there is then a direct mapping between the structure and the logical form. But only after the pronunciation has been fixed.
- [every book] _{i} [_{TP} Sue read t_i].

QR

- Sue read every book.
For every book x , Sue read x .
- [every book] _{i} [_{TP} Sue read t_i].
- As with *wh*-movement, the *trace* is the variable at logical form—moving quantifiers is a way to establish a quantifier-variable structure.
- This movement is called Quantifier Raising (QR), and it happens to every quantifier before LF.

Quantifiers and binding

- Every girl aced her exams.
- [Every girl] _{i} [t_i aced her _{i} exams]
- For every girl x , x aced x 's exams
- Not only the trace of QR, but also pronouns, can be bound by the quantifier, their referent determined by the quantifier.

Quantifiers and binding

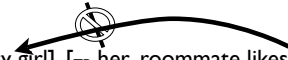
- [Every girl] _{i} [t_i aced her _{i} exams]
 - Binding (assigning reference) is subject to c-command. A quantifier can only assign reference to a variable (its trace and possibly other pronouns) which it c-commands.
- Her brother said that every girl aced her exams.
- The things which a quantifier c-commands are said to be in its **scope**.
- Quantifiers can only bind variables in their scope.

WCO

- Now, let's look at weak crossover again.
- Every girl likes her roommate.
- For every girl x , x likes x 's roommate.
- Her roommate likes every girl.
- For every girl x , x 's roommate likes x .
- Why can't the second sentence have this meaning?

WCO

- [Every girl] _{i} [_{TP} t_i likes her _{i} roommate].
- For every girl x , x likes x 's roommate.



- [Every girl] _{i} [_{TP} her _{i} roommate likes t_i].
- For every girl x , x 's roommate likes x .
- Answer: WCO again. But WCO is about moving a quantifier over a variable—so if WCO rules out this meaning, there must have been movement. There must have been QR. A movement we couldn't see.

ACD

- Here's another reason to believe in QR, *antecedent contained deletion*. This one's kind of complicated, so hang on tight.
- First, we need to talk about VP ellipsis.
- Mary bought a record, and Bill did too.
- [_{TP} Mary -ed [_{VP} buy a record]] and [_{TP} Bill -ed [_{VP} buy a record]] too.

VP ellipsis

- Mary bought a record and Bill bought a tape.
≠ Mary bought a record and Bill did too.
- VP ellipsis is allowed *when a preceding VP is identical*.
- To *interpret* this, you need to use the content of the preceding VP.
- Mary bought a record and Bill did (buy a record) too.

VP ellipsis

- We will consider the process of VP ellipsis to be one of *deletion under identity*.
- Underlyingly:
-ed [_{VP} Mary sleep] and -ed [_{VP} Bill sleep] too.
- Before deletion:
Mary -ed [_{VP} t sleep] and Bill -ed [_{VP} t sleep] too
- Pronunciation:
Mary -ed [_{VP} t sleep] and Bill -ed ~~(t sleep)~~ too
Mary slept and Bill did too

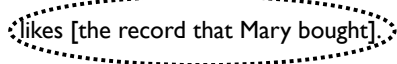
VP ellipsis

- So, as long as two VPs in sequence look identical (where traces of movement look identical to one another—they sound the same), we are allowed to pronounce the second one *very quietly*.
- Like an extreme case of
Mary bought a record and
Bill bought a record too.

VP ellipsis

- Note that *identity* is actually fairly abstract.
- John slept and Mary will too.
- John slept and Mary will _{sleep} too.
- Before deletion:
John -ed [_{VP} t sleep] and Mary will [_{VP} t sleep] too
- The inflectional features of *v* don't matter for identity; the verb doesn't *inherently* have a tense suffix.

VP ellipsis with relative clauses

- Now, consider a DP with a relative clause:
- the record [Op_i that Mary bought t_i].
- Bill likes [the record that Mary bought].
- Bill likes the record that Mary bought and Sue does too.
- Bill likes the record that Mary bought and Sue does (like the record that Mary bought) too.

ACD

- Bill likes every book Mary does.
- Bill [_{VP} likes every book Op_i Mary [_{VP} likes t_i]].
- vP : likes [every book Op Mary likes t]
- vP : likes t
- Those aren't the same. VP ellipsis *shouldn't* work, but yet it does.
- The deleted VP is *contained* in the antecedent VP (*antecedent-contained deletion*)

QR and ACD

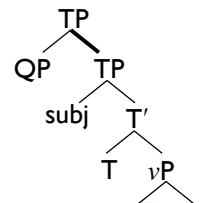
- But now let's consider what QR would do.
- *Every book that Mary likes* is a quantifier.
- Quantifiers have to move up past the subject by LF.
- Bill likes every book Mary does.
- Pronunciation (before covert movement):
Bill [_{VP} likes [every book Op_i Mary [_{VP} likes t_i]]].
- LF:
[every book Op_i Mary [_{VP} likes t_i]]_i Bill [_{VP} likes t_i].
- But now the VPs *are* identical. So QR allows us to explain ACD in a natural way.

Where do quantifiers go?

- Every student left.
- [Every student]_i [_{TP} t_i left]
- We need a variable in subject position, so QR must be moving the quantifier out of TP, to somewhere higher than TP.
- Believe me that it is also moving somewhere *lower* than CP.

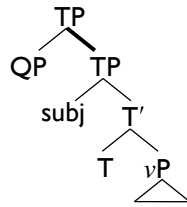
Adjunction to TP

- In order to accommodate this, we need to formulate a new position to which quantifiers move.
- This position is going to be *adjoined to TP*.



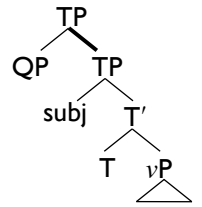
Adjunction to TP

- One difference between QR (adjunction to TP) and movement to SpecTP is in the motivations.
- Moving to SpecTP or moving to SpecCP is motivated by some need of T (EPP:T needs a DP in its specifier) or C ([Q] C needs a [+WH] in its specifier).
- Moving a quantifier (QR) is required because the *quantifier* needs to get out of the TP (for interpretation). TP *itself* has no need for quantifiers.



Adjunction to TP

- So, we could say that moving to Spec is something that happens if the moving thing is *pulled* (T is pulling up a subject to satisfy its own needs, not the needs of the moving subject) or *pushed* (quantifiers move to satisfy their own needs, not the needs of the T).
- An XP that is *pulled* up goes into Spec.
- An XP that is *pushed* up adjoins.



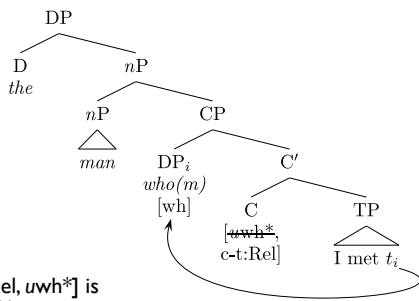
Relative clauses

- Another place where we see *wh*-movement, besides in explicit questions (either in the main clause or embedded) is in **relative clauses**.
 - The book which I read
 - The woman who(m) I met
- These consist of a **head noun** (*book, woman*) and then what appears to be a *wh*-question that further specifies the referent of the head noun.

Relative clauses

- Relative clauses serve to *modify* the head noun.
- Kind of like adjectives, or PP modifiers.
 - *The unhappy students.*
 - *The students from Vancouver.*
 - *The students who solved the problem.*
- So where would you put them?

Relative clauses



- The structure of a relative clause:
 - A CP [clause-type:Rel, *wh**] is adjoined to the NP, like an adjective, or a PP modifier.
 - The meaning is essentially “the man with the property of being the answer to ‘Who did I meet?’”
 - We’ll see in a moment that C [Rel] can be pronounced as either \emptyset or as *that*.

Differences between questions and relative clauses

- The “question” inside a relative clause has a couple of odd properties, not shared with regular main clause or embedded questions.
 - *The problem what I solved.
 - The problem which I solved.
 - The problem which I will solve.
 - The problem I solved.
 - The problem that I solved.

Which/that/∅

- In addition to being able to say
 - The book which Mary read
- We can also say
 - The book that Mary read
 - and
 - The book Mary read
- And they all mean the same thing. So we expect that they would all have basically the same structure (they all have a question adjoined in the *nP*)—**so where is the *wh*-word in the last two?**

Op

- The secret to these last two kinds of relative clauses is **Op, the silent *wh*-word**.
- That is, *the book which Mary read* and *the book Mary read* are really exactly the same except that in one case you pronounce the *wh*-word, and in the other, you don't.
 - the book [_{CP} which_i Mary read t_i]
 - the book [_{CP} Op_i Mary read t_i]

Op

- It is also possible to pronounce *that* with *Op*, giving us:
 - the book [_{CP} Op_i that [_{TP} Mary read t_i]]
- Why can't we pronounce *that* with *which*?
- *the book [_{CP} which_i that [_{TP} Mary read t_i]]

Doubly-Filled COMP filter

- The Doubly-Filled COMP filter is the traditional "explanation":
- **Doubly-Filled COMP filter:**
*_[CP wh-word if/that/for...]
- You can't pronounce both a *wh*-word and C at the same time. Thus:
 - the book [_{CP} Op_i [_{TP} Mary read t_i]]
 - the book [_{CP} Op_i that [_{TP} Mary read t_i]]
 - the book [_{CP} which_i [_{TP} Mary read t_i]]
 - *the book [_{CP} which_i that [_{TP} Mary read t_i]]

Op

- Skeptical of *Op*? Is there really *wh*-movement of *Op*, a silent *wh*-phrase?
- I read the book [_{CP} which_i [_{TP} Mary said [_{CP} that [_{TP} Bill bought t_i]]]].
- *I read the book [_{CP} which_i [_{IP} Mary wonders [_{CP} who [_{TP} bought t_i]]]].
- I read the book [_{CP} Op_i (that) [_{TP} Mary said [_{CP} that [_{TP} Bill bought t_i]]]].
- *I read the book [_{CP} Op_i (that) [_{TP} Mary wonders [_{CP} who [_{TP} bought t_i]]]].

Op

- If we have a silent *wh*-word, why can't we ask questions with it?
 - Where_i did Mary buy this book t_i ?
 - The place [_{Op_i} Mary bought this book t_i]
 - When_i did Mary buy this book t_i ?
 - The time [_{Op_i} Mary bought this book t_i]
 - Why_i did Mary buy this book t_i ?
 - The reason [_{Op_i} Mary bought this book t_i]
 - How_i did Mary buy this book t_i ?
 - The way [_{Op_i} Mary bought this book t_i]
 - *_{Op_i} did Mary buy this book t_i ?
- See why?

Op

- Recoverability condition: The content of a null category must be recoverable.
 - the place [Op_i (that) Mary bought that book t_i]
 - the day [Op_i (that) Mary bought that book t_i]
 - the reason [Op_i (that) Mary bought that book t_i]
 - the way [Op_i (that) Mary bought that book t_i]
- In each case, we can tell what the *wh*-phrase is by looking at the head noun.