Logical Form and Theta Theory: the syntax/semantics interface, Take One
LING 522, January 23, 2002

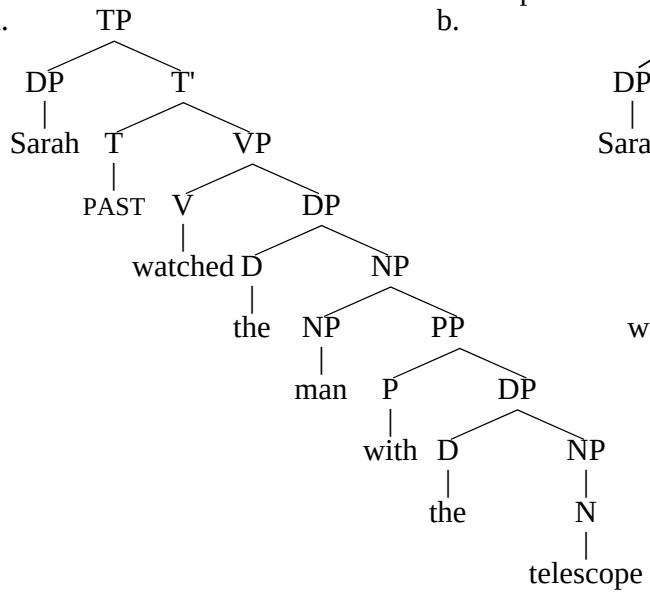
Logical Form (LF): To the present day, there are powerful reasons to believe that the logical form of a sentence (something we suppose is psychologically real) brings us a step closer to the meaning of that sentence, qua theoreticians and qua speakers. Something like the derivation of the LF of a sentence is an obligatory "passage" to get to the interpretation (the meaning) of that sentence.

1 Structural ambiguity = semantic ambiguity

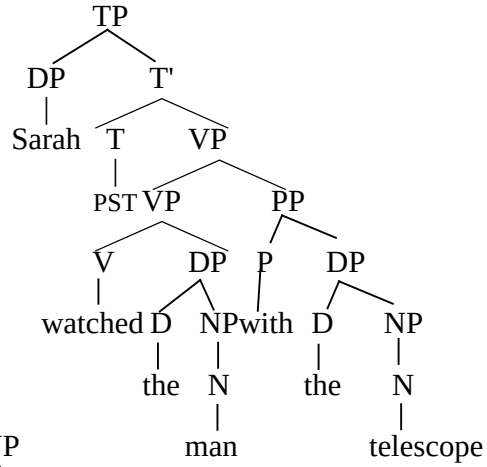
Before phrase structure came along as a claim about the hidden structure of sentences, there was no principled account of the ambiguity of strings like (1):

1. Sarah watched the man with the telescope.

2. a.



b.



The idea is that the semantic ambiguity is *caused by* syntactic ambiguity: either the PP can be structurally realized as an adjunct on the VP, in which case it modifies Mary's action (characterizing it as *with the telescope*), or the PP can be structurally realized as an adjunct on the NP, in which case it modifies the man, describing him as having a telescope. (That is, although the *string* is ambiguous, the *structure* never is — which seems correct in normal use: the speaker always knows which s/he means!)

3. a. Sarah borked the fendle with the dax.
   b. Sarah watched the man for an hour with the telescope (=2b, *2a).

This ambiguity can be brought out overtly by playing with word order, e.g. by introducing a temporal adverbial, as in 3b, in which case only the adjunct reading is available. The different structures correspond to different entailments:

4. a. The fendle had a dax → entailed by 2a but not 2b.
   b. Sarah did something using a dax → entailed by 2b but not 2a.

These are purely structural aspects of meaning. Similarly, some types of sentences appear to have inherent ambiguities and entailments that hold no matter what lexical items are involved:

5. a. All men are mortal. John is a man. Thus, John is mortal.
   b. All daxes are blicket. Quizbang is a dax. Thus, Quizbang is blicket.
   (c. Colorless green ideas sleep furiously. Superiority is a colorless green idea. Thus, Superiority sleeps furiously.)

6. A man is mugged every three minutes.
   a. For each three-minute time period, there is some man who is mugged during that interval — not the same man every time.
   b. That poor man! (There is some particular man such that every three minutes, that man is mugged).
   c. Every linguistics student reads some book (but I don't know which one).

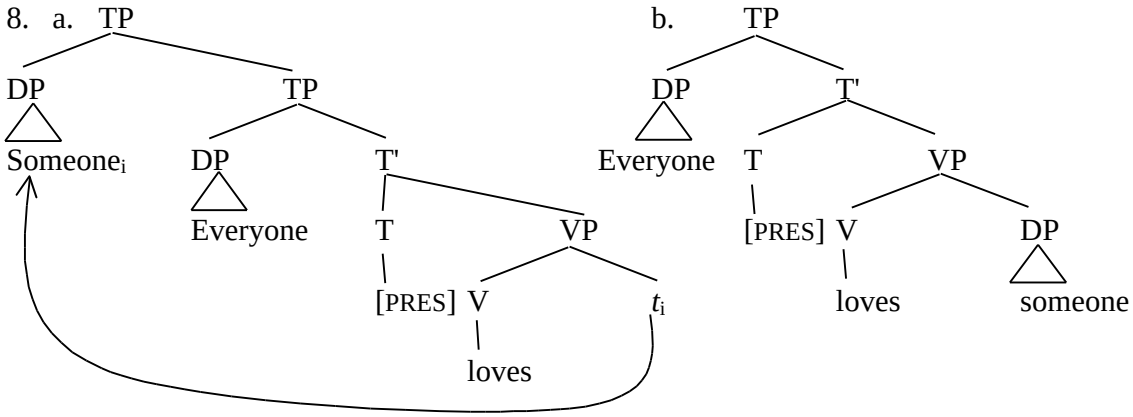
And, of course, as we saw last time, the entailments and ambiguities appear to be essentially structural — like the PP case, it doesn't matter what the actual predicates are.

The idea behind LF is that sentences like 6a are structurally ambiguous as well, and structurally ambiguous in a way that explains the semantic ambiguity in a similar way that the ambiguous modifier is accounted for above. The problem is that no messing with word order tests in English show how the structure of the string might differ on the various readings: the structure is apparently identical in both readings.

For a sentence like "Everyone loves someone", logicians have shown us a good way to capture the ambiguity:

7. a. $\forall x \exists y$ (x loves y)
   b. $\exists y \forall x$(x loves y)

It's a simple problem of scope — of whether the universal takes the existential in its scope, or the other way around. This looks very similar to the problem of PP modification above — the scope of modification is determined by what the modfiying phrase attaches to. We could accomplish the same thing for quantifier phrases if we proposed that the quantifier (or the whole quantified phrase) moves and adjoins to what it takes scope over:



This much movement will get the relative scope of the quantifiers right, but it doesn't make for a nice breakdown like that of the predicate-logic representation, where each quantifier binds a variable. In order to map to an interpretable predicate-logical representation, something more has to happen, generating variables for the quantifiers to bind and predicating them of the verb. Also, of course, there's the small problem of word order: this is not how you pronounce the sentence!

Is there anything that looks like a variable in either of these sentences? clearly there is — the *trace* in 8a. For independent reasons, traces of A-bar movement have been assumed to be bound variables. Consider the following:

9. Who did John think Mary saw *t*?

This means something like: *For what x, x a person, did John think Mary saw x*? The wh-phrase binds the trace that is the object of *see*. (And it has the advantage of doing it in the overt syntax — we can *see* that the wh-phrase has moved, and that *see* is missing an object).

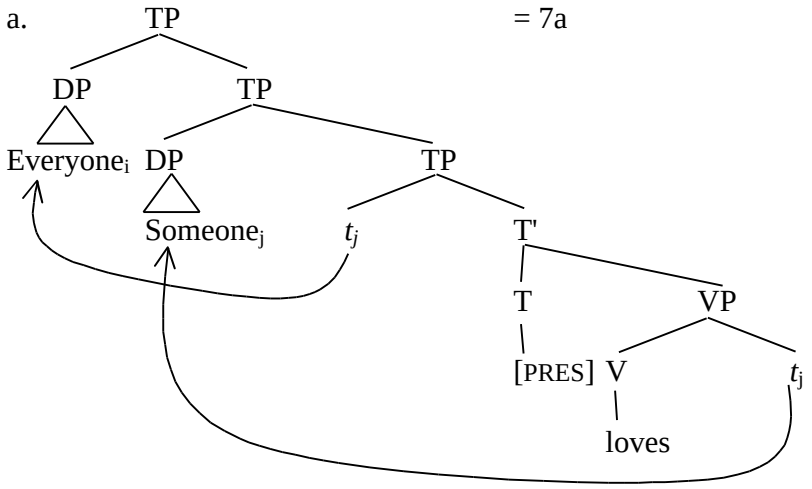
Note that *pronouns* can also be bound variables — in fact they're the prototypical bound variable: their reference varies with the quantifier, hence they are bound by it:

9'. a. Everyone$_i$'s mother loves him$_i$/them$_i$.
b. Everyone$_i$ loves his$_i$/their$_i$ mother.

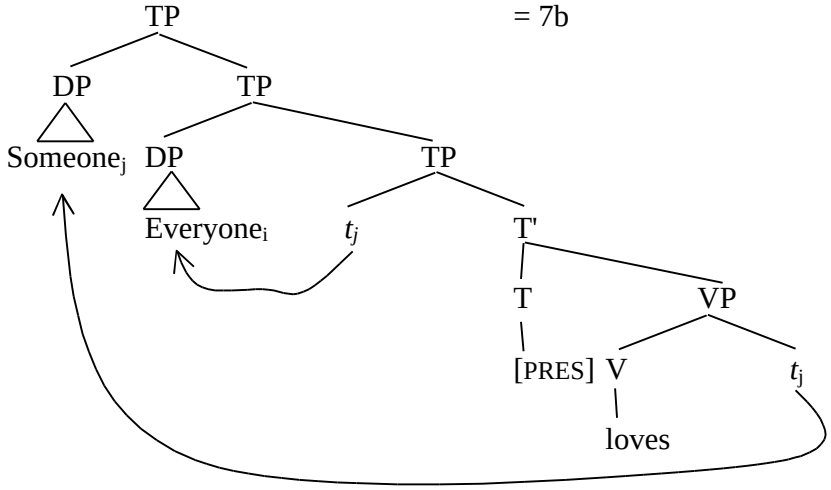
So A-bar traces are varbiables, and pronouns anteceded by quantifiers are variables; in some sense, an A-bar trace is just an unpronounced pronoun.

If traces can be bound variables, then we have all the tools we need to make the quantified phrases 8a and 8b look exactly like their predicate-logical counterparts:

9. a. = 7a



b. = 7b



So, if we assume (based on the evidence from adverbial modification) that *scope = c-command*, and we assume (based on evidence from wh-movement) that *A-bar trace = variable*, we can create a syntactic representation of quantified sentences that are exactly isomorphic to the predicate logic representations that we (think we) understand, using just syntactic tools like *Move-α*.

Problem: in English, the pronounced form of the sentence looks nothing like this!
Question: is there any evidence that these movements actually do take place? We have tests that we can use, based on our understanding of movement theory from data where we can actually see the movement.

10. 2 possibilities:

a) (Generative semanticists): D-structure = meaning. Therefore the predicate-logical representation is the one that ought to be projected, and the surface form derived from that. Basically, you ought to start with forms like in (9) and move the

quantifiers *down* to the position of their variables to pronounce it. That is, base-generate the scrambled order.

b) (Interpretive semanticists): These are syntactic movements like any other syntactic movements; they transform the base-generated structure. If syntactic movement affects meaning, then what we can conclude is that the D-structure hypothesis is *wrong* — meaning is an amalgam of lexical properties *plus the syntactic derivation:* Interpretation must happen *post*-syntactically, not pre-syntactically.

➔ not only that, but there must be syntactic movement happening that we cannot see — syntax *after* s-structure, which generates the Logical Form that is the input to the conceptual-intensional system (the *real* semantics).

If (b) is right, then the movements that take place in the hidden dimension should have properties that we associate with regular movement operations. That will then mitigate against (a), as well, since the downward movement that they would have to propose to capture such facts is unlike any other movement in the generative paradigm — move-α is always *upward*, for the hypothesized reason that traces of movement are anaphors which must be bound by their antecedent — where *bound* = c-commanded locally by their antecedent. Since the whole point of these empty categories is that they *be* bound and hence behave like bound variables, to propose that some other kind of movement is responsible seems like shooting yourself in the foot.

So, is there any reason to think that (b) is right? That is, is there any evidence that movement actually can take place where we can't see it?

11. Two kinds of places to look for hidden movement:
    a) are sentences like 7 subject to any type of restriction that we know regular, overt movement in English (like wh-movement) is subject to?
    b) cross-linguistic evidence:
        i) do some languages move their quantifier phrases overtly?
        ii) do some languages move their wh-phrases covertly?

It turns out the answer to both (a) and (b), and both parts of (b), is *yes*.

A: Evidence from apparent similarities between LF movement of quantifiers and wh-movement, which is a kind of movement we know something about:

Weak Crossover

12. a. $John_i$ loves his_i mother.
    b. Every boy_i loves his_i mother.
    c. *He_i loves $John_i$'s mother.
    d. *He_i loves every boy_i's mother.
    e. His_i mother loves $John_i$.

f. Who$_i$ does Mary think loves his$_i$ mother?
g. ??His$_i$ mother loves every boy$_i$.
h. ??Who$_i$ does his$_i$ mother love?

Judgements in a-f are predicted by the Binding Theory. g-h, however, should be legitimate interpretations, as far as the binding theory is concerned, but they're very odd. Not only that, their surface structures are very different, which seems to imply that they require a different treatment. But, if we propose QR of *every boy* in (g), their structures become identical, and we can argue that whatever constraint rules out (h) also rules out (g). One possible such constraint is that each quantifier can only bind *one* variable — Koopman and Sportiche's Bijection Principle. Multiple binding (as in g & h) of two variables by one quantifier is ill-formed in natural language. (Note that it's probably ok in predicate logic — x(x likes x) is perfectly well-formed).

Inverse Linking

13. Inverse linking: If QR produces traces, and if traces must be locally bound by their A-bar antecedent (the Proper Binding Condition), then QR should not be able to generate structures with unbound traces in them — readings containing unbound traces should be illegitimate.

[Some man from [every California city]] owns a Porsche.

Reading 1: There is some man from every California city (that is, one single man who has lived in every California city) who owns a Porsche. (an unlikely reading, but a possible one.
Reading 2: In every California city, there is some man (a different man in each city) who owns a Porsche.

These two readings correspond to the following two QR structures:

1: $[_{TP}\ [_{DP}$ Some $[_{NP}\ [_{DP}$every California city$]_i\ [_{NP}$ [man] [from t_i]]] $]_j\ [_{TP}\ t_j$ owns a Porsche] $_{TP}]$

2: $[_{TP}\ [_{DP}$ every California city$]_i\ [_{TP}\ [_{DP}$ Some man from $t_i]_j\ [_{TP}\ t_j$ owns a Porsche] $_{TP}]\ _{TP}]$

(In (1), *every California city* has adjoined to the NP within *Some man from every California city*: this gives it DP-internal scope over a variable that is the complement to *from*.)

(In (2), first, *Some man from every California city* has adjoined to TP, binding a variable in subject position of TP (the subject of *owns a Porsche*). Then, *every California city* has QRed and adjoined to the new TP created by the previous adjunction, binding a trace that is the complement to *from* and taking scope over the existential quantifier in *some*).

Note, though, that there is a third possible structure predicted by QR: what if *every California city* moved all the way out of its containing DP (as in 2 above) and adjoined to TP first, and then *Some man from* adjoined to TP second? That would give the following structure:

3: $[_{TP}\ [_{DP}$ Some man from $t_i]_j\ [_{TP}\ [_{DP}$ every California city$]_i\ [_{TP}\ t_j$ owns a Porsche$]\ _{TP}]\ _{TP}]$

This structure should have a reading as follows: For some person x, every California city is such that x owns a Porsche — barely intelligible (although predicate-logically well-formed) and certainly not an available reading. And if QR is a syntactic process, we already have a built-in explanation of why this reading is not available: Proper Binding. Once the quantifier phrase *Some man from* t_i is moved upward across *every California city*, the trace of *every California city* is no longer properly bound by its antecedent (its antecedent does not c-command it!). Hence the syntax rules out this structure, and the available interpretations of the sentence confirm that no such syntactic structure ever makes it to the interpretive component.

Wh-interpretation in quantificational environments

14. Interactions between wh-phrases and quantifiers confirm that quantifiers are some type of animal that is very similar to a wh-phrase:

a. What did everyone buy for Max?
wh>everyone answer: "A nintendo set." (everyone got together and bought it)
everyone>wh answer: John got him a tie, Mary got him a tea set, Betty got him…

Two scopes, corresponding to the idea that wh-phrases are quantificational and can interact with quantifiers.

b. Who bought everything for Max?
wh>everything answer: John bought him everything (all the presents you see)
*everything>wh answer: John got him the tie, Mary got him the tea set, Betty got him…

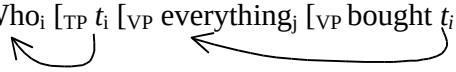
May argued that this is an effect of the Path Containment Condition proposed by Pesetsky — paths have to nest. (Very much like "attract closest" in Minimalism). Here's the idea:

15. in 14a) the LF structure is
$[_{CP}$ What$_i\ [_{C'}$ did $[_{TP}$ everyone$_j\ [_{TP}\ t_j\ [_{VP}$ buy t_i for Max$]]]]]]$?

Crucially, May claims that this is enough to get *both* readings — even though *everyone* hasn't moved to the left of *what* — because *everyone* and *what* are so close together in the structure (they m-command each other, according to GB assumptions), either one can take wide scope. Note that the path travelled by *everyone* is nicely nested inside the path travelled by *What*. (This account would mean that we'd have to revise the trees for various scopes in (9) above).

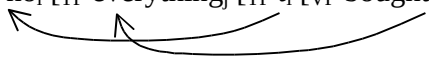
16. in 14b), the LF structure is:

a. $[_{CP}$ Who$_i$ $[_{TP}$ t_i $[_{VP}$ everything$_j$ $[_{VP}$ bought t_i for Max]]]]?



In order for the non-existent wide-scope reading for *everything* to occur, *everything* would have to get up to adjoin to TP, where it would be very close to *who*$_i$. But if it did that, the structure would be the following:

b. $[_{CP}$ Who$_i$ $[_{TP}$ everything$_j$ $[_{TP}$ t_i $[_{VP}$ bought t_j for Max]]]]?



The paths would have to *cross* — violating the Path Containment Condition (or Attract, in more modern terms). That's why, according to May, the wide-scope reading for *everything* is unavailable here.

Restrictive Quantification

Finally, a note on why QR is nice from a syntax/semantics isomorphism perpective:
In predicate logic, there's two ways to represent sentences containing universal quantification: as if-then statements, or as restricted quantifications:

17. Every student flunked.

x ((x is a student) → (x flunked))	(conditional — unrestricted)
x:x is a student (x flunked)	(restrictive quantification)

Similarly with existential quantification:

18. A student flunked.

x ((x is a student) & (x flunked))	(coordination — unrestricted)
x:x is a student(x flunked)	(restrictive quantification)

In fact, with sentences like 17 and 18, there's no way to choose which is the right representation. But with some very similar quantificational structures, we can see that restrictive quantification is the way to go.

19. a. Which man is a bachelor?

i)	Whichx ((x is a man) & (x is a bachelor))?	(coordination — unrestricted)
ii)	Whichx:x is a man (x is a bachelor)?	(restrictive quantification)

b. Which bachelor is a man?
   i) Whichx ((x is a bachelor) & (x is a man))? (coordination — unrestricted)
   ii) Whichx:x is a bachelor (x is a man)? (restrictive quantification)

Consider reading 19a(i) and 19b(i): left-to-right order should be irrelevant in the quantified-over part of the structure, because coordination isn't sensitive to such things, so these two representations should be equivalent. But question 19a is normal, while 19b is weird (because all bachelors are men!). The restrictive quantification option is much more appropriate, as it captures the idea that "Which bachelor" is asking a question about some member of the set of bachelors. not just any old person out there in the world. (Compare, on the other hand, the equivalence of "Some cats are mouse-eaters" and "Some mouse-eaters are cats".)

And for the inadequacy of conditional interpretations of strong quantifiers, consider:

20. Most students flunked:
   (i) Mostx((x is a student) → (x flunked)) (conditional — unrestricted)
   (ii) Mostx:x is a student(x flunked) (restrictive quantification)

Recall from your predicate logic class that if the antecedent to a conditional is false, the whole conditional is true. (20i) says, "For most people x it is the case that (if x is a student, x flunked). Now, this will turn out to be true for everybody that's not a student — which is surely most people in the world — so even if *none* of the students flunked, for most people it'll be a true statement. So "Most students flunked" should turn out to be true (or at least not false) even in a world where no students flunked (as long as there are more non-students than students), which it obviously isn't. On the other hand (20ii) says something much closer to the meaning of the sentence: Of the set of students, *most of that set* flunked.

So restrictive quantification takes care of more interpretive phenomena than unrestricted quantificiation. What on earth has that got to do with QR?

→ well, if QR is syntactic movement, subject to the regular constraints on such movement, it's movement of *phrases*, not heads. So a sentence like "John likes every student that he knows" has an LF representation like 21a, not 21b:

21. a. [[Every student that he knows] [John likes *t*]]
   b. [[Every] [John likes [*t* student that he knows]]

Now, which of the structures in 21 is more isomorphic to the restricted quantification representation in predicate logic, noted above? 21a, which is legitimate syntactically, also looks closer to the right predicate-logical representation. 21b, which is illegitimate syntactically, is closer to the unrestricted cases. Given that we have seen that restricted quantification is in fact what we get in these cases, we can argue that that's because QR is syntactic movement and syntactic movement must target *phrases* — hence restrictive quantification is the only choice here.

(It might be the case, though, that adverbial quantification languages do unrestricted quantification — which is what we'd expect if adverbs don't form a constituent with the things they can quantify over. (Eloise?)) Also, consider the interaction of quantification and negation:

23. a. All that glitters is not gold. (= it is not the case that everything that glitters is gold)
    b. All my brothers aren't coming to the store. (= every one of my brothers are such that they aren't coming to the store = no brothers are coming)
    a'. All that glitters is not gold (= every thing that glitters is such that it is not gold = no glittering things are gold).
    b'. All my brothers aren't coming to the store (=it is not the case that every one of my brothers are coming to the store — just a few are).

Do we want to propose a rule of negation movement? How can we give sentential negation optionally wide scope, esp. if negation is a *head* (of a projection like NegP)?

B: Evidence for LF from cross-linguistic investigation of moving vs. non-moving quantificational constituents:

23. Evidence from scrambling languages: In a language like Hungarian or Persian, DPs can be moved around fairly freely in a sentence. In such languages, the scope of quantifiers is completely fixed, depending on what order they appear in the sentence. This could be Overt Quantifier Raising. If English has such a process, except that it isn't reflected by the order the words are uttered in, UG will be simpler.

Evidence from wh-movement cross-linguistically: wh-in-situ

24.	a.	What does John think [Mary bought *t*] ?	matrix wh-- direct question
	b.	*John thinks [what Mary bought *t*].	embedded wh -- statement
	c.	*What does John wonder [Mary bought *t*] ?	matrix wh- direct question
	d.	John wonders [what Mary bought *t*]	embedded wh -- statement
	e.	What does John remember [Mary bought *t*] ?	matrix wh-- direct question
	f.	John remembers [what Mary bought *t*].	embedded wh -statement.

This can be expressed as selectional restrictions on the type of clause that each verb takes as its complement:

think [-wh]
wonder [+wh]
remember [± wh]

25. a. Zhangsan yiwei Lisi mai-le shenme?
Zhangsan thinks Lisi bought what?
direct question.

b. Zhangsan xiang-zhidao Lisi mai-le shenme.
Zhangsan wonders Lisi bought what
statement

c. Zhangsan jide Lisi mai-le shenme
Zhangsan remembers Lisi bought what
direct question OR *statement*

So, in English, these distinctions are marked grammatically, via wh-movement to the matrix or embedded clause. In Chinese, they seem to be marked interpretively only. BUT, if LF is a real level, and Chinese has covert LF movement, then these interpretive differences will be marked formally (grammatically) in Chinese as well — reducing the load on the interpretive component and making a nice UG account. That means that at LF, the sentences in 25 in Chinese will have the following structures, corresponding exactly to 24a and d,e,f in English:

26. a. [shenme [Zhangsan yiwei [Lisi mai-le *t*]]]
What Z. thinks Lisi bought?
b. [Zhangsan xiang-zhidao [shenme [Lisi mai-le *t*]]]
Z. wonders what Lisi bought.
c. [shenme [Zhangsan jide [Lisi mai-le *t*]]]
what Z remembers Lisi bought?
d. [Zhangsan jide [shenme [Lisi mai-le *t*]]]
Z. remembers what Lisi bought.

There are obviously lots of questions: whether *in-situ* wh-phrases in English raise at LF; whether LF movement is subject to the same conditions as overt movement (e.g. does LF movement have to take the whole pied-piped phrase along, like overt movement? Our discussion of restrictive modification would imply *yes*, but in fact other evidence suggests that *no*), whether LF movement is subject to things like the PCC, etc. But what I hope you understand is *why* there's supposed to be a level of LF – why the grammar looks like this: