Lecture 6. NP Interpretation, Quantification, and Type-shifting.

Suggested reading: Partee, Barbara (1986) "Noun phrase interpretation and type-shifting principles", in Groenendijk, de Jongh, and Stokhof, eds., *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*, GRASS 8, Foris, Dordrecht, 115-143.

1. Linguistic background:

1.1. Tension between simplicity and generality, between uniformity and flexiblity

Example: Natural language NP's (noun phrases): *John, every man* both NP's. Same type?

Montague: Yes: all NP's type <<e,t>,t>.
John: $\lambda P.P(j)$
every man: $\lambda P.\forall x[man(x) \rightarrow P(x)]$

$$\left\{ \begin{array}{l} John \\ every\ man \\ no\ man \end{array} \right\} + walks$$

t/IV IV $\Rightarrow$ t

Montague's category-to-type correspondence: uniform and general, not "simple" (generalized to highest types ever needed), not flexible.

Linguistic evidence (Section 2.2): Some NPs are of type e, some type <e,t>, some type <<e,t>,t>.

1.2. General processing strategy proposal:

Partee and Rooth (1983) on conjunction: (not included this year). There we argued that transitive verbs come in two different types, but that when they are conjoined, the "lower-type" verbs automatically type-shift to the higher type so that conjunction can always conjoin two elements of the same type.

Similarly, if we said that *the teacher* is type e and *every student* is type <<e,t,>,t>, we would expect that they couldn't conjoin. But they can. Solution: *The teacher* can shift from a type e meaning to a type <<e,t>,t> meaning, then conjunction can proceed.

General strategy: (from Partee and Rooth 1983):
"Use the simplest types consistent with coherent typing of entire sentence." Higher types invoked by "coercion": e.g. to conjoin *John and every woman*, *needed and bought.* There is in principle nothing wrong with infinite ambiguity if the system is designed to access higher types only when there is some reason to do so.

Query: What does it take to insure that such a system of flexible typing and type-shifting will always yield a unique "simplest" result? Under what conditions or by what measures does such a strategy offer greater overall simplicity than Montague's strategy of uniformly generalizing to the "hardest case"?

2. NP Type Multiplicity

2.1. Montague tradition:

Uniform treatment of NP's as generalized quantifiers, type $(e\rightarrow t)\rightarrow t$.

John	$\lambda \boldsymbol{P}[\boldsymbol{P}(\mathbf{j})]$
a man	$\lambda \boldsymbol{P}\exists \boldsymbol{x}[\mathbf{man}(\boldsymbol{x}) \ \&\ \boldsymbol{P}(\boldsymbol{x})]$
every man	$\lambda \boldsymbol{P}\forall \boldsymbol{x}[\mathbf{man}(\boldsymbol{x}) \rightarrow \boldsymbol{P}(\boldsymbol{x})]$

Intuitive type multiplicity of NP's:

John	"referential use":	**j** (or **John**)	type e
a fool	"predicative use":	**fool**	type $e\rightarrow t$
every man	"quantifier use":	as above	type $(e\rightarrow t)\rightarrow t$

Resolution (Partee 1986a): All NP's have meaning of type $(e\rightarrow t)\rightarrow t$; some also have meanings of types e and/or $e\rightarrow t$. Find general principles for predicting these. Predicates may semantically take arguments of type e, $e\rightarrow t$, or $(e\rightarrow t)\rightarrow t$, among others.

Type choice determined by a combination of factors including coercion by demands of predicates, "try simplest types first" strategy, and default preferences of particular determiners.

2.2. Evidence for multiple types for NP's.

Evidence for type e (Kamp-Heim): While any singular NP can bind a singular pronoun in its (c-command or f-command) domain, only an e-type NP can normally license a singular discourse pronoun.

(9) John /the man/ a man walked in. He looked tired.
(10) Every man /no man/ more than one man walked in. *He looked tired.

Evidence for type <e,t>: subcategorization for predicative arguments and conjoinablility of predicative NPs and APs in such positions.

(11) Mary considers John competent in semantics and an authority on unicorns.
(12) Mary considers that an island /two islands / many islands / the prettiest island / the harbor / *every island / *most islands / *this island / *?Hawaii / Utopia.

In general, the possibility of an NP having a predicative interpretation is predictable from the model-theoretic properties of its interpretation as a generalized quantifier; apparent counterexample (13) from Williams (1983) can be explained (see Partee (1986))

(13) This house has been *every color*.

2.3. Some type-shifting functors for NPs.

[diagram 1 is cut and pasted
from p. 121 of Partee (1986)]

DIAGRAM 1

lift:	$\mathbf{j} \rightarrow \lambda P[P(\mathbf{j})]$	total; injective
lower:	maps a principal ultrafilter onto its generator	partial; surjective
	lower (lift (j)) = j	
ident:	$\mathbf{j} \rightarrow \lambda x[x = \mathbf{j}]$	total; injective
iota:	$P \rightarrow \iota x[P(x)]$	partial; surjective
	iota(ident(j)) = j	
nom:	$P \rightarrow {}^{\cap}P$ (Chierchia)	almost total; injective
pred:	$x \rightarrow {}^{\cup}x$ (Chierchia)	partial;surjective
	pred (nom(*P*)) = *P*	

2.4. "Naturalness" arguments: THE, A, and BE.

(14) **THE**: $Q \Rightarrow \lambda P[\exists x[\forall y[Q(y) \leftrightarrow y = x]] \ \&\ P(x)]$
A: $Q \Rightarrow \lambda P[\exists x[Q(x) \ \&\ P(x)]$
BE: $\mathbf{P}_{<<e,t>,t>} \Rightarrow \lambda x[\ \mathbf{P}(\lambda y[y = x])]$ or $\lambda x[\{x\} \in \mathbf{P}]$

Compare Montague's "transitive verb" *be*: $\lambda \mathbf{P}_{<<e,t>,t>}[\lambda x[\ \mathbf{P}(\lambda y[y = x])]]$

2.4.1 THE

The argument in Partee (1986) for the naturalness of **THE** comes largely from considering the interpretations of definite singular NPs like "the king" in all three types. I will not go through the argument here in detail, but will just summarize the main points with the aid of Diagram 2.

[diagram 2 is cut and pasted
from p. 123 of Partee (1986)]

Diagram 2

[Solid lines indicate total functions, dotted lines partial ones.]

Iota and **THE** are related to each other by the fact that whenever **iota** is defined, i.e. whenever there is one and only one king, **lift** (**iota** (**king**)) = **THE** (**king**) and **lower** (**THE** (**king**)) = **iota** (**king**), and furthermore whenever **iota** is not defined, **THE** (**king**) is vacuous in that it denotes the empty set of properties.

(15) <u>**Proposal about BE**</u>: **BE** is not the meaning of English *be* but rather a type-shifting functor that is applied to the generalized quantifier meaning of an NP whenever we find the NP is an <e,t> position.
(16) <u>**Proposal about *be***</u>: (following Williams (1983)) The English *be* subcategorizes semantically for an e argument and an <e,t> argument, and has as its meaning "apply predicate", i.e. $\lambda P \lambda x[P(x)]$.
Then the predicative reading of *the king* is as given in (17).

(17) **Predicative reading of *the king*: BE(THE(king))**

In terms of logical formulas, **BE**(**THE**(**king**)) works out to be $\lambda x[\mathbf{king}(x) \ \&\ \forall y[\mathbf{king}(y) \leftrightarrow y = x]]$, or equivalently, $\lambda x \exists y[\mathbf{king}(x) \rightarrow x = y]]$. This gives the singleton set of the unique king if there is one, the empty set otherwise. It is always defined, so the predicative reading also requires no presuppositions.

Note that if there is <u>at most</u> one king, then **king** = **BE**(**THE**(**king**))

(18) (a) John is {the president / president}
(b) John is {the teacher / *teacher}

The double-headed arrow on the **ident** mapping in Diagram 2 reflects the fact that for **iota** to be defined there must be one and only one king, hence **king** = **BE**(**THE**(**king**)) = **ident**(**iota**(**king**)). In fact, when iota is defined, the diagram is fully commutative: **king** = **BE**(**THE**(**king**)) = **ident**(**iota**(**king**)) = **ident**(**lower**(**THE**(**king**))) = **BE**(**lift**(**iota**(**king**))), etc. This property of the mappings lends some formal support to the idea that there is a unity among the three meanings of *the king* in spite of the difference in type.

2.4.2 A and BE

Let **A** be the categorematic version of Montague's treatment of *a/an*: in IL terms, $\lambda \boldsymbol{Q}[\lambda \boldsymbol{P}[\exists x[\boldsymbol{Q}(x) \& \boldsymbol{P}(x)]]$. If we focus first on the naturalness of **BE**, we can then argue that **A** is natural in part by virtue of being an inverse of **BE**. The operation **BE** has some very nice formal properties that are summarized in (19) and (20) below.

(19) Fact 1: **BE** is a homomorphism from <<e,t>,t> to <e,t> viewed as Boolean structures, i.e:

$$\mathbf{BE}(P_1 \cap P_2) = \mathbf{BE}(P_1) \cap \mathbf{BE}(P_2)$$
$$\mathbf{BE}(P_1 \cup P_2) = \mathbf{BE}(P_1) \cup \mathbf{BE}(P_2)$$
$$\mathbf{BE}(\neg P_1) = \neg \mathbf{BE}(P_1)$$

(20) Fact 2: **BE** is the unique homomorphism *h* that makes Diagram 3 commute.

[diagram 3 is cut and pasted
from p. 126 of Partee (1986)]

DIAGRAM 3

Now what exactly does **BE** do? We can write an expression equivalent to Montague's IL interpretation of English *be* but in set- theoretical terms as follows: $\lambda \mathbf{P}\lambda x[\{x\} \in \mathbf{P}]$. That is, it

applies to a generalized quantifier, finds all the singletons therein, and collects their elements into a set. The commutativity of Diagram 3 is then straightforward. So **BE** is indeed a particularly nice, structure-preserving mapping from <<e,t>,t> to <e,t>.

(21) (MG) **be**(**TR**(*a man*)) = **be** ($\lambda P \exists x[\mathbf{man}(x) \& P(x)]$)
= $\lambda x[\mathbf{man}(x)]$
= **man**
(MG) **be**(**TR**(*John*)) = **be** ($\lambda P\, P(\mathbf{j})$)
= $\lambda x[x=\mathbf{j}]$
(MG) **be**(**TR**(*no man*)) = $\lambda x[\neg \mathbf{man}(x)]$
(MG) **be**(**TR**(*every man*)) = $\lambda x[\forall y[\mathbf{man}(y) \rightarrow y=x]]$

Now, having given some grounds for claiming that **BE** is a "natural" type-shifting functor, we can use that to support the naturalness of **A**, since it turns out that **A** is an inverse of **BE** in that **BE**(**A**(***P***) = ***P*** for all ***P***.

I would conjecture, in fact, that among all possible DET-type functors, **A** (which combines English *a* and *some*) and **THE** are the most "natural" and hence the most likely to operate syncategorematically in natural languages, or not to be expressed at all, and that **BE** is the most "natural" functor from <<e,t>,t> meanings to <e,t> meanings.

2.5 Further Discussion Topics.

If time remains, we may want to discuss some further topics related to type shifting and coercion, including the shiftability of weak NPs to predicate readings and the various possibilities for *two, three*, etc.

2.5.1. Cardinal numbers as adjectives or determiners

The following is based on material on and around p. 130 in Partee (1986).

Suppose the basic type for cardinals is <e,t>: predicates of individuals. A "plural individual" such as the group denoted by *John, Bill and Harry* will have the property denoted by *three* if it is a plural individual with exactly three atomic parts.

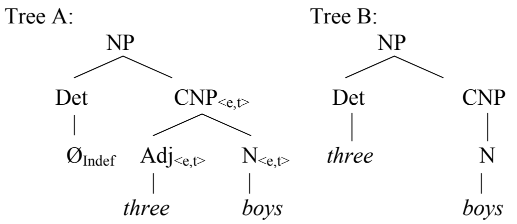
(22) $\mathbf{TR}(three_{<e,t>}) = \lambda x\, [\mathbf{three}\,(x)\,]$

Then *three* is like simple adjectives like *blue*, type <e,t>. If we want to make adjectives into functions that take the noun as argument, we can type-shift *three* or *blue* to meanings like the following:

(23) $\mathbf{TR}(three_{<<e,t>,<e,t>>}) = \lambda P \lambda x[P(x) \,\&\, \mathbf{three}\,(x)]$

Now suppose we wanted to say that a numeral could sometimes act as a determiner. In particular let us suppose that the following two structures could have the same semantics, with the tree on the left representing the more "semantically transparent" structure.

For familiarity, we follow Montague's interpretation of the indefinite article, although Heim's approach could also be applied to such examples.



Tree A: **TR**(*three*$_{<e,t>}$ *boys*) = $\boldsymbol{\lambda x[\textbf{boy*}(x)\ \&\ \textbf{three}\ (x)]}$ (where **boy*** is a predicate of plural entities that is true of ***x*** if **boy** is true of each of the atomic parts of ***x***. This comes from Link, which we'll read for next week.)

(24) $\textbf{TR}(Ø_{Indef}) = \textbf{TR}(a) = \boldsymbol{\lambda Q \lambda P[\exists y\ [Q(y)\ \&\ P(y)]]}$

(25) $\textbf{TR}(Ø_{Indef}\ \textit{three boys}) = \boldsymbol{\lambda Q \lambda P[\exists y\ [Q(y)\ \&\ P(y)]]\ (\lambda x[\textbf{boy*}(x)\ \&\ \textbf{three}\ (x)]\ )}$
which reduces in two steps to:

$$\boldsymbol{\lambda P[\exists y\ [\textbf{boy*}(y)\ \&\ \textbf{three}\ (y)\ \&\ P(y)]]}$$

Tree B:

To get the same meaning from Tree B, we just have to assume that the meaning of Det *three* is obtained by **function composition** of the meanings of the Det $Ø_{Indef}$ and the Adjectival *three*:

(26) $\textbf{TR}(\textit{three}_{DET}) = \boldsymbol{\lambda Z\ [\textbf{TR}(Ø_{Indef})\ (\textbf{TR}(\textit{three}_{<e,t>})\ (Z)\ )\ ]}$

2.5.2. The Williams puzzle: (Partee 1986, pp 132-136)

(27) *This house has been every color.*

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HOMEWORK #3: Quantification and Properties of Russian Determiners. Due April 8.

Choose two or three that suit your level and your interests. Feel free to modify the problems if you wish, and/or to work on or discuss near-equivalents. Do at least one from problems 1-6 (Lecture 6) and at least one from problems 7-9 (Lecture 5.)

Everyone please do problem 9, so that we can collect and compare the results.

1. a. Look back at Fragment 1 in Lecture 3. At the end of Section **1.3** is a translation of *is* a_{pred} *man*. Work out how that translation results from compositional semantic rules plus simplification via lambda-conversion.

   b. Show how the same translation could be achieved by first interpreting *a man* as a generalized quantifier (Montague's translation), and then applying the **BE** type-shifting operator to shift the interpretation to type <e,t> (and simplifying the result by lambda-conversion); the remainder of the derivation (combining with the *be* of Lecture 3) would be the same, so you needn't repeat it.

2. Approaches to Russian "bare singular NPs". Consider a singular noun like *mal'čik* or *kniga* used as a complete NP with no article.

(i) Find a context in which you believe the NP is best interpreted as a predicate of type <e,t>, the same type as a lexical common noun. What evidence can you find for treating the NP in that context as type <e,t>?

(ii) Assume that the subject of a transitive or intransitive verb is normally a type e or <<e,t>,t> position. Here are some hypotheses that could be considered for interpreting a bare singular NP as a type e or <<e,t>,t> NP in subject position.

(a) There is a singular empty Det in Russian whose interpretation is neutral between definite and indefinite.

(b) There are two or three different empty Det's in Russian: definite, indefinite, and perhaps "generic" (But I don't plan to try to discuss "generic" now).

(c) There is no empty Det in Russian at all. When a noun with no Det (or a common noun phrase, CNP, with no Det), of type <e,t>, occurs in subject position, it type-shifts to a type e or a type <<e,t>,t> interpretation. (Either a single unambiguous interpretation, neutral between definite and indefinite, by a single type-shifting principle, or else ambiguously, with two or three available type-shifts analogous to the two or three empty determiners hypothesized in (b).)

Look back at the fragment grammar of English in the handout of Lecture 3. For one of the alternatives (a), (b), or (c) (your choice), modify the rules that relate to CN(P), NP and DET to fit that alternative. (That includes the chart in 1.1, the Syntactic Rules in 1.2, possibly the type-driven translation principles in 1.2.2.1, and the lexical meanings of the determiners in 1.3.)

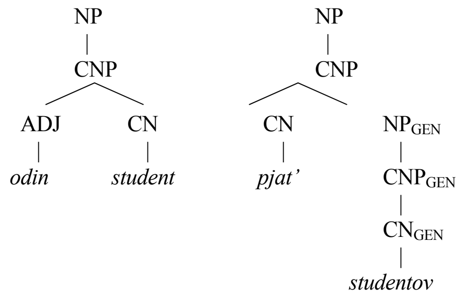
(iii) Can you think of other hypotheses for interpreting a bare singular NP as the subject of a sentence?

3. Where would you start looking for arguments to help decide the issues raised in question 2? (This is an open-ended problem. Any beginnings of suggestions are welcome.)

4. Show that the following claim made on page 124 of Partee (1986) is true:
(i) Whenever *iota*(*king'*) is defined, i.e. whenever there is one and only one king, then
lift(*iota*(*king'*) = *THE* (*king'*)

5. Show that the following claims made on pages 124 -125 of Partee (1986) are true:
(i) *BE*(*THE* (*king'*)) is of type <e,t>.
(ii) If there is at most one king, then *king'* = *BE*(*THE* (*king'*))

6. On p. 130 in Partee (1986) there is some discussion of the possibility of treating numerals like *two, three* either as adjectives or as indefinite determiners, with easy type-shifts between the two uses. In Russian, some numerals seem like adjectives, some seem more like nouns (governing genitive on their complement.) Suppose that were true. I.e. suppose it were correct that the syntactic structures for *odin student* and *pjat' studentov* were as below. Does it follow that the resulting semantics of the entire NP would have to come out different? Why or why not? What relevant principles of type-shifting or type-driven translation can you think of to help make the semantics more uniform than the morphology and the surface syntax?
(Note: we have not discussed plurals. So in order to avoid the complications of the singular-plural difference between *odin* and *pjat'*, it would be ok for now to pretend that the second tree has the same lexical items as the first, i.e. *odin student* with two different syntactic structures.)



For the next questions, look back at the handout for Lecture 5, Section 3.2. on Weak Determiners in Russian.

7. Give examples to show that "V komnate est' _______" is not a perfect example of an environment which permits only weak determiners. Do you agree with the students in the 2001 class that the environment "U nego est' ______ sestra/sestry/sester." IS a good example of a 'weak-determiners-only' environment? What about "V komnate imeetsja _______" ?

8. The environments "V komnate est' _______" and "V komnate imeetsja _______" seem to be *almost* successful test-environments for weak vs. strong. Can you identify any of the additional factors that make strong determiners sometimes possible in those environments?

9. Once again, let's try to classify the following Russian determiners as weak or strong: Один, этот, каждый, много, многие, несколько, никакой. (Add others if you wish.)
a. Test them in the environment "U nego est' ______ sestra/sestry/sester."
b. Use Keenan's "symmetry" test, given on page 6 of the handout of Lecture 5.
c. Report and discuss any apparent mismatches between the evidence from the syntactic test (a) and the evidence from the semantic test (b).