Lecture 6. Dynamic Semantics, Presuppositions, and Context Change, II.

Readings: Full references and links are in References at the end. These are all on the CD.
(1) (Heim 1983a) On the projection problem for presuppositions.
(2) (Kamp 1981) A theory of truth and semantic representation.
Optional readings:
(3) (Heim 1982) Heim dissertation, Chapter 3.
(4) (Heim 1983b) File change semantics and the familiarity theory of definiteness.
(5) (Stalnaker 1978) Assertion.
(6) (van der Sandt 1992) Presupposition projection as anaphora resolution.

1. Kamp's Discourse Representation Theory.

In this section, drawn largely from (Partee 1984), I'll sketch the key features of Hans Kamp's Discourse Representation Theory (DRT) (Kamp 1981). Kamp's theory shares many features with Heim's, and has continued to be developed and applied to many domains in linguistics and computational linguistics since its introduction (Kamp and Reyle 1993, Kamp and Rossdeutscher 1994, Rohrer et al. 2001).

Kamp's approach makes crucial use of an intermediate level of representation, "Discourse Representation Structures", mediating between syntax and model-theoretic interpretation. A DR can be thought of as a description of a partial model. A simple DR counts as true with respect to a complete model if it is *embeddable* into the model; embeddability is a technical notion in Kamp's system which plays a role analogous to satisfaction conditions in a standard semantics for predicate logic. (I won't give the full definition, but I'll illustrate it below.) In more complex cases, the DRS consists of a structured set of DR's, and the embeddability conditions for the entire DRS are recursively defined in terms of embeddability of substructures. When we look at Heim's File Change Semantics, we'll see analogous rules for the truth-conditions of a file relative to a model and a context.

A *discourse* is simply a finite sequence of sentences. The fragment treated in (Kamp 1981) includes simple sentences similar to those in our first fragment, plus *if-then* sentences, including "donkey sentences." The simplest cases are those discourses in which none of the sentences contains *if-then* or *every* and all the NPs are either proper names of indefinite NPs. As an example we give the DR of the two-sentence discourse in (1):

(1) Pedro owns a donkey. He beats it.

The first sentence of (1) leads to the following DR (Kamp, 1981, p.287), constructed by processing it top-down according to syntax-driven construction rules:

DR (1) (incomplete)

u	*v*
.	.
Pedro owns a donkey	
u = Pedro	
u owns a donkey	
donkey (*v*)	
u owns *v*	

In general, each occurrence of a proper name or an indefinite NP leas to the introduction of a new "discourse referent" or "discourse entity" in the DR. By contrast, pronouns must be interpreted as referring to discourse entities already contained in the DR. (Deictic uses of pronouns are assimilated to this treatment by allowing for accommodation of discourse referents that come from the context into a DR. We'll return to Kamp's and Heim's treatment of deictics and demonstratives when we discuss that topic in a later lecture.)

The complete DR for (1) is then the following (Kamp 1981, p.287):

DR (1) (complete, showing intermediate steps)

u	*v*
.	.
Pedro owns a donkey	
u = Pedro	
u owns a donkey	
donkey (*v*)	
u owns *v*	
He beats it	
u beats it	
u beats *v*	

This DR is equivalent to one in which we omit intermediate steps.

DR (1) (complete, omitting intermediate steps)

u	*v*
.	.
u = Pedro	
donkey (*v*)	
u owns *v*	
u beats *v*	

The discourse (1) will be true in a model *M* with respect to DR(1) just in case <u>there is a way of embedding</u> DR(1) into M, i.e. a mapping of *u* and *v* onto individuals in *M* such that all of the conditions in DR(1) are satisfied.

Note that the existential quantifier in the embeddability conditions has the effect of giving the discourse entity *v* corresponding to *a donkey* an existentially quantified interpretation, with scope extending over the whole discourse. (Heim's File Change Semantics does the same thing; and her Chapter 2 theory inserted an unselective ∃ at the Text node.) Thus the truth conditions

assigned to (1) in Kamp's system are the same as those for the first-order sentence (1'), or equivalently (1'').

(1') ∃u∃v(u = p & donkey(v) & own(u, v) & beat (u,v))
(1'') ∃v(donkey(v) & own(p, v) & beat (p,v))

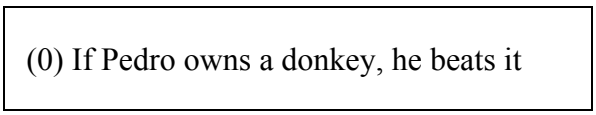
An indefinite NP introduces what amounts to a free variable, which doesn't get formally bound, but gets implicitly bound in the passage from DRS to truth-conditions via embeddability; this is part of what allows Kamp (and likewise Heim) to provide a unified treatment of pronouns with definite and indefinite antecedents. All pronouns are treated identically at the DRS level: any pronoun may be equated at the appropriate construction step with any discourse entity accessible to it in the DRS; we discuss accessibility below.

Universal quantifiers and conditional sentences give rise to more complex DRSs with special embedding conditions which are relevant to bound-variable anaphora (Partee 1978) and the treatment of donkey-sentences. We illustrate first with the conditonal sentence (2).

(2) If Pedro owns a donkey, he beats it.

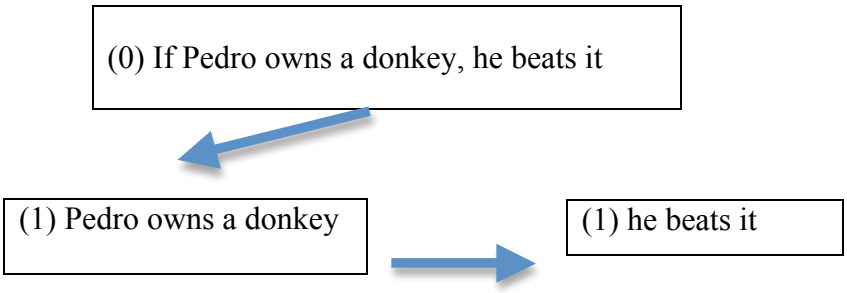
Step 1.

DR_0 (2)



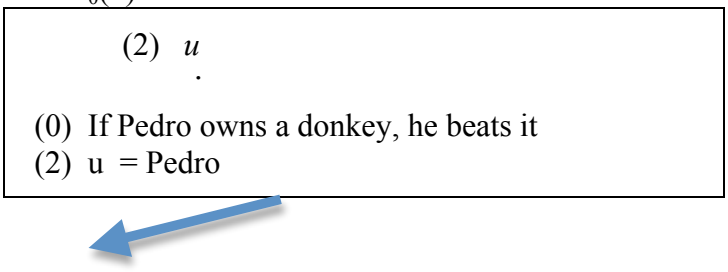
Step 2 (see detailed discussion in (Partee 1984).) The arrows indicate a stipulated "subordination relation", which determines accessibility for anaphora (and for presupposition satisfaction). I'll add numbers to annotate the steps.

DRS (2) (incomplete)

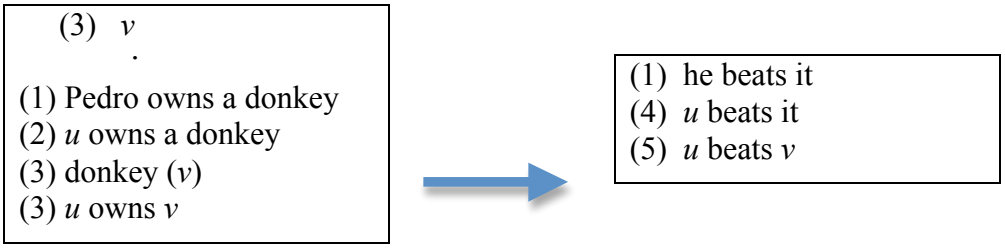


Then each of the two embedded DRs is processed in the usual way, antecedent first, with the proviso that a discourse entity corresponding to a proper noun, together with its identity condition, is placed in the top DR of the DRS (making it available for anaphora anywhere in the discourse.)

DRS (2) DR_0(2)



$DR_1(2)$ $DR_2(2)$



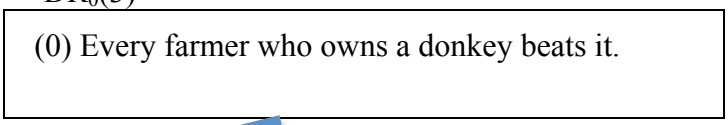
In steps 4 and 5, we are able to assign the entities *u* and *v* to the pronouns because DR_2 is subordinate to both DR_1 and DR_0.

The embeddability conditions for DRS's resulting from the *if-then* rule is roughly as follows: DRS(2) is embeddable in M if there is a mapping which satisfies the atomic conditions in DR_0, (i.e. which assigns *u* to Pedro) such that every extension of it which satisfies DR_1 also satisfies DR_2 .

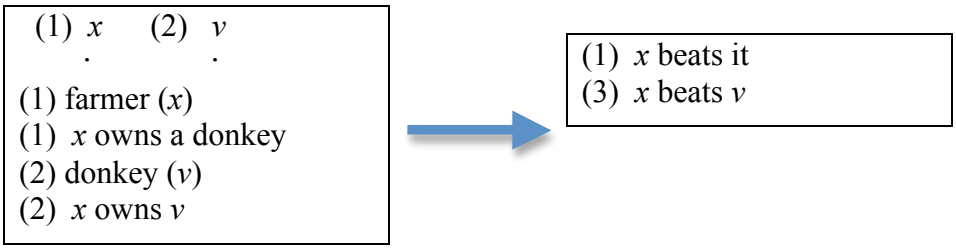
The rules for constructing DRS's for sentences with an *every*-NP are very similar; we illustrate with sentence (3) and its DRS.

(3) Every farmer who owns a donkey beats it.

DRS (3) $DR_0(3)$



$DR_1(3)$ $DR_2(3)$



The embeddability condition for *every*-constructions is the same as that for *if-then* sentences. We can refer to such DRS configurations as universal/conditional structures.

Note that while the construction of DRS's is determined (up to the choice of antecedents for pronouns) by the syntactic rules, syntactically similar sentences or discourses may receive quite different DRS's, particularly because of the difference between the rule for *every* and the rule for *a*. Thus while donkey sentences like (2) and (3) receive a natural interpretation in this system, the syntactically similar sentences (4) and (5) with *every* in place of *a* fail, correctly, to get a reading in which the pronoun is linked to the *every*-phrase.

(4) If Pedro owns every donkey$_i$, he beats it$_{j/*i}$.
(5) A farmer who owns every donkey$_i$ beats it$_{j/*i}$.

In both (4) and (5), the pronoun *it* is in a DR which is not subordinate to the DR which contains the discourse entity introduced by the *every* rule, and thus that antecedent entity is not accessible to the pronoun. (Check this for yourself! Or ask about it in seminar.)

Kamp's system, like Heim's, goes a long way toward providing a unified treatment of nominal anaphora, unifying bound variable anaphora, co-refential anaphora, and donkey pronouns. It also captures the natural connection between universal quantification and conditionals, and between existential quantification and conjunction. Since it treats *a donkey* and *every donkey* very differently, it is very different from Montague's unified treatment of NPs as generalized quantifiers. A "type-shifting" approach that attempts combine the strengths of the Kamp-Heim approach with the attractive generalizations of Montague's approach can be found in (Partee 1986).

2. File Change Semantics and the Anaphoric Theory of Definiteness: Heim Chapter III

Informal summary: In Chapter II, much of the work was done by the "Rules of Construal" that constructed a Logical Form for each sentence (and for discourses consisting of a sequence of sentences, a "text".) Logical Form is a syntactic level of representation. Heim provided compositional interpretation rules that apply to Logical Forms. A notion of "context" was included, so that non-anaphoric pronouns could be interpreted if the context provided a value to the corresponding index (indexed variable). This notion of "context" is not dynamic: A sentence or text is evaluated with respect to a model, an interpretation function, and a context, but the context does not "change" during the interpretation process.

In Chapter III, Heim introduces "File Change Semantics", a dynamic theory in which the very notion of what the basic semantic value of a sentence is is changed. In this theory, sentences are interpreted in contexts, but sentences also cause changes in the context. The idea that sentences not only depend on the context for their interpretation but also cause changes in the context goes back to Stalnaker (1978). Stalnaker developed Grice's notion of *common ground*, the presuppositions (assumed by the speaker to be) shared by the speaker and hearer at any point in a conversational exchange. Stalnaker models the common ground as a set of possible worlds: those possible worlds compatible with everything the speaker presupposes. Heim wants to enrich the notion of common ground to include not only what the speaker and hearer believe to be true, but what "discourse referents" are active at a given point in the conversation. Both for Stalnaker and for Heim, the common ground can change as the conversation progresses. For Stalnaker, the common ground changes as new propositions are asserted and accepted: as more 'facts' enter the common ground, the corresponding set of possible worlds gets smaller. (The participants get gradually closer to pinning down 'which world' they believe is the actual world. Bigger set of facts = smaller set of possible worlds.) For Heim, the common ground can change in that way, but also in the introduction of 'discourse referents' and the information associated with them (and in the elimination of discourse referents whose life span has ended.)

The basic semantic value of a sentence in Heim's File Change Semantics is not its truth-conditions, but its "file change potential": A sentence is evaluated with respect to a file, and can cause changes in the file. But truth-conditions are not gone: file-change potential is "truth conditions and more". A whole *file* is now true or false with respect to a model and an interpretation (and a context). And we can still define what it is for a sentence to be true with respect to a context, a model, and an interpretation. Oversimplifying:

(6) A **file F** is true if there is some sequence **a** that satisfies it.

(7) A **formula φ** is true with respect to a file F if F + φ is true, and false with respect to F if F is true and F + φ is false. (I.e. a formula is true if adding it to a true file gives another true file. It's false if adding it to a true file makes a false file.)

But we need to look more closely at files and their 'satisfaction sets' to understand this better.

Caveat: The treatment of quantified sentences with tripartite structures is a bit complex, and I'm not going to go over the details: see Section 4 of Chapter III. We have seen how quantified sentences work in Heim's Chapter II theory and in DRT; in Heim's Chapter III theory, files are dynamically manipulated with the same net effect but with more of the work in the semantics.

2.1. Informative discourse and file-keeping.

2.1.1. Introduction

Metaphorically speaking, if A is speaking and B is trying to understand what A is saying, B's job is to construct and update a 'file' that contains, at any point in the conversation, the information that A has conveyed up to that point. Heim considers an example, in which A utters a 4-sentence text.

(8) (a) A woman was bitten by a dog.
(b) She hit him with a paddle.
(c) It broke in half.
(d)The dog ran away.

Start with empty file F_0. (an idealization.)

First sentence (a) *A woman was bitten by a dog.*

The two indefinite NPs cause the introduction of two new "file cards" 1, 2, on which we enter the following information:

F_1:

1	2
➢ woman ➢ bitten by 2	➢ dog ➢ bit 1

Second sentence (b): *She hit him with a paddle.* The indefinite *a paddle* leads to the creation of a new file card 3, and we add the information of this sentence to all three cards, since all 3 'discourse referents' are mentioned in the sentence.

F_2:

1	2	3
➢ woman ➢ bitten by 2 ➢ hit 2 with 3	➢ dog ➢ bit 1 ➢ hit by 1 with 3	➢ paddle ➢ was used by 1 to hit 2

Third sentence (c): *It broke in half.* We add this information just to card 3.

F_3:

1	2	3
➢ woman ➢ bitten by 2 ➢ hit 2 with 3	➢ dog ➢ bit 1 ➢ hit by 1 with 3	➢ paddle ➢ was used by 1 to hit 2 ➢ broke in half

Fourth sentence (d): *The dog ran away.* A definite NP refers to an existing file card. We add the information just to that card, since none of the other entities are mentioned in this sentence.

F_4:

1	2	3
➢ woman ➢ bitten by 2 ➢ hit 2 with 3	➢ dog ➢ bit 1 ➢ hit by 1 with 3 ➢ ran away	➢ paddle ➢ was used by 1 to hit 2 ➢ broke in half

File card *n* represents the *n*th new discourse entity introduced, and contains all the information that has been given about that entity at a given point in the discourse.

The whole file, consisting of a sequence of file cards, represents the common ground of speaker and hearer, containing both *information* and *discourse entities.*

How do indefinite and definite NPs lead to updates of the file? By the following rule: **For every indefinite NP, start a new card. For every definite NP, update a suitable old card.**

This is the most basic metaphor behind the anaphoric theory of definiteness and the file change theory. Now we have to clarify what lies behind the metaphor, and how it connects to truth-conditional semantics.

2.1.2. How files relate to facts, and how utterances change files.

First of all, let's go back to the semantics of first-order predicate logic for a minute. Remember our assignments *g*? In logic it's common to say that a formula like *love*(*x,y*) is true or false with respect to an model M and an assignment *g*, where M specifies a domain of entities D and includes an interpretation function I (a "lexicon") that assigns semantic values to basic terms and predicates; it assigns some set of ordered pairs of elements of D to a two-place predicate like *love*. We write all of that as

$[[love(x,y)]]^{M,g} = 1$ (or =0, as the case may be).

Another way to say the same thing is to say that *g satisfies* the formula *love*(*x,y*). An assignment satisfies a formula if the values it assigns to the free variables in the formula make the formula true. (A formula with no free variables is either satisfied by every assignment or is satisfied by no assignment. That's why a formula with no free variable can be simply true with respect to M.)

For Heim, because of the way indefinites introduce new discourse referents that may have a limited lifespan, it is easier to work with *finite* assignment functions which assign values only to the 'currently active' variables, or discourse referents.

And because she equates the discourse referents with natural numbers 1, 2, 3 (you can think of them as x_1, x_2, x_3), her assignment functions take the form of (finite) *sequences*. The assignment function which we might think of as

$x_1 \rightarrow$ John, $x_2 \rightarrow$ John, $x_3 \rightarrow$ Mary

is encoded as the 3-membered sequence <John, John, Mary>. (Two of the crucial differences between a *sequence* and a *set* are that in a sequence, order matters, and (as a result) in a sequence, repetitions are not redundant.)

Heim defines the *satisfaction* of a file in terms of sequences. A file is satisfied by a sequence of individuals if all the open sentences on the file cards are true with respect to the assignment of the first individual in the sequence to "1", the second to "2", etc. We write a_N to represent a sequence with N members; its members will be picked out as $a_1, a_2, \ldots, a_n$, where n = N.

> **Truth:** A file is said to be *true*, or "consistent with the facts" (this could easily be amended to "true with respect to a model M") if there is *some* sequence that satisfies it.

Consider file $\mathbf{F_1}$ above. Any sequence A_N whose first member, a_1, is a woman, whose second member a_2, is a dog, and such that a_2 bit a_1, satisfies that file $\mathbf{F_2}$.

NOTE carefully the implicit ∃: Both in the definition above and in Kamp's definition of what it is for a DRS to be embeddable in a model, there is a "metalinguistic" or "implicit" existential quantifier. This eliminates the need for a text-level existential closure rule at the level of logical form.

Satisfaction sets: In order to define satisfaction for complex sentences recursively, we need to introduce the notion of a *satisfaction set*, the set of sequences that satisfy a given file. We write Sat ($\mathbf{F_0}$), Sat ($\mathbf{F_1}$), etc.

How utterances lead to context-change: As we add sentences to the discourse (look again at our first sample text), each sentence leads to a change in the file, and the satisfaction set of each successive file is smaller than that of the preceding one.

Sat ($\mathbf{F_0}$) = A^N, the set of all sequences whatsoever.

Sat ($\mathbf{F_1}$) = {a_N: a_1 is a woman, a_2, is a dog, and a_2 bit a_1 }

Sat ($\mathbf{F_2}$) = {a_N: a_1 is a woman, a_2, is a dog, a_3 is a paddle, a_2 bit a_1, and a_1 hit a_2 with a_3 }

etc.

The change from $\mathbf{F_1}$ to $\mathbf{F_2}$ can be described as follows: Sat ($\mathbf{F_2}$) = Sat ($\mathbf{F_1}$) ∩ {a_N: a_N satisfies S^b}, where S^b is the disambiguated logical form of sentence (b). As Heim puts it (p.280):

> In general terms, the satisfaction condition of an utterance relates in the following way to the file change which that utterance brings about:
>
> (A) If sentence S is uttered under the reading represented by logical form φ, and **F** is the file that obtains at that stage of the conversation at which the utterance occurs, and **F'** is the file that obtains after that utterance, then the following relation holds between **F** and **F'**:
>
> Sat(**F'**) = Sat(**F**) ∩ {a_N: a_N satisfies φ}

2.1.3. File cards as discourse referents.

Heim discusses the fact that her "file cards" are designed to capture what Karttunen had in mind in his paper on "Discourse referents" (Karttunen 1976).

Later work such as (Erteschik-Shir 1997, Vallduví 1992, Vallduví and Engdahl 1996) suggests formulating further rules that impose more structure on a file, moving active file cards to the "top of the file", etc. See also related work on "centering" and anaphora resolution (Roberts 1998, Walker and Prince 1996, Walker et al. 1997).

2.1.4. Files as common grounds.

Files are not really satisfied just by sequences but by ordered pairs of a possible world and a sequence (relative to a model). This is how sequences can be seen as enrichments of Stalnaker's notion of a *common ground* discussed at the beginning of section 2 above.

2.1.5. File change potentials and satisfaction conditions.

The relation between the semantic interpretation of a sentence in terms of satisfaction conditions (the classic semantic value for sentences) and its interpretation in terms of *file change potential* can be expressed in the following reformulation of Principle A:

(A) $\quad Sat(\mathbf{F} + \varphi) = Sat(\mathbf{F}) \cap \{a_N: a_N \text{ satisfies } \varphi\}$

This treats classical satisfaction conditions as basic and defines file change potential in terms of them. But Heim argues for going a step farther and taking file change potential as basic. I won't repeat the details here, but by the end of the chapter she develops arguments for preferring to take file change potential as basic and to define truth and satisfaction derivatively from file change potential.

2.2. Novelty and Familiarity

2.2.1. The domain of a file; how definiteness affects file change.

If we know only the satisfaction set of a file, we can't determine how many cards and which cards it contains. We need to keep track of the *domain* of a file as well as of its satisfaction set. Dom(**F**) is the set that contains every number which is the number of some file card in **F**.

Then file change potential has two dimensions: the way the satisfaction set changes and the way the domain changes.

2.2.2. Deixis and familiarity with respect to the file.

The Chapter 2 theory included two kinds of definite NPs: anaphoric definites which pick up old indices, and deictic pronouns whose indices may be new: "novel definites" whose value is provided by the context. In Chapter 3, where novelty and familiarity are considered not in terms of logical forms but in terms of properties of files, Heim says that both deictic reference and anaphoric reference presuppose that the referent be already "familiar" to the audience. (This should be questioned, I think!) Cards can be added to the file by virtue of contextual salience.

> **The Novelty-Familiarity Condition:** Suppose something is uttered under the reading represented by φ, and the file prior to the utterance is **F**. Then for every NP_i in φ, it must be the case that: $i \in Dom(\mathbf{F})$ if NP_i is definite, and $i \notin Dom(\mathbf{F})$ if NP_i is indefinite. Otherwise, the utterance is not felicitous under this reading.

2.3. Truth

(9) A **file F** is true if there is some sequence **a** that satisfies it.

(10) A **formula φ** is true with respect to a file **F** if **F** + φ is true, and false with respect to **F** is **F** is true and **F** + φ is false. (I.e. a formula is true if adding it to a true file gives another true file. It's false if adding it to a true file makes a false file.)

Omitted: How the context-change potential of quantified sentences works. Roughly: a sequence satisfies a universally quantified formula if every way it can be extended to satisfy the restrictor clause has a further extension that also satisfies the nuclear scope. (This is more complex because if we try to think of this in terms of files and updates to files, we are really having to quantify over possible updates to files, just as in classical logic we have to quantify over assignments.)

2.4. Conclusion: Motivation for the File Change Model of Semantics.

Heim concludes with four arguments in favor of the file change model of Chapter III over both the Chapter II "logical form" approach and previous treatments.

Argument 1: File change semantics treats conjunction very differently from any of the other "logical connectives" like negation or disjunction. Conjunction is simpler than the others. Negation and disjunction are like quantification in requiring the construction of auxiliary files. This seems to fit the facts. Conjunction is psychologically the simplest; and when we just string sentences together, we interpret them as conjoined.

Argument 2: File change semantics offers a solution to the projection problem for presuppositions. (See Section 3 below.) The projection problem provides both a general argument for context-change semantics (now often known as dynamic semantics) and a specific argument for characterizing contexts as files, since this lets us assign context-change potentials to units as small as open formulas.

Argument 3. File change semantics offers a good account of the interaction of semantics and pragmatics, via operations of interpretation (semantic) and accommodation (pragmatic) in the updating of files. [We haven't illustrated accommodation very much here, but it is at work in many instances where a definite NP doesn't have an explicit antecedent but is 'inferrable', as in *John bought a car. The windshield was cracked.*

Argument 4. File change semantics provides a framework in which the theory of definiteness can be stated in a single principle, the Extended Novelty-Familiarity Condition.

Summary of most important issues in Heim's dissertation and the Kamp-Heim approach:

- **Non-uniform treatment of NPs:** indefinites (and all weak NPs)/ definites/ pronouns/ essentially quantificational NPs with operator, restrictor, nuclear scope
- **Unselective binding**
- **Quantified formulas vs. "cumulative" (conjunctive) formulas**
- **Text vs. sentence**
- **Non-linguistic antecedents accommodated in *files*, not in LFs**
- **Meaning is context-change potential; anaphora and presupposition unified**
- **The relation between pragmatics and semantics – the crucial role of *context***

3. Presuppositions and their parallels to anaphora

3.1. Background on presuppositions

Recall our discussion of presuppositions in Lecture 4 and the readings from that lecture, especially (Gamut 1991, Chapter 6) and (Kadmon 2001) (you now have the whole Kadmon book on your CD.)

A classic definition of ***semantic presupposition***: A sentence S presupposes a proposition *p* if *p* must be true in order for S to have a truth-value (to be true or false).

An approximate definition of ***pragmatic presupposition:*** A use of sentence S in context C pragmatically presupposes *p* if *p* is backgrounded and taken for granted by the speaker in C.

Test for backgrounding: *p* is in the background of S if *p* is implied by all of the sentences in the "S family":

(11) a. S
b. It is not the case that S.
c. Is it the case that S?
d. If S, then S'.

Example: definite NPs and possessive NPs

We have already discussed the presuppositionality of *the king*, and Heim extended that discussion to include definites that contain or by themselves function as 'bound variables', like *the capital* in example (12a), or *the donkey he owns* in a typical donkey-sentence – these definites are not "referential", but they are still presuppositional. [Exercise for you: if they are not referential, how do we describe what their presuppositions are?] Another example of the same sort is possessive NPs: *John's son* or *his son*, when it occurs in argument position (rather than predicate position) presupposes that John or "he" has a son, and in an example like (13b), *he* may be a bound variable. (In the examples I have indicated optional negation to test for the relevant presuppositions.)

(12) a. (Not) in every country is *the capital* the largest city.
b. (Not) every$_i$ woman loves *the city where she$_i$ was born.*

(13) a. John's son is (not) at home.
b. (Not) every$_i$ one of those men was looking at his$_i$ son.

If we follow Frege and take the denotations of most words to be *functions*, then semantic presuppositions can be treated formally as **conditions on the well-definedness of functions.** Recall, for instance, our definition of the iota-operator used for the referential sense of the definite article: ιx[**king**(x)] is defined iff there is one and only one king, and undefined otherwise. Heim's anaphoric theory of definites does not involve an iota operator, but it shares with that analysis the requirement that the descriptive content of the definite NP must be presupposed: if *the king* bears index *n*, then the *n*th file card in the current file must already contain (or entail) the information that *n* is a king. In general, when a presupposition (precondition) of a function is not satisfied, the function is not defined and it is impossible to compute a value. (Heim 1983a)

3.2. The projection problem for presuppositions

In our initial examples, we have looked only at presuppositions of whole sentences. When presuppositional constructions occur in embedded contexts, we find that sometimes the

presupposition of an embedded part survives as a presupposition of the whole sentence, and sometimes it does not. The problem of which presuppositions are "projected" to the top level and which are not is known as the "projection problem" for presuppositions; it is part of the broader problem of compositionality. Two of the earliest works on the problem are (Langendoen and Savin 1971) and most influentially (Karttunen 1973). Karttunen's classic examples include the following.

(14) a. Jack has children and *all of Jack's children* are bald.
b. If Jack has children, then *all of Jack's children* are bald.
c. Either Jack has no children or *all of Jack's children* are bald.

(15) *All of Jack's children* are bald.

(16) Jack has children.

Whereas *all of Jack's children* in a simple sentence like (15) presupposes (16), none of the sentences in (14) carry that presupposition. In (14a), (16) is asserted in the first clause, and the presupposition of the second clause is satisfied in its local context by the fact of that assertion in the first clause. In (14b), the presupposition in the consequent is satisfied by the content of the antecedent, and therefore does not survive as a presupposition of the whole. Example (14c) is the most complex, and we won't discuss it in detail: the combination of negation and disjunction has properties that neither one has alone. But here too, the presupposition of the second clause is satisfied locally and does not become a presupposition of the whole.

Note that whether a presupposition of an embedded clause becomes a presupposition of the whole sentence depends on the content as well as the form of the whole sentence. The sentences in (17) have the same 'form' as those in (14), but because they do not provide an 'antecedent' proposition to satisfy the presupposition, the presupposition (16) is projected upwards and becomes a presupposition of the entire sentence. Those in (18) have a potential 'antecedent' for the presupposition, but because of the different form, that 'antecedent' is not in a position where it can satisfy the presupposition, so again (16) becomes a presupposition of the entire sentence.

(17) a. Jack himself has lots of hair but *all of Jack's children* are bald.
b. If I am not mistaken, then *all of Jack's children* are bald.
c. Either none of Mary's children are fat or *all of Jack's children* are bald.

(18) a. #*All of Jack's children* are bald, and Jack has children. (Anomalous)
b. If Jack's first wife claims that Jack has children, then *all of Jack's children* are bald.
c. #Either Jack has children or *all of Jack's children* are bald. (Anomalous)

3.3. Anaphoric properties of presuppositions and other context-dependent phenomena

As noted by Heim (1982, 1983a), Zeevat (1992), van der Sandt (1989, 1992), Partee (1993), there is a virtually perfect correspondence between the structural and semantic contexts in which anaphoric expressions can find their antecedents and the structural and semantic contexts in which presuppositions can 'find' the propositions that satisfy them.

Van der Sandt (1992) compares the sentences in (14) above with the sentences in (19):

(19) a. John owns a donkey. He beats it.
b. If John owns a donkey, he beats it.
c. Either John does not own a donkey or he beats it.

Looking back at the sentences in (14) in light of the analogies with anaphora, we can say that in (14b) and (14c), the proposition that satisfies the presupposition has a "limited lifespan". In (14a), as in cases of 'discourse anaphora', the proposition has been added to the common ground of the whole discourse, and its lifespan would be unlimited.

The parallels extend to binding phenomena. We have seen in Heim's original work that an anaphoric definite may be interpreted as a bound variable, as in (12a-b), and other kinds of presuppositions as well can have "bound variable" instances, as in (20).

(20) a. Every girl who started to smoke in high school has *stopped smoking*.
b. If anyone$_i$ lost anything, *what they$_i$ lost* will be recovered in 24 hours.
c. If a boy smokes, his mother always *knows that he smokes.*

Partee (1984) shows that the same kinds of phenomena can be found in the domain of temporal anaphora and can be analyzed well in the Kamp-Heim framework. Partee (1989) builds on work of Mitchell (1986) to extend similar considerations to the binding of implicit variables in words like *local, home, nearby*.

4. Dynamic semantics

All of these parallels give added support to some version of *dynamic semantics.* Truth-conditional semantics and context-dependent phenomena cannot be "modular"; not only whole sentences but also their parts can add "discourse referents" or propositional content to the "local context", and compositional semantics must have access to all of these kinds of content. Context-change and context-dependence are recursive in the same way as more traditional semantic content.

There has been much more work on this whole family of problems since the original work of Heim and Kamp. One issue that has been interestingly controversial is the status of intermediate representations like Kamp's Discourse Representation Structures: they seem to be syntactic rather than semantic objects: is it indispensable to have some such "representation" level in between the syntax proper and the model-theoretic semantics? Kamp argued "yes", while Groenendijk and Stokhof (Groenendijk and Stokhof 1990, 1991) argued "no", and proposed a dynamic variant of first-order logic and a dynamic variant of Montague Grammar to capture the main properties of the Kamp-Heim theory. Muskens (1993) showed how Kamp's theory could be made compositional in the classical sense. (Note that in Montague's theory, compositionality required that any intermediate representational language should be in principle dispensable.) See also (Muskens et al. 1997), (Chierchia 1992, Chierchia 1995, Dekker 1993, Dekker 1996).

Appendix: Comparing Heim's Ch. II and Ch. III theories

(This is only a partial description; not very much is said here about definiteness.)

Chapter II: What are the rules and constraints?

Construal Rules
1. NP-Indexing: Assign every NP a referential index. (p. 132)
2. NP-Prefixing: Adjoin every non-pronominal NP to S. (p. 132)
3. Quantifier (Operator) Construal: Attach every quantifier (operator[1]) as a leftmost immediate constituent of S. (p. 133) (Applies both to *every* and to *always*; and to *not, must, ...*)

[1] On p. 143, "quantifier" is generalized to "operator", which includes quantifiers, negation, and temporal and modal operators (quantifiers over times and worlds).

4. Position *if*-clause in the position of "restrictor", between quantifier and the rest of the sentence. (p. 134) (not given full status as a rule of construal)
5. Existential closure 1: Adjoin a quantifier ∃ to the nuclear scope of every quantifier. (p. 138)
6. Text formation: Attach a sequence of sentences under a T-node. (p. 139)
7. Existential closure 2: Adjoin the quantifier ∃ to T. (p.140)
8. Quantifier (Operator) Indexing: Copy the referential index of every indefinite NP as a selection index onto the lowest c-commanding quantifier (operator). (It applies to ∃ as well as to other quantifiers and operators.) (p. 146)

Wellformedness conditions:

1. Novelty Condition: An indefinite NP must not have the same referential index as any NP to its left. (p.151)

Chapter III.

Simplify the "construal" component, provide an enriched theory of semantic interpretation that takes over some of the burden carried by the construal component of Chapter II. In particular, eliminate Existential Closure, Quantifier Indexing, and the Novelty Condition. Build "existential closure" into the interpretation of the truth of a file in a model. Build a theory of definiteness into the principles which interpret logical form.

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