

CLASS 1: OVERVIEW & POSSIBLE WORLDS SEMANTICS

1. Introduction

1.1. Intensionality & Displacement

Certain linguistic devices allow us to talk about possibilities and necessities beyond the 'here' and 'now' (Hockett's *displacement* property of language).

- (1) a. John **may** be doing the dishes.
- b. John **must** do the dishes to obey his father.
- c. John **said** that he was going to do the dishes.
- d. Mary **wants** John to do the dishes.
- e. Mary **thinks** that John is doing the dishes.
- f. **Reportedly**, John is doing the dishes.
- g. Jean **serait** en train de faire la vaisselle.

None of these sentences *requires* that John actually be doing the dishes to be true.

What *do* they require to be true?

They require John to be doing the dishes not necessarily in reality but in some hypothetical states of affairs: e.g., states of affairs where John is an obedient son (b); states of affairs that comply with Mary's beliefs (e) or desires (d); states of affairs in which some rumor is true (f-g)...

The truth of sentences involving 'intensional' operators depends on whether the proposition they embed is true in hypothetical situations other than the actual one.

**Today:** Survey various intensional operators we'll be discussing in this course.  
Introduce *possible worlds* semantics to model their displacing properties.

1.2. Overview of the course

*The cast*

**ATTITUDE VERBS:** *think, say, want, argue, hope...*

Attitude verbs are so-called because they express an *attitude* of the subject w.r.t. a proposition (its complement): a belief in (a), a desire in (b).

- (2) a. John thinks that Mary is doing the dishes.
- b. John wants Mary to do the dishes.

**MODALS:** *must, may, might, pouvoir, devoir, falloir...*

Modals vary along two dimensions:

- Strength: *possibility* (e.g., *can, pouvoir*) or *necessity* (e.g., *must*)
  - 'Flavors':
- (3) a. **Epistemic** (*knowledge-based*)  
(In view of the available evidence) John *must/might/may* be the murderer.
  - b. **Deontic** (*permission/obligation*)  
(In view of his dad's orders) John *may* watch TV, but he *must* go to bed at 8.
  - c. **Ability**  
(In view of his physical abilities,) John *can* lift 200 lbs.
  - d. **Bouletic** (*desire-based*)  
(In view of his desire to retire at age 50,) John *should* work hard now.

**EVIDENTIALS:** encode information about the speaker's *source of information*, e.g., direct observation, hearsay or inference (Chafe and Nichols 1986, Aikhenvald 2004).

While all languages can express the source of their evidence (e.g., via attitude verbs, *I heard John is doing the dishes*), certain languages have dedicated grammatical markers:

- (4) **Quechua (Faller 2002)**  
Marya-qa yachay wasi-pi-s ka-sha-n  
Marya-top know house-loc-**report** be-prog-3  
Marya is at school' (the speaker was told this)

*The plot*

Both **attitude verbs** and **modals** (and arguably **evidentials**) invoke situations that go beyond the here and now, in the realm of the possible and the necessary. This is successfully captured in a *possible worlds* framework, by having the truth of sentences like (1) in *our world* depend on truth of the embedded complement in some *other worlds*.

We'll take a closer look at modals, evidentials and attitude verbs, their distribution, co-occurrence, and course of acquisition. We'll examine some puzzling interactions and similarities between them, and ask what underlies these similarities:

- Are they merely superficial and due to the use of a limited set of resources (e.g., quantification over possible worlds)?
- Do they run deeper, and in fact reflect identity?
- Are these independent systems, but which stand in some kind of dependency?

**1) Epistemic and root modals. Polysemy or unitary semantics?**

Cross-linguistically, the same modals can express various flavors: e.g., *pouvoir* can have all of the interpretations in (3).

This cross-linguistic trend suggests that each modal comes in a single lexical entry, with particular flavors determined by context, which is what Kratzer proposed in a series of influential papers (Kratzer 1977, 1978, 1981, 1991).

**Distribution puzzle:** Systematic correlation between modal syntax and modal meaning: *epistemics* tend to scope high (> tense, aspect, negation, quantifiers, other modals), while *root* modals (i.e., all non epistemic modals) tend to scope low (cf. Cinque's hierarchy).

While the cross-linguistic trend to use the same words for epistemic and root modality favors a unitary account, their distribution favors a *polysemy* account. We will see that there are even reasons to believe that epistemics aren't modals at all, and should instead be treated as *evidentials*.

**2) Epistemic Modals ■ Evidentials?**

While evidentials have a meaning that can roughly be paraphrased using attitude verbs, they differ in two crucial aspects:

- Evidentials typically don't embed (≠ attitudes: *John said that Paul thinks that...*)
- The speaker is typically committed to the truth of the embedded clause with evidentials, but not with attitudes.

We will see that function- and distribution-wise, **evidentials** are very close to **epistemic modals**. We will look at proposals that argue that they are one and the same category, (Drubig 2001; Matthewson 2010).

**3) Epistemic modals and attitude verbs: dependency?**

As we'll see shortly, under a classical Hintikka picture, attitude verbs receive a uniform semantics.

Yet, there are obvious differences. In particular, mood selection: certain attitudes select for indicative, others for subjunctive mood in Romance.

- (5) a. Jean pense que Marie **fait** la vaisselle.  
b. Jean veut que Marie **fasse** la vaisselle.

Interestingly, epistemics seem to be sensitive to this distinction:

**Distribution puzzle:** Epistemics can appear in the complement of certain attitude verbs, but not others: they cannot appear in complements of those that select for *subjunctive*:

- (6) a. John thinks/claimed/argued that Mary must be the murderer.  
b. #John hopes/wishes/demanded that Mary must be the murderer.

**Question 1:** Does mood selection reflect two different semantic classes?

Complex question complicated by non-uniform behavior across Romance languages (Italian *think* selects for subjunctive; Romanian *emotive factives* select for indicative...).

Vast literature on what underlies mood selection: *assertivity* (Bolinger 1968, Terrell & Hooper 1974), *irrealis* (Bergen 1978, Givon 1994, Portner 1997), *strong intentionality* (Farkas 1985), *veridicality* (Giannakidou 1997, Quer 1998), a.o.

We adopt Bolinger's (1968) *representational* vs. *non representational* distinction, and assume that (with notable exceptions) the former take indicative, the latter subjunctive:

- **Representational attitudes:** *believe, think, argue, claim, conclude...*  
propositionally consistent attitudinal state  
(*one's beliefs are consistent*)
- **Non-representational attitudes:** *want, wish, command, demand...*  
propositionally inconsistent attitudinal state  
(*desires need not be consistent*)

**Question 2:** Why should epistemic modality be sensitive to this distinction?

*Hypothesis:* only *representational* attitudes can provide a consistent information state, which, we'll argue, epistemic modals are anaphoric to (Anand & Hacquard 2009).

*The view from acquisition:*

- *Root* modals acquired before *epistemic* modals.
- *Non-representational* attitudes (*want*) acquired before *representational* (*think*)
- *Evidentials* produced early (age 2) by children learning a language like Korean, where they are obligatory (Choi 1995), but full meaning not acquired until late. (Papafraou 2010)

*Timeline of acquisition*

Age 2	root modality ( <i>ability/deontic</i> )	Non rep. attitude ( <i>want</i> )
Age 2;5		Rep. attitude ( <i>think</i> ): <i>formulaic/parenthetical uses only</i>
Age 3;5	epistemic modality	Rep. attitude ( <i>think</i> )
Age 5+	Full distinction between epistemic modals (strength) and evidentials	

- Can development data illuminate our semantic analyses and *vice versa*?

- Why are representational attitudes and epistemic modals acquired late? And root modals and non representational attitudes early?
- If they share a uniform semantics, shouldn't all modals/all attitudes be acquired at the same time?
- And if acquired at different times, why this particular order?
- Does this timeline merely track *conceptual* development? (cf. Papafragou 1998)

*The plan:*

Today: *Possible worlds* semantics: modals and attitude verbs.  
 Tuesday: Epistemic modals and evidentials: Identity?  
 Thursday: Root and epistemic modals: Polysemy?  
 Thursday: Epistemic modals and attitude verbs: Anaphoricity?

## 2. Possible Worlds Semantics

Modal displacement: appeal to *possible worlds*.

The truth of a sentence like (7) in *our world* depends on the truth of the embedded proposition in some *other* worlds:

(7) John thinks that Mary is doing the dishes.

(7) is true in our world if Mary is doing the dishes in *John's belief worlds* (*John's candidate worlds for the actual world*), regardless of whether Mary is actually doing the dishes in our world.

*Possible worlds semantics* largely due to Kripke (1963), and Hintikka (1961), following ideas of Carnap (1947).<sup>1</sup> The notion of a *possible world* can be traced back at least to Leibniz, according to whom the 'universe' (the *actual world*) was one (in fact, the best one) among an infinite number of possible worlds living in God's mind.

*Possible worlds: possible states of affairs* = 'ways things might have been' (Lewis 1973)

### 2.1. Frege's Sinn und Bedeutung (Sense and Reference)

- (8) The president of France is a white man.  
 (9) The president of France will always be a white man.

<sup>1</sup>Kripke was concerned with formal languages, giving a semantics for logics used to model reasoning about modal notions. The application to *natural language* is largely due to Montague.

(9) is ambiguous in a way (8) isn't. This difference is blamed on the fact that (8) is an *extensional context* and (9) an *intensional* one (triggered by future *will*).

If we replace 'the president of France' with 'Sarkozy' – a name for the current *referent* of 'the president of France', the truth conditions in (8) don't change. (9) loses one reading:

- (10) Sarkozy is a white man.  
 (11) Sarkozy will always be a white man.

- **Reference** varies with the facts and time of evaluation.

- (12) [[The president of France]]<sup>w\*,2010</sup> = Sarkozy  
 (13) [[The president of France]]<sup>w\*,1984</sup> = Mitterrand  
 (14) [[The president of France]]<sup>w<sup>12</sup>,2010</sup> = Royal

- **Sense** determines *Reference*. *Reference* varies with the facts and time of evaluation; thus the *sense* must be a function from the latter to the former.

**Possible worlds framework:**

<b>Extension</b> of $\alpha$ in $w$ :	$[[\alpha]]^w$	= <i>Bedeutung</i>
<b>Intension</b> of $\alpha$ :	$[[\alpha]]_e := \lambda w. [[\alpha]]^w$	≈ <i>Sinn</i>

*Extensions* are given for an arbitrary world  $w$ . The *intension* of an expression is a function from a possible world to its extension in that world:  $\langle s, \dots \rangle$

meaning (*intension*) + 'circumstances' (*world*)  $\Rightarrow$  reference (*extension*).

For **definite descriptions**, the extension is an individual (type  $e$ ); the intension is an individual concept (type  $\langle s, e \rangle$ )

- (15) a. [[the president of the US]]<sup>w\*</sup> = Obama  
 b. [[the president of the US]]<sub>e</sub> =  $\lambda w. [[\text{the president of the US}]]^w$

For **sentences**, the extension is a truth value. Its intension is a proposition:

- (16) a. [[Mary is doing the dishes]]<sup>w<sup>1</sup></sup> = 1 iff Mary is doing the dishes in  $w_1$   
 b. [[Mary is doing the dishes]]<sub>e</sub> =  $\lambda w. [[\text{Mary is doing the dishes}]]^w$

*In function talk:* a proposition is a function from worlds to truth values.

*In set talk:* a proposition is a set of worlds, namely the set of worlds in which that proposition is true.

- (17) A proposition  $p$  is true in world  $w$  iff  $w \in p$

The **Sense (intension)** of a sentence is what's relevant for determining the truth value (& sense) of larger sentences containing it:

- (18) a. John thinks that it is raining.  
b. It might be raining.

Expressions like '*John thinks*' or *might* shift the world under which the embedded sentence it embeds is evaluated: the reference (truth value) of the whole depends on the reference of the embedded sentence *at the relevant world*.

## 2.2. Attitude verbs as quantifiers over possible worlds

Hintikka (1962): quantification over worlds compatible with *beliefs, hopes, desires*...

- (19)  $[[\text{believe}]]^w = \lambda p_{\langle st \rangle} . \lambda x . \forall w' \text{ compatible with } x \text{'s beliefs in } w : q(w') = 1$   
(20)  $[[\text{Mary believes that John is doing the dishes}]]^w$   
*In all worlds w' compatible with Mary's beliefs in w, John is doing dishes in w'*

*What are the worlds compatible with Mary's beliefs?*

- (21) Mary's beliefs in w =  $\text{BeliefState}(\text{Mary})(w) = \{p \mid p \text{ is a belief of Mary in } w\}$

The worlds compatible with Mary's beliefs (i.e., the worlds quantified over by *believe*) is the *intersection* of Mary's belief state, i.e., the set of worlds in which all of Mary's beliefs are true:

- (22)  $\cap \text{BeliefState}(\text{Mary})(w) = \{w' \mid \forall p \in \text{BeliefState}(\text{Mary})(w) : p(w') = 1\}$

There are 3 types of propositions:

- those that Mary believes to be *true*: each is true in all of Mary's belief worlds
- those that Mary believes to be *false*: each is false in all of Mary's belief worlds
- those that Mary is *agnostic* about: true in some but not all of Mary's belief worlds

This set of worlds can be arrived at via an *accessibility relation*:

**Accessibility relations:** binary relations on the set of all possible worlds.

- (23) *Doxastic*:  $\mathcal{R}_{\text{DOXASTIC}(x)} := \lambda w . \lambda w' . w' \text{ is compatible with } x \text{'s beliefs in } w$

For Hintikka, all attitudes are uniformly treated as universal quantifiers over possible worlds, where what changes from one attitude to the next is the accessibility relation:

- (24)  $[[\text{believe}]]^w = \lambda p_{\langle st \rangle} . \lambda x . \forall w' \in W [\mathcal{R}_{\text{doxastic}(x)}(w)(w') = 1 \rightarrow q(w') = 1]$   
 $[[\text{want}]]^w = \lambda p_{\langle st \rangle} . \lambda x . \forall w' \in W [\mathcal{R}_{\text{bouletic}(x)}(w)(w') = 1 \rightarrow q(w') = 1]$   
 $[[\text{say}]]^w = \lambda p_{\langle st \rangle} . \lambda x . \forall w' \in W [\mathcal{R}_{\text{speech}(x)}(w)(w') = 1 \rightarrow q(w') = 1]$

## 2.3. Modals as quantifiers over possible worlds

Recall, modals express possibilities or necessities:

- (25) a. John *may* be home  
b. John *must* be home

Parallel patterns of entailments and logical equivalences as with quantifiers *some/every*:

- (26) a. John *must* be home  $\Rightarrow$  John *may* be home  
b. John *may* be home  $\equiv$  It's *not* the case that it *must* be the case that J is *not* home  
c. John *must* be home  $\equiv$  It's *not* the case that it *may* be the case that J is *not* home  
(27) a. *Every student* is home  $\Rightarrow$  *Some student* is home  
b. *Some student* is home  $\equiv$  It's *not* the case that *every student* is *not* home  
c. *Every student* is home  $\equiv$  It is *not* the case that *some student* is *not* home

### Modals are quantifiers over possible worlds:

**Necessity:** universal quantification; **Possibility:** existential quantification.

*First attempt:*

- (28) a.  $[[\text{must}]]^{w,g} = \lambda p_{\langle st \rangle} . \forall w' : p(w') = 1$   
b.  $[[\text{can}]]^{w,g} = \lambda p_{\langle st \rangle} . \exists w' : p(w') = 1$

### Contingency and Relativity: Modal flavor

- (29) a. John must do the dishes (in view of his father's orders) [deontic]  
b. John must be home (he's not in his office) [epistemic]  
c. John must write a dissertation (if he wants to get a PhD) [bouletic]

- Modals really take two arguments: a restriction (accessibility relation) and a nuclear scope (a proposition).
- Quantificational semantics of *must/can* (the **force** of quantification) stays constant, but what we change is the nature of the accessibility relation.

**Accessibility relations:**

- Epistemic:*  $\mathcal{R}_E := \lambda w. \lambda w'. w'$  is compatible with the evidence in  $w$   
*Deontic:*  $\mathcal{R}_D := \lambda w. \lambda w'. w'$  is compatible with the laws in  $w$   
*Bouletic:*  $\mathcal{R}_B := \lambda w. \lambda w'. w'$  is compatible with certain desires in  $w$

Lexical entries (from von Fintel and Heim 2005):

- (30) For any  $w \in W$ :  
 a.  $[[\text{must}]]^w = [[\text{have to}]]^w = \dots = \lambda \mathcal{R}_{\langle s, st \rangle} \lambda q_{\langle st \rangle} \forall w' \in W [\mathcal{R}(w)(w') = 1 \rightarrow q(w') = 1]$   
 (in set talk  $\mathcal{R}(w) \subseteq q$ )  
 b.  $[[\text{can}]]^w = [[\text{may}]]^w = \dots = \lambda \mathcal{R}_{\langle s, st \rangle} \lambda q_{\langle st \rangle} \exists w' \in W [\mathcal{R}(w)(w') = 1 \ \& \ q(w') = 1]$   
 (in set talk  $\mathcal{R}(w) \cap q \neq \emptyset$ )
- (31)  $[[\text{John must be home}]]^{w,g} = 1$  iff in all worlds  $w'$  compatible with the evidence in  $w$ , John is home in  $w'$

One difference between modals and attitudes is whether the accessibility relation is fixed.

- For attitudes, the accessibility relation is hard-wired.
- For modals, it could be as well:

- (32) a.  $[[\text{must}_{\text{deontic}}]]^w = \lambda q_{\langle st \rangle} \forall w' \in W [\mathcal{R}_{\text{deontic}}(w)(w') = 1 \rightarrow q(w') = 1]$   
 b.  $[[\text{must}_{\text{epistemic}}]]^w = \lambda q_{\langle st \rangle} \forall w' \in W [\mathcal{R}_{\text{epistemic}}(w)(w') = 1 \rightarrow q(w') = 1]$

- However, this would create undesirable multiplications of homonyms. A major contribution of Kratzer's theory was to argue each modal comes in a single lexical entry, with their accessibility relation provided by the **context**.

**The role of context: Improbability of an ambiguity account (Kratzer 1977):**

Not only do modals come in various flavors, but each flavor comes in many subflavors:

- (33) John may watch TV  
 (34)  $\text{may}_{\text{deontic } 1}$  : permission in view of John's parents' orders.  
 $\text{may}_{\text{deontic } 2}$  : permission in view of the rules of the dorm.  
 $\text{may}_{\text{deontic } 3}$  : permission in view of the rules of the fire station.

- A modal flavor can be specified by an overt '*in view of*' phrase. In this case, this phrase isn't redundant. We need a neutral *may* on top of all the others:

- (35) John may watch TV in view of the rules of the dorm.

**Kratzer's proposal:** In the absence of an overt restriction, the **context** provides the modal's restriction via **conversational backgrounds**.

A **conversational background**  $f$  is a function which assigns to each world a set of propositions, e.g., a set of known facts: *that John is not in the office, that John lives in Paris...*

- (36) a.  $f_{\text{epistemic}}: \lambda w. \lambda p. p$  is one of the propositions we know in  $w$ .  
 b.  $f_{\text{deontic}}: \lambda w. \lambda p. p$  is one of the propositions given by the law in  $w$

From a conversational background we can build a corresponding accessibility relation:

- (37)  $\mathcal{R}_{\text{epis}}(w, w') = \cap f(w) = \{w' \mid w' \text{ is a world in which all the propositions } p \text{ (such that } p \text{ expresses a piece of established knowledge in } w) \text{ hold}\}$

*Next time:*

We'll take a closer look at *epistemic* modals. We will see that there are reasons to doubt that they should receive a modal semantics. Instead, they may best be analyzed as *evidentials*.

*Reading next time:* Matthewson (2010); (Drubig 2001)