Tutorial 'Introduction to Semantic Theory' (No. 4)

Attitude predicates and intensionality

H&K12

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Session 7

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Our agenda today

- Something new:

  Attitude predicates and intensionality, Accessibility relations

  Reflexivity and veridicality

- Some exercise to help you with assignment 8

Extensional semantics

This is our system up to this point:

- We have identified the denotation of sentences with their actual **truth-values** in relation to the real world.
- The extension of a complex expression can be computed from the extensions of its parts.

However, this assumption is wrong for examples of the following kind:

(1) a.Burt **believes** that $_{S1}$ [it is raining in New York.]

b. Burt **believes** that $_{S2}$ [it is snowing in Berlin.]

Where the extensional semantics breaks down: Problem 1

(1) a. Burt **believes** that $_{S1}$ [it is raining in New York.]

b. Burt **believes** that $_{S2}$ [it is snowing in Berlin.]

<u>Let the situation *S* be that it is raining in New York and it is snowing in Berlin .</u>

Then [[$_{S1}$ it is raining in New York]]= [[$_{S2}$ it is snowing in Berlin]]=1.

Since [[beleive]] and [[Burt]] will be assigned the same denotation in both (1a) and (1b), then we predict that : [[Burt **believes** that S1]] = [[Burt **believes** that S2]]

However, [[(1a)]] and [[(1b)]] are not equivalent. Our current system is unable to capture the act of “believing”.

Attitude verbs

In human language, we often report the mental state or a communicative act of some individual: What someone believes, wants, hopes, says, etc.

(2) a. Burt **believes** that it is raining in New York.

b. Joan **wants** to go to the movies.

c. Peggy **hopes** that she will get a raise. mental state

(3) a. Pete **said** that the bagel was tasty.

b. Don **promised** that he would be home for dinner.

c. Roger **claimed** that his car had broken down. communicative acts

These two classes of verbs are called **attitude verbs.**

Where the extensional semantics breaks down: Problem 2

Standardly we evaluate a sentence in the here and now.

[[Chomksy smokes]]= 1 iff Chomksy smokes <u>(here and now)</u>.

But human language is not restricted to discourse about the actual here and now. The shifting of the evaluation is called **displacement .**

(4) a. In Hamburg, it is raining right now. **Spatial Displacement**

b. A few days ago, it rained. **Temporal Displacement**

c. If the low pressure system had not moved away, it might have been raining now. **Modal Displacement**

Intensionality as evaluation shifting

The sentences with displacement are **nonextensional contexts,** which cannnot be captured by truth-conditions.

We need to move to a semantics that is ***intensional***. In other words:

It has to contain operators that “displace” the evaluation of their complements from the actual here and now to other points of reference (spatially, temporally, and modally)

Intensionality: Evaluation relative to worlds

Intension as a function relativizes meaning:

Input: <u>A package of the various factors which can determine the extension</u>

↓

Output: <u>An appropriate extension</u>

Within the scope of this lecture, we will focus on only one kind of the input package: **Possible worlds**.

What is a world

We use the technical notion of “world” in a way that is as **inclusive** as possible.

When we choose a world *w* as evaluation world for a sentence S, it means **the whole record of w** is relevant for evaluation of S' truth:

- everything there ever was in *w*,
- everything there presently is in *w*, and
- everything there ever will be in *w*

Individuals and **entities** more generally are parts of worlds.

Possible worlds Semantics

w is assumed to be **the actual world**, often notated as w_0.
However, things might have been different in countless ways, and each different way of putting everything together is a possible world.

In w_0, Chomsky is a linguist who smokes.
In w_2, Chomsky is a singer who never smokes.

For simplicity, we will stay away from the metaphysical debate.

Extension vs. intension

<u>Extension:</u>

In our old extensional semantics, the notation "[[α]]" was read as "the semantic value of α", or "the extension of *α* (in w_0)". In the new "intensional" system, we read $[[\alpha]]^w$ as "the extension of *α* with respect to a given world of evaluation *w*". **The extension is world dependent.**

<u>Intension</u>

A function (with domain W) which maps every possible world to the extension of α in that world. **The intension is world independent.**

$$[\![\alpha]\!]_{\not{c}} := \lambda \mathrm{w}.\ [\![\alpha]\!]^{w}$$

Intensional Domains

D_s = W, the set of all possible worlds

D_e = D, the set of all possible individuals

D_t = {0,1}, the set of truth-values

We expand the set of semantic types by adding a new basic type, **the type s**. We now have three basic types: **e, t, and s**.

Remember our recursive definition of semantic types:

If a and b are semantic types, *<a,b>* is a semantic type.

For the intensional system:

If *a* is a type, then ***< s,a >*** is a type.

Extension vs. intension

Expression type	Lexical entries	Extension	Intension
Proper names	[[Tony]]^w = Tony	individual: e	individual concept: <s, e>
Predicates	[[smoke]]^w = λx ∈ De . x smokes in w [[criminal]]^w = x ∈ De . x is a criminal in w	Predicates: <e,t>	property: <s,<e,t>>
connectives, negation, Determiners	[[and]]^w = p ∈ Dt . [q ∈ Dt . p = q = 1] [[not]]^w = p ∈ Dt . p = 0 [[the]] = λf∈D<e,t>: ∃ !x [f(x) = 1]. the y such that f(y) = 1.	<t,<t,t>> <t,t> <<e,t>,e>	<s,<t,<t,t>>> <s,<t,t>> <s,<<e,t>,e>>
Sentences	[[Tony smokes]]= 1 iff Tony smokes in w	truth-value: t	proposition: <s,t>

World (in)dependence

Expression type	Lexical entries	World (in)dependency of extension
Proper names	$[[\text{Tony}]]^w = \text{Tony}$	World independent. Rigid designators: They denote the same individual in every possible world
Predicates	$[[\text{smoke}]]^w = \lambda x \in D_e$. x smokes in w $[[\text{criminal}]]^w = x \in D_e$. x is a criminal in w	World dependent. The denotation of redicates differs from world to world.
connectives, negation, Determiners	$[[\text{and}]]^w = p \in D_t . [q \in D_t . p = q = 1]$ $[[\text{not}]]^w = p \in D_t . p = 0$ $[[\text{the}]] = \lambda f \in D<e,t>: \exists !x\ [f(x) = 1]$. the y such that $f(y) = 1$.	World independent. Their denotation do not vary with the world.
Sentences	[[Tony smokes]]= = 1 iff Tony smokes in w	World independent.

Semantic rules with evaluation parameter

Except for assignment function, we now have a new evaluation parameter: **Possible worlds.**

Accordingly, we need to relativize the interpretation function [[ ]] to both parameters:

$[[\alpha]]^{w,a}$, when α is assignment-independent, $[[\alpha]]^{w, a} = [[\alpha]]^{w, \varnothing}$

Semantic rules with evaluation parameter

TN1 If $\boldsymbol{\alpha}$ is a terminal node, then for any possible world w $\boldsymbol{\alpha}$ is in the domain of $[\![\ ]\!]^w$ if $[\![\boldsymbol{\alpha}]\!]^w$ is specified in the lexicon.

TN2 If $\boldsymbol{\alpha}$ is a pronoun, then for any possible world w and any assignment a, $[\![\boldsymbol{\alpha}]\!]^{w,a} = \text{a}$.

NN If $\boldsymbol{\alpha}$ is a non-branching node, and $\boldsymbol{\beta}$ is $\boldsymbol{\alpha}$'s daughter, then for any possible world w and any assignment a, $\boldsymbol{\alpha}$ is in the domain of $[\![\ ]\!]^{w,a}$ if $\boldsymbol{\beta}$ is in the domain of $[\![\ ]\!]^{w,a}$. Then $[\![\boldsymbol{\alpha}]\!]^{w,a} = [\![\boldsymbol{\beta}]\!]^{w,a}$.

PM If $\boldsymbol{\alpha}$ is a branching node and $\{\boldsymbol{\beta}, \boldsymbol{\gamma}\}$ is the set of $\boldsymbol{\alpha}$'s daughters, then for any possible world w and any assignment a, $\boldsymbol{\alpha}$ is in the domain of $[\![\ ]\!]^{w,a}$ if $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are in the domain of $[\![\ ]\!]^{w,a}$ and $[\![\boldsymbol{\beta}]\!]^{w,a}$ and $[\![\boldsymbol{\gamma}]\!]^{w,a}$ are both in $D_{\langle e,t\rangle}$. Then $[\![\boldsymbol{\alpha}]\!]^{w,a} = \lambda x \in D_e\ .\ [\![\boldsymbol{\beta}]\!]^{w,a}(x) = [\![\boldsymbol{\gamma}]\!]^{w,a}(x) = 1$.

FA If $\boldsymbol{\alpha}$ is a branching node and $\{\boldsymbol{\beta}, \boldsymbol{\gamma}\}$ is the set of $\boldsymbol{\alpha}$'s daughters, then for any possible world w and any assignment a, $\boldsymbol{\alpha}$ is in the domain of $[\![\ ]\!]^{w,a}$ if $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are in the domain of $[\![\ ]\!]^{w,a}$ and $[\![\boldsymbol{\gamma}]\!]^{w,a}$ is in the domain of $[\![\boldsymbol{\beta}]\!]^{w,a}$. Then $[\![\boldsymbol{\alpha}]\!]^{w,a} = [\![\boldsymbol{\beta}]\!]^{w,a}([\![\boldsymbol{\gamma}]\!]^{w,a})$.

Attitude verbs

Now let's go back to attitude verbs. Recall the problem we encountered, repeated below:

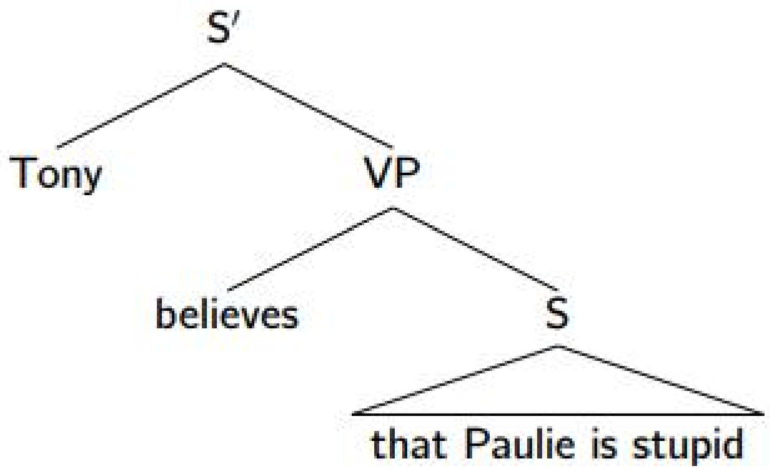
(1) a. Burt **believes** that $_{S1}$ [it is raining in New York.]

b. Burt **believes** that $_{S2}$ [it is snowing in Berlin.]

Since [[beleive]] and [[Burt]] will be assigned the same denotation in both (1a) and (1b), then we predict that (1a) and (1b) are equivalent.

The question is: How can we capture the content of an attitude such as “believing”?

To understand “believe”



[[believes]]^{w} is a function: Proposition S of type <s,t> ⟶ A function VP from an individual (the belief holder) <e> to a truth-value <t>.

[[believes]]^{w} should be of type <<s,t>,<e,t>>.

To understand “believe”

What then are beliefs? Intuitively, beliefs represent ways that things are, according to the belief holder. Our beliefs simply leave too many questions unsettled.
For example, right now Tony doesn't know what kind of person Paulie is. The best he can do is have ***a set of candidates*** $W_T^{\mathcal{B}}$ for the actual world *w*:

$W_T^{\mathcal{B}}$

w_1: Paulie is smart in w_1.
w_2: Paulie is stupid in w_2.
w_3: Paulie is not stupid in w_3.
....

If Tony believes that Paulie is stupid, this means w_1 and w_3 must be excluded from Tony's set of candidate worlds $W_T^{\mathcal{B}}$. We say, w_1 and w_3 are not **compatible** with what Tony believes in the actual world *w*.

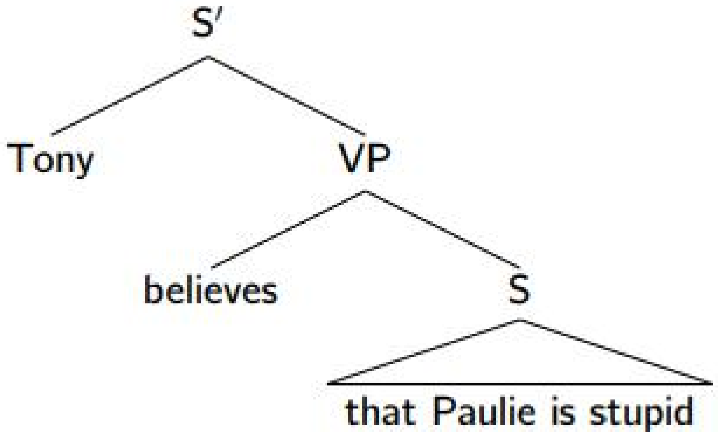
Lexical entry of *believe*

The truth conditions of a belief report can thus be stated as in (5):

(5) [[Tony believes S]]^w= 1 iff every possible world *w'* of Tony's set of candidates $W_T^{\mathcal{B}}$ is compatible with what x believes in *w.*

$$[\![\textbf{believe}]\!]^w = \lambda p_{\langle s,t\rangle} .\ [\lambda x_e\ .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 1]]$$

To understand “believe”



[[believes]]^w is a function: Proposition S of type <s,t> ⟶ A function VP from an individual (the belief holder) <e> to a truth-value <t>.

Type *<<s,t>,<e,t>>*

$$[\![\text{believe}]\!]^w = \lambda p_{\langle s,t\rangle} .\ [\lambda x_e\ .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 1]]$$

A new rule: Intensional functional application (IFA)

This semantics requires believe to be fed a sentence intension *p* as an argument. But our old rule only takes extension as argument.

If $\boldsymbol{\alpha}$ is a branching node and $\{\boldsymbol{\beta}, \boldsymbol{\gamma}\}$ is the set of $\boldsymbol{\alpha}$'s daughters, then for any possible world w and any assignment a, if $[\![\boldsymbol{\beta}]\!]^{w,a}$ is a function whose domain includes $[\![\boldsymbol{\gamma}]\!]^{a}_{\text{¢}}$, $[\![\boldsymbol{\alpha}]\!]^{w,a} = [\![\boldsymbol{\beta}]\!]^{w,a}([\![\boldsymbol{\gamma}]\!]^{a}_{\text{¢}})$.

Computing the truth-conditions

$[\![\text{that Paulie is stupid}]\!]^{w} = 1$ iff Paulie is stupid in w

$$\begin{aligned}
&[\![\text{believes that Paulie is stupid}]\!]^{w} \\
&= [\![\text{believes}]\!]^{w}([\![\text{that Paulie is stupid}]\!]_{\not c}) \qquad \text{(IFA)} \\
&= [\lambda p_{\langle s,t\rangle} .\ [\lambda x_e .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 1]]] \\
&\quad ([\![\text{that Paulie is stupid}]\!]_{\not c}) \\
&= [\lambda p_{\langle s,t\rangle} .\ [\lambda x_e .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 1]]] \\
&\quad ([\lambda w''.[\![\text{that Paulie is stupid}]\!]^{w''}]) \\
&= [\lambda p_{\langle s,t\rangle} .\ [\lambda x_e .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 1]]] \\
&\quad ([\lambda w''.\text{Paulie is stupid in } w'']) \\
&= [\lambda x_e .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow \\
&\quad [\lambda w''.\text{Paulie is stupid in } w''](w') = 1]] \\
&= [\lambda x_e .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow \text{Paulie is stupid in } w']]
\end{aligned}$$

$$\begin{aligned}
&[\![\text{Tony believes that Paulie is stupid}]\!]^{w} \\
&= 1 \text{ iff } \forall w'[w' \text{ is compatible with what T believes in } w \rightarrow \text{Paulie is stupid in } w']
\end{aligned}$$

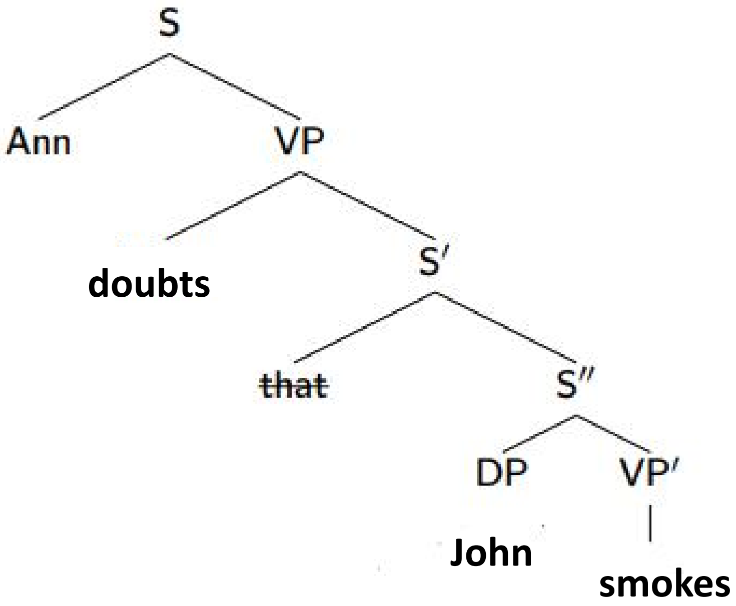
Exercise 18: Propositional attitude predicates

Doubt is definable via *believe*.

$$[\![\text{doubt}]\!]^{w} = \lambda p_{\langle s,t\rangle}.\ [\lambda x_e\ .\ \forall w'[w' \text{ is compatible with what } x \text{ believes in } w \rightarrow p(w') = 0]]$$

Compute the truth-conditions of (6).

(6) Ann doubts that John won.



Exercise 18: Solutions

$[[S']]^{w,g} = [[S']]^{w,\varnothing}$ (DEA)

$= [[S']]^{w}$ (AID)

$= [[VP']]^{w}([[DP]]^{w})$ (FA)

$= [[smokes]]^{w}([[John]]^{w})$ (2xNN)

$= [\lambda x \in De \,.\, x \text{ smokes in } w]$ (John) (2xTN1)

$= 1$ iff John smokes in w

$[[VP]] = [[doubts]]^{w,g} ([\![S']\!]^{g}_{¢})$ (IFA)

$= [[doubts]]^{w} ([[\lambda w'. [[S']]^{w'})$ (DEA, AID)

$= [\lambda p \in D_{<s,t>} \,.\, [\lambda x \in D_{e} \,.\, \forall w'' [w'' \text{ is compatible with what } x \text{ believes in } w \rightarrow$
$p(w'') = 0]]] ([\lambda w'. [[S']]^{w'}])$ (TN1)

$= [\lambda x \in D_{e} \,.\, \forall w'' [w'' \text{ is compatible with what } x \text{ believes in } w \rightarrow [\lambda w'. [[S']]^{w'}] (w'')=0]]$

$= [\lambda x \in D_{e} \,.\, \forall w'' [w'' \text{ is compatible with what } x \text{ believes in } w \rightarrow [[S']]^{w''}= 0]]$

Exercise 18: Solutions

$[[S]]^{w,g} = [[VP]]^{w,g}([[Ann]]^{w,g})$ (FA)

$= [[VP]]^{w}([[Ann]]^{w})$ (AID)

$= [\lambda x \in D_e . \forall w'' [w'' \text{ is compatible with what } x \text{ believes in } w \rightarrow [[S']]^{w''} = 0]] \ (Ann)$ ($[[VP]]^{w,}$ TN1)

$= 1$ iff $\forall w'' [w''$ is compatible with what Ann believes in $w \rightarrow [[S']]^{w''} = 0]$

$= 1$ iff w'' is compatible with what Ann believes in $w \rightarrow$ John smokes in $w'' = 0$

Accessibility relation

Just like believe, other attitude verbs (hope, know, expect) also quantify over a set of possible worlds as candidates for *w*.

$$[\![\textbf{know}]\!]^w = \lambda p_{st} \,.\, [\lambda x_e \,.\, \forall w'[w' \text{ is compatible with what } x \text{ knows in } w \rightarrow p(w') = 1]]$$

$$[\![\textbf{expect}]\!]^w = \lambda p_{\langle s,t\rangle} .\, [\lambda x_e \,.\, \forall w'[w' \text{ is compatible with what } x \text{ expects in } w \rightarrow p(w') = 1]]$$

$$[\![\textbf{hope}]\!]^w = \lambda p_{\langle s,t\rangle} .\, [\lambda x_e \,.\, \forall w'[w' \text{ is compatible with what } x \text{ hopes in } w \rightarrow p(w') = 1]]$$

Accessibility relation

When every possible *w'* in the set of candidates worlds is compatible with what x believes in *w,* we say the worlds are **accessible** given x's beliefs in *w*.

$$[\![\text{believe}]\!]^{w} = \lambda p_{\langle s,t\rangle}.\ [\lambda x_e\ .\ \forall w'[w\mathcal{R}^{\mathcal{B}}_{x} w' \rightarrow p(w') = 1]]$$

The sole difference between various attitudes is in the **accessibility relation** that determines the set of worlds they quantify over.

$$[\![\text{hope}]\!]^{w} = \lambda p_{\langle s,t\rangle}.\ [\lambda x_e\ .\ \forall w'[w\mathcal{R}^{\mathcal{H}}_{x} w' \rightarrow p(w') = 1]]$$

$$[\![\text{expect}]\!]^{w} = \lambda p_{\langle s,t\rangle}.\ [\lambda x_e\ .\ \forall w'[w\mathcal{R}^{\mathcal{E}}_{x} w' \rightarrow p(w') = 1]]$$

$$[\![\text{know}]\!]^{w} = \lambda p_{\langle s,t\rangle}.\ [\lambda x_e\ .\ \forall w'[w\mathcal{R}^{\mathcal{K}}_{x} w' \rightarrow p(w') = 1]]$$

Reflexivity and veridicality

The concept of knowledge crucially contains the concept of truth: what we know must be true. So if in *w* we know that something is the case then it must be the case in *w*. So, w must be compatible with all we know in w. $\mathcal{R}_x^{\mathcal{K}}$ is **reflexive**. However, we can have false beliefs. $\mathcal{R}_x^{\mathcal{B}}$ is **not reflexive.**

Reflexive accessibility relation licenses the inference that the embedded clause is true. This is called **veridicality.**

(7)	a. I **know** *p*.	Inference: *p* must be true. (**reflexive, veridical**)
	b. I believe *p.*	No Inference that *p* must be true. (**non-reflexive, non-veridical**)
	c. I hope *p.*	No Inference that *p* must be true. (**non-reflexive, non-veridical**)
	d. I doubt *p.*	No Inference that *p* must be true. (**non-reflexive, non-veridical**)

Exercise 18: Accessibility relation

1) What kind of possible accessibility relation do the following attitude predicates involve? What inferences do these sentence have?

2) Try to come up with a lexical entry for ***glad***.

(8) a. John **assumed** that it is raning outside.
b. That John won the game **shocked** me.
c. Mary was **glad** that John called her.
d. John **regreted** that he left the party.
e. Mary **found out** that John left the party.

Exercise 18: Solutions

(8) a. John **assumed** that it is not raning outside. $\not\leadsto$ It is raning outside.

assume’s accessibility relation is non-reflexive, non-veridical

b. That John won the game **shocked** me. $\leadsto$ John won the game.

shock’s accessibility relation is reflexive and veridical.

c. Mary was **glad** that John called her. $\leadsto$ John called Mary.

glad’s accessibility relation is reflexive and veridical.

d. John **regreted** that he left the party. $\leadsto$ He left the party.

regret's accessibility relation is reflexive and veridical.

e. Mary **found out** that John left the party. $\leadsto$ John left the party.

find out's accessibility relation is reflexive and veridical.

Exercise 18: Solutions

Emotive factives like “glad” “happy” “surprised” have their accessibility relation presumably based on mood. There is a fact that John called Mary (hence that John called Mary is true), and that fact made Mary happy.

Lexical entry:

[[glad]]^{w,a} = $\lambda p \in D_{<s,t>}$ and $p(w) = 1$. [$\lambda x \in D_e$. $\forall w''$ [w'' is compatible with what x would feel gald about in $w \rightarrow p(w'') = 1$]]

or

[[glad]]^{w,a} = $\lambda p \in D_{<s,t>}$ and $p(w) = 1$. [$\lambda x \in D_e$. $\forall w'$ [$w \mathcal{R}^{\mathcal{G}}_x w'$ $\rightarrow p(w'') = 1$]]