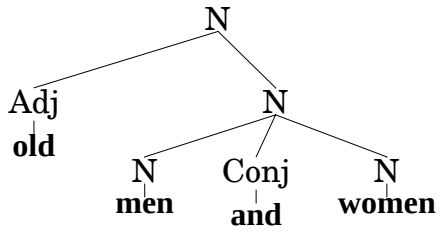
PART 1: Syntax-Semantics Interface

1. Syntax

(1.1) If $\Delta_1,...,\Delta_n$ are deep structures of the corresponding syntactic categories $\kappa_1,...,\kappa_n$, then the result of applying the (n -place) syntactic construction C to $(\Delta_1,...,\Delta_n)$ will be a deep structure of category κ_{n+1}.
Notation: $(C, \kappa_1,...,\kappa_n,\kappa_{n+1})$

(1.2) **old men and women**

(1.3)

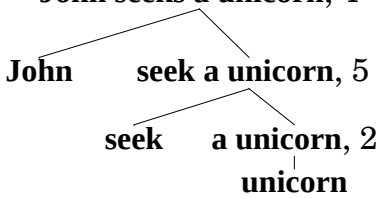


(USC) Uniqueness of Structure Constraint on an algebra $(\Sigma, (C_i)_{i\in I})$:
If $C_i(\Delta_1,...,\Delta_n) = C_j(\Delta'_1,...,\Delta'_m)$, then $i = j$, and $(\Delta_1,...,\Delta_n) = (\Delta'_1,...,\Delta'_m)$ (and hence $C_i = C_j$, $m = n$, $\Delta_1 = \Delta'_1$, ...,$\Delta_n = \Delta'_m$).

(1.4) $(_N\ (_{Adj}$ **old** $)_{Adj}\ (_N\ (_N$ **men** $)_N\ (_{Conj}$ **and**$)_{Conj}\ (_N$ **women**$)_N\ )_N\ )_N$

(1.5) **Jones seeks a horse such v_7 that it v_7 speaks**

(1.6) **John seeks a unicorn**, 4



Definition

A *(deep) syntax* is a quintuple $(\Sigma,(C_i)_{i\in I},(L_k)_{k\in K},R,S)$, where

- $(\Sigma, (C_i)_{i\in I})$ satisfies (USC);
- the *L*exicon $\bigcup_{k\in K} L_k$ generates the set Σ of (syntactic) structures;
  (i.e. no lecial item is a value of an operation C_i and Σ is the smallest set that contains the lexicon and is closed under all C_i);
- the elements of *R*[ules] are as in (1.1) – where C is one of the C_i and all $\kappa_j \in K$[ategories];
- S[entence] $\in K$.

If $\Delta\in\Sigma$ and $k^*\in K$, then Δ *is of category* k^* if either $\Delta\in L_{k^*}$ (in which case Δ's *rank* $\rho(\Delta)$ is 0), or $\Delta = C_i(\Delta_1,...,\Delta_n)$ (and thus $\rho(\Delta) = max(\rho(\Delta_1),...,\rho(\Delta_1)) + 1$), $\Delta_1,...,\Delta_n$ are of categories $k_1,...,k_n$, respectively, and $(C_i,k_1,...,k_n,k^*)\in R$.

2. Compositionality

(2.1) The meaning of a complex expression can be determined from the meanings of its parts.

(2.2) If S_1 and S_2 are sentences (of some fixed language), then so is '(S_1 **and** S_2)'.

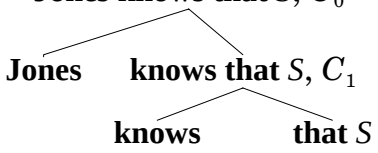
(2.3) $C(\Delta,\Delta')$ = '(Δ **and** Δ')', whenever Δ and Δ' are structures.

(2.4) If $C(\Delta_1,\ldots,\Delta_n)$ is a structure, then its meaning is uniquely determined by the meanings of $\Delta_1,\ldots,\Delta_n$ and C.

(2.5) For each (n-place) syntactic construction C there is a corresponding (n-place) meaning combination M such that the meaning of any structure $C(\Delta_1,\ldots,\Delta_n)$ is $M(b_1,\ldots,b_n)$, where b_1 is Δ_1's meaning, etc.

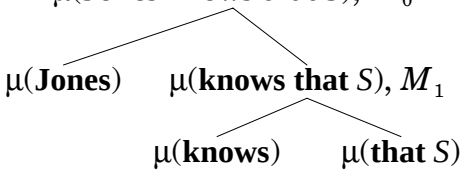
(2.6) $\mu(C(\Delta_1,\ldots,\Delta_n)) = M(\mu(\Delta_1),\ldots,\mu(\Delta_n))$

(2.7) **Jones knows that** S, C_0

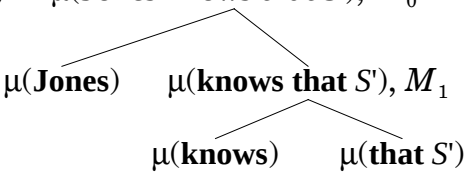


(2.8) $M_0(\mu(\textbf{Jones}),M_1(\mu(\textbf{love}),\mu(\textbf{Smith})))$

(2.9) μ(**Jones knows that** S), M_0



(2.10) μ(**Jones knows that** S'), M_0



(2.11) μ(**that** S) = μ(**that** S') $\Rightarrow$ μ(**Jones knows that** S) = μ(**Jones knows that** S')

(2.12) L_1 = {**0**,…,**9**}; $L_n = \emptyset$ ($n \neq 1$); $C_n(\Delta,\Delta')$ = '[$_n$ Δ Δ']' $R = \{(C_n,1,n,n+1) \mid n \geq 1\}$.

(2.13) $M_n(x,y) = 10^n x + y$

(2.14) $\mu(C_2(\mathbf{7}, C_1(\mathbf{1},\mathbf{2})))$

$= M_2(\mu(\mathbf{7}),\mu(C_1(\mathbf{1},\mathbf{2})))$

$= M_2(\mu(\mathbf{7}),M_1(\mu(\mathbf{1}),\mu(\mathbf{2})))$

$= M_2(7,M_1(1,2))$

$= 10^2 \times 7 + 10^1 \times 1 + 2$

$= 712$

Definitions

Given a syntax $(\Sigma,(C_i)_{i\in I},(L_k)_{k\in K},R,\mathrm{S})$, a *corresponding semantics* is a triple $(B,\mu_0,(M_i)_{i\in I})$, where B is some non-empty set; $\mu_0: \bigcup_{k\in K} L_k \rightarrow B$; and $(M_i)_{i\in I}$ is similar to $(C_i)_{i\in I}$. Given any $\Delta\in\Sigma$, then either $\Delta\in L_{k^*}$ and its *meaning* (according to $(B,\mu_0,(M_i)_{i\in I})$) is $\mu_0(\Delta)$; or else $\Delta = C_i(\Delta_1,\ldots,\Delta_n)$ and its *meaning* [...] is $\mu(C(\Delta_1,\ldots,\Delta_n)) = M(\mu(\Delta_1),\ldots,\mu(\Delta_n))$, where $\mu(\Delta_1),\ldots,\mu(\Delta_n)$ are the respective meanings [...] of $\Delta_1,\ldots,\Delta_n$.

(2.15) **(∃*x*) P(*x*)**

(2.16) **P(a)**

(2.17) The meaning of a complex expression is determined by the meanings of (certain) less complex expressions.

(2.18) **(∀*x*) P(*x*)**

(2.19) There exists a function *f* which can be applied to pairs consisting of syntactic constructions and sets of meanings such that the meaning of a complex structure Δ of the form $C(\Delta_1,..,\Delta_n)$ equals the value $f(C,\mathrm{b}[\mathrm{X}])$, where X is some set of structures of ranks less than Δ.

PART 2: Meaning and Reference

3. Local Perspective

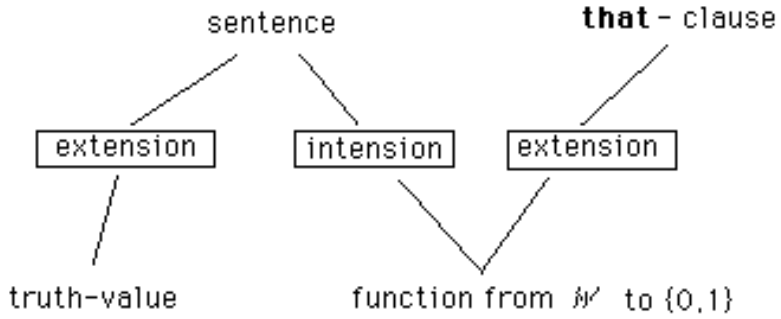
(3.1)

Syntactic Category	*Type of extension*	*Example*	*Extension of example*
proper name	individual (bearer)	**Fritz**	*Fritz Hamm*
definite description	individual (described)	**the fifth-biggest city of France**	*Nice*
count nouns	set (of individuals)	**table**	*set of tables*
intransitive verb	set (of individuals)	**sleep**	*set of sleepers*
transitive verb	set of pairs (of individuals)	**eat**	*set of pairs (eater,food)*
ditransitive verb	set of triples (of individuals)	**give**	*set of triples (giver,recipient, gift)*
sentence	truth value (Ø or {Ø})	**snow is white**	*1*

(3.2) **Jones knows that snow is white.**

(3.3) **Jones knows that grass is green.**

(3.13)



(3.14) (i) $\{\boldsymbol{t},\boldsymbol{e}\}\subseteq\mathbf{IT}$, and $\{(a,b),(\boldsymbol{s},b)\}\subseteq\mathbf{IT}$ if $\{a,b\}\subseteq\mathbf{IT}$. types

(ii) $\mathbf{E}_{\boldsymbol{t}}=\{0,1\}$, $\mathbf{E}_{\boldsymbol{e}}=\mathbf{U}$, $E_{(a,b)}=\mathbf{E}_b^{\mathbf{E}_a}$, $\mathbf{E}_{(\boldsymbol{s},b)}=\mathbf{E}_b^{\mathbf{W}}$. extensions

(iii) $\mathbf{I}_a=\mathbf{E}_{(\boldsymbol{s},a)}$; $\mathbf{M}_{\boldsymbol{a}}=\mathbf{I}_{\boldsymbol{a}}^{\mathbf{C}}$. intensions and meanings

(iv) A *point of reference* is an element of $\mathbf{W}\times\mathbf{C}$.

(v) A *property* is an element of $\mathbf{I}_{\boldsymbol{et}}$.

(vi) P is a *subproperty* of Q iff $P(w)\subseteq Q(w)$, for any $w\in\mathbf{W}$.

Definition

A *local (Fregean) language* is a quintuple $(\Xi,f,(M_i)_{i\in I},\mu_0,\boldsymbol{\Delta})$, where

- $\Xi=(\Sigma,(C_i)_{i\in I},(L_k)_{k\in K},R,\mathrm{S})$ is a syntax;
- $f\colon K\to\mathbf{IT}$ is a function (type assignment) such that $f(\mathrm{S})=\boldsymbol{t}$;
- $\mu_0:\bigcup_{k\in K}L_k\to\bigcup_{a\in\mathbf{IT}}\mathbf{M}_a$ is a function (lexical meaning assignment) such that $\mu_0(\delta)\in\mathbf{M}_a$ whenever $\delta\in L_k$ and $f(k)=a$;
- $(M_i)_{i\in I}$ is a family of meaning operations (similar to $(C_i)_{i\in I}$) such that $M_i(b_1,\ldots,b_n)\in\mathbf{M}_{f(k_0)}$ whenever $b_1\in\mathbf{M}_{f(k_1)},\ldots,b_n\in\mathbf{M}_{f(k_n)}$ and $(M_i,k_1,\ldots,k_n,k_0)\in R$.
- $\boldsymbol{\Delta}$ is the *diagonal*, i.e. the set of $(w,c)\in\mathbf{W}\times\mathbf{C}$ such that $w=w_c$.

$\Rightarrow$ If Δ is of category k, then its meaning is in $\mathbf{M}_{f(k)}$.

(3.15) $M(b_1,\ldots,b_n)(c)(w)=M'(b_1(c),\ldots,b_n(c))(c)(w)$

(3.16) $M(b_1,\ldots,b_n)(c)=M'(b_1(c),\ldots,b_n(c))(c)$

(3.17) δ is *deictic* iff $\mu(\varphi)(c)(w)=\mu(\varphi)(c)(w')$, for all $w,w'\in\mathbf{W}$.

(3.18) δ is a *hyponym of* δ' (*in* a local language L) iff $\mu_0(\delta)(c)(w)$ is a subproperty of $\mu_0(\delta')(c)(w)$ whenever (c,w) is a point of $\left\{\begin{matrix}\text{reference}\\\text{utterance}\end{matrix}\right\}$.

(3.19) φ of category S is an *a priori truth* iff $\mu(\varphi)(c)(w)=1$, for all $(w,c)\in\boldsymbol{\Delta}$.

4. Global Perspective

(4.1) The meaning of **pebble** is that (local) meaning b of type $\langle e,t\rangle$ such that for any point of reference (w,c) and any individual x the following holds:

$$b(c)(w)(x) = \begin{cases} 1, \text{ if } x \text{ is a pebble with respect to the relevant paramters of } \langle w,c\rangle; \\ 0, \text{ otherwise.} \end{cases}$$

(4.2) The meaning of **stone** is that closed meaning b of type $(\boldsymbol{e},\boldsymbol{t})$ such that for any point of reference (w,c) and any individual x the following holds:

$$b(c)(w)(x) = \begin{cases} 1, \text{ if } x \text{ is a stone with respect to the relevant paramters of } \langle w,c\rangle; \\ 0, \text{ otherwise.} \end{cases}$$

Definitions

(i) An *ontology* is a pair (E,C) where $C \neq \emptyset$ and there are non-empty sets D and W such that $E = (E_a)_{a\in \mathbf{IT}}$ satisfies the equations (3.14)(ii).

(ii) An *ersatz (Fregean) language* based on an ontology (E,C) is a quintuple that is like a local language except that E and C play the respective rôles of extensions and contexts.

(iii) A *global (Fregean) language* is a class of *ersatz* local languages that share the same syntax and type assignment.

(iv) δ is $\left\{\begin{array}{c} \textit{deictic} \\ \textit{a hyponym of } \delta' \\ \textit{an a priori truth} \end{array}\right\}$ in a global language iff δ is $\left\{\begin{array}{c} \text{deictic} \\ \text{a hyponym of } \delta' \\ \text{an a priori truth} \end{array}\right\}$ in each of its members.

(4.3) φ of category S is *contingent (in* a given [*ersatz*] local language L iff there are points of reference (w,c) and (w',c') such that $\mu(\varphi)(c)(w) = 1$ and $\mu(\varphi)(c')(w') = 0$, where $\mu_L(\varphi)$ is the meaning of $\mu_L(\varphi)$ according to L.

(4.4) φ of category S is *independent of* ψ of category S *(in* a given [*ersatz*] local language) iff $\{(\mu_L(\varphi)(c)(w),\mu_L(\psi)(c)(w)) \mid (w,c) \text{ is a point of reference of } L\}$ has 4 members.

PART 3: Indirect Interpretation

5. Translation

(5.1)

English		Logic	
structure	*category*	$\lvert$ *structure* $\rvert$	*type*
book	N	B	***et***
cheap	Adj	**C**	***et***
($_{\mathrm{N}}$ ($_{\mathrm{Adj}}$**cheap**), ($_{\mathrm{N}}$ **book**)) [=F_{mod}(**cheap**,**book**)]	N	[λx [**C**(x) $\wedge$ **B**(x)]] [= F_{λ}($\boldsymbol{x}$,$F_{\wedge}$(F_{app}(**C**,$\boldsymbol{x}$),F_{app}(**B**,$\boldsymbol{x}$)))]	***et***

(5.2) $\lvert F_{\mathrm{mod}}(\Delta,\Delta') \rvert = F_{\lambda}(\boldsymbol{x},F_{\wedge}(F_{\mathrm{app}}(\Delta,\boldsymbol{x}),F_{\mathrm{app}}(\Delta',\boldsymbol{x})))$ where $\boldsymbol{x}$ is a fixed variable

(5.3) A *syntactic polynomial* (over a given syntax) is a term of the form $\boldsymbol{F(X_1,\ldots,X_n)}$, where $\boldsymbol{F}$ is the (unique) name of an n-place syntactic construction (of that syntax) and each $\boldsymbol{X_i}$ is either itself a syntactic polynomial (…), or a *meta-variable* (standing in for an arbitrary structure), or the (unique) name of a particular structure (…).
A *derived construction* (*on* a syntax) if is an operation on syntactic structures (…) that is denoted by some syntactic polynomial (…) – in the more or less obvious sense.

(5.4) A *translation* from a syntax $\Xi = (\Sigma,(C_i)_{i\in I},(L_k)_{k\in K},R,\mathrm{S})$ to a syntax $\Xi' = (\Sigma',(C'_i)_{i\in I'},(L'_k)_{k\in K'},R',\mathrm{S}')$ is a triple $(g,t,(T_i)_{i\in I},)$ such that:

- $g\colon K \to K'$ is a function (category assignment) such that $g(\mathrm{S}) = \mathrm{S}'$;
- $t\colon \bigcup_{k\in K} L_k \to \Sigma'$ is a function (lexical translation) such that $t(\delta)$ is a structure of category $g(k)$ in Ξ' whenever $\delta\in L_k$;
- $(T_i)_{i\in I}$ is a family of derived constructions on Ξ' that is similar to $(C_i)_{i\in I}$;
- if $(C_i,k_1,\ldots,k_n,k^*)\in R$, and $\Delta_1,\ldots,\Delta_n$ are structures of the respective categories $k_1,\ldots,k_n$, then $T_i(\Delta_1,\ldots,\Delta_n)$ is of category $g(k^*)$.

Given any $\Delta\in\Sigma$, then either $\Delta\in L_{k^*}$ and its *translation* $\lvert\Delta\rvert$ (according to $(g,t,(T_i)_{i\in I},)$) is $t(\Delta)$; or else $\Delta = C_i(\Delta_1,\ldots,\Delta_n)$ and its *translation* […] is $\lvert C_i(\Delta_1,\ldots,\Delta_n)\rvert = T_i(\lvert\Delta_1\rvert,\ldots,\lvert\Delta_n\rvert)$, where $\lvert\Delta_1\rvert),\ldots,\lvert\Delta_n\rvert$ are the respective translations […] of $\Delta_1,\ldots,\Delta_n$.

6. Intensional Type Logic (ITL)

(6.1) The *variables* of ITL form a family $(Var_a)_{a\in\mathbf{IT}}$ of pairwise disjoint, infinite sets; the *constants* of ITL form a family $(Con_a)_{a\in\mathbf{IT}}$ of pairwise disjoint sets; the *syncategorematic expressions* form the set {**λ**,(,),**=**,^,ˇ}. No variable is a constant or a syncategorematic expression, etc.

The *syntax of ITL* is a quintuple $(\Sigma,(C_i)_{i\in I},(L_k)_{k\in K},R,\boldsymbol{t})$, where:

- Σ consists of (finite) strings over $\bigcup_{a\in\mathbf{IT}} Con_a \cup \bigcup_{a\in\mathbf{IT}} Var_a \cup$ {**λ**,(,),**=**,^,ˇ};
- I = {app,abs,id,cup,cap};
- $C_{\text{app}}(\Delta,\Delta') = \Delta(\Delta')$; $C_{\text{abs}}(\Delta,\Delta') = (\boldsymbol{\lambda}\Delta\ \Delta')$;$C_{\text{id}}(\Delta,\Delta') = (\Delta = \Delta')$; $C_{\text{cup}}(\Delta) = {}^{\vee}\Delta$; $C_{\text{cap}}(\Delta) = {}^{\wedge}\Delta$;
- $K = \mathbf{IT} \cup \{(\text{VAR},a) \mid a\in\mathbf{IT}\}$;
- $L_k = Var_k \cup Con_k$ if $k\in\mathbf{IT}$; $L_k = Var_a$ if $k = (\text{VAR},a)$;
- R = $\{\{(C_{\text{app}},(a,b),a,b) \mid a,b\in\mathbf{IT}\},\{(C_{\text{abs}},((\text{VAR},a),b,(a,b) \mid a,b\in\mathbf{IT}\},\{(C_{\text{id}},a,a,\boldsymbol{t}) \mid a\in\mathbf{IT}\}$, $\{(C_{\text{cup}},(\boldsymbol{s},a),a) \mid a\in\mathbf{IT}\},\{(C_{\text{cup}},a,(\boldsymbol{s},a)) \mid a\in\mathbf{IT}\}$.

An ITL-ontology is a pair (E,C), where $E = (E_a)_{a\in\mathbf{IT}}$ satisfies the equations (3.14)(ii) and C is the set of *variable assignments*, i.e. the set of functions $h: \bigcup_{a\in\mathbf{IT}} Var_a \rightarrow \bigcup_{a\in\mathbf{IT}} E_a$ such that $h(\boldsymbol{x}) \in E_a$ whenever $\boldsymbol{x}\in Var_a$.

A local (*ersatz*) *language of ITL* is a Fregean langugage (E,C) $(\Xi,f,(M_i)_{i\in I},\mu_0,\boldsymbol{\Delta})$ based on an ITL-ontology where

- Ξ is the syntax of ITL;
- $f(a) = f((\text{VAR},a)) = a$, for any $a\in\mathbf{IT}$;
- for any b, $b'\in \bigcup_{a\in\mathbf{IT}} E_a$, $w,w'\in W$, $h\in C$, and $u\in U$ the following hold:
  $M_{\text{app}}(b,b')(h)(w) = b(h)(w)(b'(h)(w))$ whenever $b\in \mathbf{M}_{a,b}$ and $b'\in \mathbf{M}_a$;
  $M_{\text{abs}}(\mu_0(\boldsymbol{x}),b)(h)(w)(u) = b(h[\boldsymbol{x}/u])(w)$ whenever $\boldsymbol{x}Var_a$ and $b\in \mathbf{M}_{a,b}$ and $h[\boldsymbol{x}/u] = (h\setminus\{(\boldsymbol{x},h(\boldsymbol{x}))\})\cup\{(\boldsymbol{x},u)\}$;
  $M_{\text{id}}(b,b')(h)(w) = \{\varnothing \mid b(h)(w) = b'(h)(w)\}$ whenever $b,b'\in \mathbf{M}_a$;
  $M_{\text{cup}}(b)(h)(w) = b(h)(w)(w)$ whenever $b\in \mathbf{M}_{\boldsymbol{s}a}$;
  $M_{\text{cap}}(b)(h)(w)(w') = b(h)(w')$.
- $\mu_0(\mathbf{c})(h)(w) = \mu_0(\mathbf{c})(h')(w)$ whenever $w\in W$, $h,h'\in C$ and $\mathbf{c}\in \bigcup_{a\in\mathbf{IT}} Con_a$;
  $\mu_0(\boldsymbol{x})(h)(w) = h(\boldsymbol{x})$ whenever $w\in W$, $h\in C$ and $\boldsymbol{x}\in \bigcup_{a\in\mathbf{IT}} Var_a$;
- $\boldsymbol{\Delta} = W\times C$.

If M is a local language of ITL, α is an ITL formula (structure), $\mu(\alpha)$ is α's menaing according to M, $h\in C$, $w\in W$, $[\![\alpha]\!]^{M,h,w}$ is $\mu(\alpha)(h)(w)$.

Given a local ITL-language M, there exists a function F: $\bigcup_{a\in\mathbf{IT}} Con_a \rightarrow \bigcup_{a\in\mathbf{IT}} I_a$ such that $F(\mathbf{c}) \in I_a$ whenever $\mathbf{c}\in Con_a$ and such that the following hold:

(i) $[\![\alpha]\!]^{M,g,w} = F(\alpha)(w)$, if $\alpha\in Con_a$;

(ii) $[\![\alpha]\!]^{M,g,w} = g(\alpha)$, if $\alpha\in Var_a$;

(iii) $[\![\alpha]\!]^{M,g,w} = [\![\alpha_1]\!]^{M,g,w}([\![\alpha_2]\!]^{M,g,w})$, if $\alpha = \alpha_1\ (\alpha_2)$;

(iv) $[\![\alpha]\!]^{M,g,w} = \{(u,[\![\alpha_1]\!]^{M,g[x/u],w}) \mid u\in D_b\}$, if $\alpha = (\boldsymbol{\lambda x}\ \alpha_1)$ und $\boldsymbol{x}\in Var_b$;

(v) $[\![\alpha]\!]^{M,g,w} = \{u \mid [u = 0$ and $[\![\alpha_1]\!]^{M,g,w} = [\![\alpha_2]\!]^{M,g,w}\ ]\ \}$, if $\alpha = (\alpha_1 = \alpha_2)$;

(vi) $[\![\alpha]\!]^{M,g,w} = [\![\alpha_1]\!]^{M,g,w}(w)$, if $\alpha = \check{}\alpha_1$;

(vii) $[\![\alpha]\!]^{M,g,w} = \{(w',[\![\alpha_1]\!]^{M,g,w'}) \mid w'\in W\}$, if $\alpha = \hat{}\alpha_1$.

(6.2) If α and α' are ITL-formulae of the same category, then α and α' are *logically equivalent* if $[\![\alpha]\!]^{M,g,w} = [\![\alpha']\!]^{M,g,w}$ for any local ITL-languages M, worlds w and assignments g. Notation: $\alpha \equiv \alpha'$.

(6.3) An ITL-formula α is *modally closed* if (i-a) $\alpha\in \bigcup_{a\in\mathbf{IT}} Var_a$; or (i-b) $\alpha = \hat{}\alpha$ (for some β), or (ii) there are modally closed α_1 and α_2 such that (ii-a) $\alpha = \alpha_1\ (\alpha_2)$, or (ii-b) $\alpha = (\boldsymbol{\lambda}\alpha_1\ \alpha_2)$, or (ii-c) $\alpha = (\alpha_1 = \alpha_2)$.

Down-Up Cancellation

$\check{}\hat{}\alpha \equiv \alpha$, for all ITL-formulae α.

Up-Down Cancellation

$\hat{}\check{}\alpha \equiv \alpha$, if α is modally closed (and of a category $(\boldsymbol{s},a)$).

Two-sorted Type Theory

2T contains $\boldsymbol{t}$, $\boldsymbol{e}$, and $\boldsymbol{s}$ and all pairs (a,b) such that $a,b\in\mathbf{2T}$.
$(Var_a)_{a\in\mathbf{2T}}$ and $(Con_a)_{a\in\mathbf{2T}}$ are analogous to ITL, but the only syntactic constructions are C_{app} , C_{abs} , and C_{id} .

Gallin's translation ($\boldsymbol{i}$ is a fixed variable in $Var_{\boldsymbol{s}}$).

(i) $\mathbf{c}* =$ '$\mathbf{c}\ (\boldsymbol{i})$', if $\mathbf{c}\in Con_a$;

(ii) $\boldsymbol{x}* = \boldsymbol{x}$, if $\boldsymbol{x}\in Var_a$;

(iii) $\alpha(\beta)* = \alpha*(\beta*)$;

(iv) $(\lambda x\alpha)* = (\boldsymbol{\lambda x}\ \alpha*)$;

(v) $(\alpha = \beta)* = (\alpha* = \beta*)$;

(vi) $\check{}\alpha* = \alpha*(\boldsymbol{i})$;

(vii) $\hat{}\alpha'* = (\boldsymbol{\lambda i}\ \alpha*)$.

Restricted **β**-conversion (ITL)

$((\boldsymbol{\lambda x}\ \alpha)\ (\beta)) \equiv \alpha[^{x}/_{\beta}]$, if (i) β does not contain a free variable that would get bound when $\boldsymbol{x}$ in α is replaced by β *and* either (ii-a) no occcurrence of $\boldsymbol{x}$ in α lies within the scope of $\hat{}$, or (ii-b) β is modally closed.

β-conversion (Ty2)

((λ*x* α) (β)) ≡ α[*x*/β] , β does not contain a free variable that would get bound when ***x*** in α is replaced by β.

[Notation: **((λ*x* α) (β))** >**β** α[*x*/β] ; transitive closure: ▷**β**]

NB1: **((λ*x* α) (*x*))** >**β** α;

NB2: **β**-contraction may increase length; e.g., if $\boldsymbol{x} \in Var_{e}$, $\mathbf{R} \in Con_{e(e(et))}$, $\mathbf{f} \in Con_{e(e(ee))}$, $\mathbf{c} \in Con_{e}$:

(λ*x* R(*x*)(*x*)(*x*))(f(c)(c)(c)) ▷**β** **R(f(c)(c)(c)) (f(c)(c)(c)) (f(c)(c)(c)))**

η-conversion (Ty2 & ITL)

(λ*x* β(*x*)) ≡ β, if ***x*** ∉ *Fr*(β)

α-conversion (Ty2 & ITL)

(λ*x* α) ≡ **(λ*y* α[*x*/*y*])** iff no occurrence of ***x*** in α lies within the scope of (some) **λ*y*** and ***y*** ∉ *Fr*(**(λ*x* α)**).

Definition

(a) α is *immediately reducible to* β iff α>**β**β or α >**η**β or α>**α**β.
[Notation: α>β ; transitive closure: α▷β]

(b) α is *normal* iff α▷β implies α▷**α**β.

(c) α is a *normal form of* β iff α▷β and β is normal.

Normal Form Theorem (Ty 2)

Every Ty2-formula has a normal form.

Church-Rosser Theorem (Ty2)

If β and β' are normal forms of α, then β ▷**α** β'.

(6.4a) **(λ*x* P((λ*y* ^*y*)(*x*)))(c)** (where $\boldsymbol{x} \in Var_{se}$, $\boldsymbol{y} \in Var_{e}$, $\mathbf{c} \in Con_{se}$, $\mathbf{P} \in Con_{(se)t}$)

(b) **P((λ*y* ^*y*)(c))**

(c) **(λ*x* P(^*x*))(c)**

Four observations on ∗:

- (ˇ^α)∗ >**β** α∗.
- An ITL-formula α is modally closed iff ***i*** ∉ *Fr*(α∗).
- If α is modally closed, (^ˇα)∗ >**η**α∗.
- If all constants and free variables of a Ty2-formula α of a type in **2T \ IT** are of types in **2T \ IT**, then α is logically equivalent to the ∗-image of some ITL-formula.

(6.5a) **(λ*i* (λ*j* (*i* = *j*))** (where $\boldsymbol{i}, \boldsymbol{j} \in Var_{s}$)

(b) **(λ*i* (λ*F* (λ*i* (*F* = (λ*p* *p*(*i*))))) ((λ*p* *p*(*i*))))** (where $F \in Var_{(st)t}$, $p \in Var_{st}$)

(c) **^(λ*F* ^(*F* = (λ*p* ˇ*p*))) ((λ*p* ˇ*p*))**

(6.6) Abbreviations in ITL and Ty2:

Notation	where	is short for
$\alpha(\beta,\gamma)$	α: $a(ab)$; β,γ: a	$\alpha(\gamma)(\beta)$
$\mathbf{T}$		$(\lambda x_t\, x) = (\lambda x\, x)$
$\bot$		$(\lambda x\ \mathbf{T}) = (\lambda x\, x)$
$\neg\varphi$	φ: t	$(\varphi = \bot)$
$(\forall x)\,\varphi$	$x \in Var$; φ: t	$(\lambda x\ \varphi) = (\lambda x\, x)$
$(\exists x)\,\varphi$	$x \in Var$; φ: t	$\neg\,(\forall x)\,\neg\,\varphi$
$[\varphi \leftrightarrow \psi]$	φ,ψ: t	$(\varphi = \psi)$
$[\varphi \wedge \psi]$	φ,ψ: t	$(\forall R_{t(tt)})\ [R(\varphi,\psi) \leftrightarrow R(\mathbf{T},\mathbf{T})]$ [alternatively: $(\forall f_{tt})\ [\varphi \leftrightarrow [f(\varphi) \leftrightarrow f(\psi)]]$]
$[\varphi \vee \psi]$	φ,ψ: t	$[\,\neg\varphi \wedge \neg\psi]$
$[\varphi \rightarrow \psi]$	φ,ψ: t	$[\,\neg\varphi \vee \psi]$
etc.		

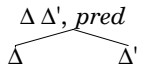
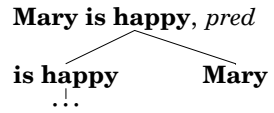
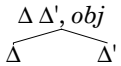
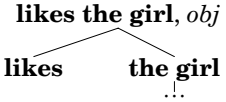
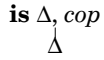
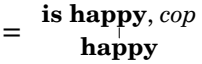
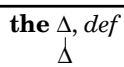
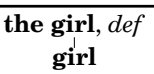
(6.7) Special ITL-conventions:

Notation	where	is short for
$\alpha\{\beta\}$	α: $s(at)$; β: a	$\check{}\alpha(\beta)$
$\alpha\{\beta,\gamma\}$	α: $s(a(at))$; β,γ: a	$\check{}\alpha(\gamma)(\beta)$
$\Box\,\varphi$	φ: t	$(\hat{}\varphi = \hat{}\mathbf{T})$
$\Diamond\,\varphi$	φ: t	$\neg\,\Box\,\neg\,\varphi$

PART 4: Descriptive Montague Grammar

7. Extensional Constructions

(7.1) Simple constructions

Construction	Corresponding Rule(s)	Example
$F_{pred}(\Delta,\Delta') =$ 	(F_{pred},NP,VP,S)	F_{pred}(**is happy**,**Mary**) = 
$F_{obj}(\Delta,\Delta') =$ 	(F_{obj},TV,NP,VP)	F_{obj}(**likes**, **the girl**) = 
$F_{cop}(\Delta) =$ 	(F_{cop},Adj,VP)	F_{cop}(**happy**) = 
$F_{def}(\Delta) =$ 	(F_{def},N,NP)	F_{def}(**girl**) = 

(7.2) Naive type assignment

Category	Example	(Extension) Type
S	**Mary is happy**; **the boy likes the girl**	***t***
NP	**Mary**; **the boy**; **the girl**	***e***
VP	**is happy**; **likes the girl**	***et***
TV	**likes**	***e*(*et*)**
Adj	**happy**	***et***

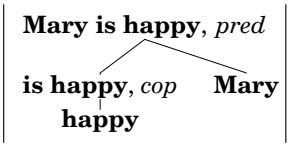
(7.3) Naive lexical translation

Item	ITL	Ty2
Mary	**m** $[\in Con_{e}]$	$\mathbf{m}_i$ $[= \mathbf{m}(i)]$
boy	**B** $[\in Con_{et}]$	$\mathbf{B}_i$
girl	**G** $[\in Con_{et}]$	$\mathbf{G}_i$
likes	**L** $[\in Con_{e(et)}]$	$\mathbf{L}_i$
happy	**H** $[\in Con_{et}]$	$\mathbf{H}_i$

(7.4) Naive meaning combinations

Construction	Corresponding Polynomial
F_{pred}	$G_{pred}(\alpha,\beta) = C_{\text{app}}(\alpha,\beta)$ $[= \alpha(\beta)]$
F_{obj}	$G_{pred}(\alpha,\beta) = C_{\text{app}}(\beta,\alpha)$ $[= \beta(\alpha)]$
F_{cop}	$G_{cop}(\alpha) = \alpha$
F_{def}	$G_{def}(\alpha) = C_{\text{app}}(\boldsymbol{\iota},\alpha)$ (where $\boldsymbol{\iota} \in Con_{(\boldsymbol{et})\boldsymbol{e}}$) $[= \boldsymbol{\iota}(\alpha)]$

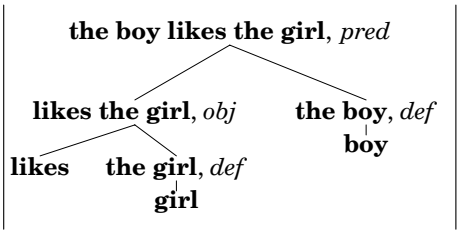
(7.5a)



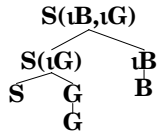
(a')

$= |F_{pred}(F_{cop}(\mathbf{happy}),\mathbf{Mary})|$
$= G_{pred}(|F_{cop}(\mathbf{happy})|,|\mathbf{Mary}|)$
$= G_{pred}(G_{cop}(|\mathbf{happy}|),|\mathbf{Mary}|)$
$= G_{pred}(G_{cop}(\mathbf{H}),\mathbf{m})$
$= G_{pred}(\mathbf{H},\mathbf{m})$
$= \mathbf{H(m)}$

(b)



(b')



$= |F_{pred}(F_{def}(\mathbf{boy})),F_{obj}(\mathbf{likes},F_{def}(\mathbf{girl}))|$
$= G_{pred}(||F_{def}(\mathbf{boy})|,F_{obj}(\mathbf{likes},F_{def}(\mathbf{girl}))|)$
$= G_{pred}(G_{def}(|\mathbf{boy}|),G_{obj}(|\mathbf{likes}|,G_{def}(|\mathbf{girl}|)))$
$= G_{pred}(G_{def}(\mathbf{B}),G_{obj}(\mathbf{L},G_{def}(\mathbf{G})))$
$= G_{pred}(\boldsymbol{\iota}(\mathbf{B}),G_{obj}(\mathbf{L},\boldsymbol{\iota}(\mathbf{G})),)$
$= G_{pred}(\boldsymbol{\iota}(\mathbf{B}),\mathbf{L}(\boldsymbol{\iota}(\mathbf{G})))$
$= \mathbf{L}(\boldsymbol{\iota}(\mathbf{G}))\ (\boldsymbol{\iota}(\mathbf{B}))$
$= \mathbf{L}(\boldsymbol{\iota}(\mathbf{B}),\boldsymbol{\iota}(\mathbf{G}))$

(7.6) **Every boy likes Mary.**

Context Principle

The reconstructed extension ρ_α of α (in $F(\alpha,\text{–})$) is a function f that assigns to the extension of any (relevant) γ the extension of $F(\alpha,\gamma)$:

- $\rho_\alpha(\mu(\beta)\ (c)\ (w)) = \mu(F(\alpha,\beta))\ (c)\ (w)$ direct version
- $|\alpha|(|\beta|) \equiv |F(\alpha,\beta)|$ indirect version
- $|\alpha| = (\boldsymbol{\lambda x}\ |F(\alpha,\boldsymbol{x})|)$ abstract version

(7.7a) $|\textbf{every boy}|(|\textbf{likes Mary}|) \equiv (\forall x)\,[\mathrm{B}(x) \rightarrow |\textbf{likes Mary}|(x)]$

$|\textbf{every boy}|(|\textbf{is happy}|) \equiv (\forall x)\,[\mathrm{B}(x) \rightarrow |\textbf{is happy}|(x)]$

…

$|\textbf{every boy}|(|\beta|) \equiv (\forall x)\,[\mathrm{B}(x) \rightarrow |\beta|(x)]$

(7.7b) $|\textbf{every boy}| = (\lambda Q_{et}\,(\forall x)\,[\mathrm{B}(x) \rightarrow P(x)])$ type $((et)t)$ [=: q]

(7.8a) $|\textbf{every}|(|\textbf{boy}|) \equiv (\lambda Q_{et}\,(\forall x)\,[|\textbf{boy}|(x) \rightarrow Q(x)])$

$|\textbf{every}|(|\textbf{girl}|) \equiv (\lambda Q_{et}\,(\forall x)\,[|\textbf{girl}|(x) \rightarrow Q(x)])$

…

$|\textbf{every}|(|\beta|) \equiv (\lambda Q_{et}\,(\forall x)\,[|\beta|(x) \rightarrow Q(x)])$

(7.8b) $|\textbf{every}| = (\lambda P_{et}\ (\lambda Q_{et}\,(\forall x)\,[P(x) \rightarrow Q(x)]))$ type $(et)q$

(7.9a) $|\textbf{every boy or every girl}|(|\textbf{likes Mary}|)$

$\equiv [(\forall x)\,[\mathrm{B}(x) \rightarrow |\textbf{likes Mary}|(x)] \vee (\forall x)\,[\mathrm{G}(x) \rightarrow |\textbf{likes Mary}|(x)]]$

$|\textbf{every boy or every girl}|(|\ \textbf{is happy}\ |)$

$\equiv [(\forall x)\,[\mathrm{B}(x) \rightarrow |\textbf{is happy}|(x)] \vee (\forall x)\,[\mathrm{G}(x) \rightarrow |\textbf{is happy}|(x)]]$

…

$|\textbf{every boy}|(|\beta|)$

$\equiv [(\forall x)\,[\mathrm{B}(x) \rightarrow |\beta|(x)] \vee (\forall x)\,[\mathrm{G}(x) \rightarrow |\beta|(x)]]$

(7.9b) $|\textbf{every boy or every girl}|$

$= (\lambda Q_{et}[(\forall x)\,[\mathrm{B}(x) \rightarrow Q(x)] \vee (\forall x)\,[\mathrm{G}(x) \rightarrow Q(x)]])$ type q

(7.10a) $|\textbf{or}|(|\textbf{every boy}|)\,(|\textbf{every girl}|)$

$\equiv (\lambda Q_{et}[(\forall x)\,[\mathrm{B}(x) \rightarrow Q(x)] \vee (\forall x)\,[\mathrm{G}(x) \rightarrow Q(x)]])$

$\equiv (\lambda Q_{et}[|\textbf{every boy}|(Q)] \vee |\textbf{every girl}|(Q)])$

$|\textbf{or}|(|\textbf{every boy}|)\,(|\textbf{some girl}|)$

$\equiv (\lambda Q_{et}[(\forall x)\,[\mathrm{B}(x) \rightarrow Q(x)] \vee (\exists x)\,[\mathrm{G}(x) \wedge Q(x)]])$

$\equiv (\lambda Q_{et}[|\textbf{every boy}|(Q)] \vee |\textbf{some girl}|(Q)])$

…

$|\textbf{or}|(|\beta|)\,(|\gamma|) \equiv (\lambda Q_{et}[|\beta|(Q)] \vee |\gamma|(Q)])$

(7.10b) $|\textbf{or}| = (\lambda \mathfrak{P}_{(et)t}\ (\lambda \mathfrak{B}_{(et)t}(\lambda Q_{et}[\mathfrak{B}(Q)] \vee \mathfrak{P}(Q)])))$ type $q(qq)$

(7.10) $|\textbf{Mary or every boy}|$

$\equiv (\lambda Q_{et}[Q(\mathrm{m})] \vee (\forall x)\,[\mathrm{B}(x) \rightarrow Q(x)]])$

$\not\equiv (\lambda Q_{et}[|\textbf{Mary}|(Q)] \vee |\textbf{every girl}|(Q)])$ wrong type (e vs. q)

(7.11a) $|\textbf{Mary}|(|\textbf{likes Mary}|) \equiv |\textbf{likes Mary}|(\mathrm{m})$

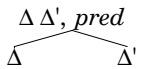
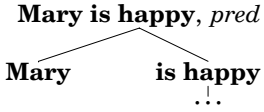
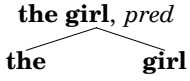
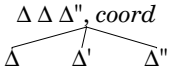
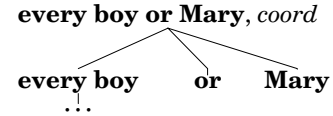
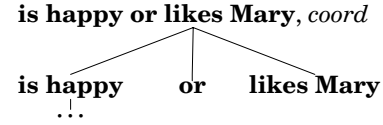
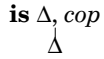
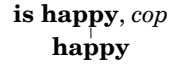
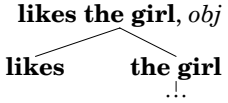
$|\textbf{Mary}\ |(|\textbf{is happy}|) \equiv |\textbf{is happy}|(\mathrm{m})$

…

$|\textbf{Mary}\ |(|\beta|) \equiv |\beta|(\mathrm{m})$

(7.11b) $|\textbf{Mary}| = (\lambda Q_{et}\ Q(\mathrm{m}))$ type q

(7.12) Revised rules and constructions

Construction	Corresponding Rule(s)	Example
$F_{pred}(\Delta,\Delta') =$ 	(F_{pred},NP,VP,S)	F_{pred}(**Mary ,is happy**) = 
	(F_{pred},Det,N,NP)	F_{pred}(**the**,**girl**) = 
$F_{coord}(\Delta,\Delta',\Delta'') =$ 	(F_{coord},NP,Conj,NP,NP)	F_{pred}(**every boy**,**or**,**Mary**) = 
	(F_{coord},VP,Conj,VP,VP)	F_{pred}(**likes Mary**,**or**, **is happy**) = 
$F_{cop}(\Delta) =$ 	(F_{cop},Adj,VP)	F_{cop}(**happy**) = 
$F_{obj}(\Delta,\Delta') =$ 	(F_{obj},TV,NP,VP)	F_{obj}(**likes**, **the girl**) = 

(7.13) Revised (and expanded) type assignment

Category	(Extension) Type
S	***t***
NP	***q***
VP	***et***
TV	***e***(***et***)
Adj	***et***
Conj	***q***(***qq***)

(7.14) Lexical translation: revisions and additions

Item	ITL
Mary	$(\lambda Q_{et}\, Q(\mathrm{m}))$
or	$(\lambda \mathfrak{P}_{(et)t}\, (\lambda \mathfrak{B}_{(et)t}(\lambda Q_{et}[\mathfrak{B}(Q)] \vee \mathfrak{P}(Q)]))$
every	$(\lambda P_{et}\ (\lambda Q_{et}\, (\forall x)\, [P(x) \rightarrow Q(x)]))$
some	$(\lambda P_{et}\ (\lambda Q_{et}\, (\exists x)\, [P(x) \wedge Q(x)]))$
the	$(\lambda P_{et}\ (\lambda Q_{et}\, (\exists x)\, (\forall y)\, [[P(y) \leftrightarrow (x = y)] \wedge Q(x)]))$

(7.15) New meaning combinations

Construction	Corresponding Polynomial
F_{pred}	$G_{pred}(\alpha,\beta) = C_{\mathrm{app}}(\alpha,\beta)$ $[= \alpha(\beta)]$
F_{coord}	$G_{coord}(\alpha,\beta,\gamma) = C_{\mathrm{app}}(C_{\mathrm{app}}(\beta,\gamma),\alpha)$ $[= \beta(\gamma)(\alpha)]$
F_{cop}	$G_{cop}(\alpha) = \alpha$
F_{obj}	$C_{\mathrm{abs}}(x, C_{\mathrm{app}}(\beta, C_{\mathrm{abs}}(y, C_{\mathrm{app}}(C_{\mathrm{app}}(\alpha,y),x))))$ $[= (\lambda x\, \beta(\lambda y\, \alpha(x,y)))]$

8. Intensional Constructions

Attitude verbs

(8.1a) **John thinks that Mary is happy.**
(8.1b) **Mary is happy.**
(8.1c) **Every boy likes Mary.**
(8.1d) **John thinks that every boy likes Mary.**

Opaque verbs

(8.2a) **John is looking for a book on Clinton.**
(8.2b) **Every book on Clinton is a book by Clinton.**
(8.2c) **John is looking for a book by Clinton.**

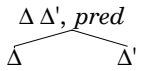
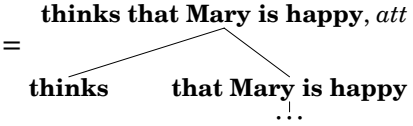
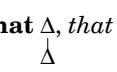
Core-intensional verbs

(8.3a) **The temperature is rising.**
(8.3b) **The temperature is ninety.**
(8.3c) **Ninety is rising.**

(8.4) Attitude reports: type assignment

Category	(Extension) Type
AttV	$(st)(et)$
Prop	st

(8.5) Attitude reports: additional rules and constructions

Construction	Corresponding Rule(s)	Example
$F_{pred}(\Delta,\Delta') =$ 	(F_{pred},AttV,Prop,VP)	F_{pred}(**thinks**,**that Mary is happy**) = 
$F_{that}(\Delta) =$ 	(F_{that},S,Prop)	F_{that}(**Mary is happy**) =

(8.6) Attitude verbs: lexical translation

Item	ITL	Ty2
thinks	**T** $[\in Con_{(\boldsymbol{st})(\boldsymbol{et})}]$	$\mathbf{T}_{\boldsymbol{i}}$
believes	$(\lambda \boldsymbol{p}\ (\lambda \boldsymbol{x}\ (\lambda \boldsymbol{q}\ \Box[{}^{\vee}\boldsymbol{q} \rightarrow {}^{\vee}\boldsymbol{p}])(\mathbf{B}(\boldsymbol{x})))$ $[\mathbf{B} \in Con_{(\boldsymbol{st})}]$	$(\lambda \boldsymbol{p}\ (\lambda \boldsymbol{x}\ (\forall \boldsymbol{j})\ [\mathbf{B}_{\boldsymbol{i}}(\boldsymbol{x})(\boldsymbol{j}) \rightarrow \boldsymbol{p}_{\boldsymbol{j}}]$

(8.7) Attitude verbs: additional meaning combination

Construction	Corresponding ITL-Polynomial	Corresponding Ty2-Polynomial
F_{that}	$G_{pred}(\alpha) = C_{\text{cap}}(\alpha)$ $[= {}^{\wedge}\alpha]$	$G_{pred}(\alpha) = C_{\text{abs}}(\boldsymbol{i},\alpha)$ $[= (\lambda \boldsymbol{i}\ \alpha)]$

(8.8) **John is-trying-for-it-to-be-the-case that John finds a book on Clinton.**

(8.9a) $|\mathbf{seeks}|(|\mathbf{a\ book}|)$

$\equiv$ $(\lambda \boldsymbol{x}\ |\mathbf{tries}|(\boldsymbol{x},{}^{\wedge}(\exists \boldsymbol{y})\ [\mathbf{B}(\boldsymbol{y}) \wedge |\mathbf{finds}|(\boldsymbol{x},\boldsymbol{y})])$

$\equiv$ $(\lambda \boldsymbol{x}\ |\mathbf{tries}|(\boldsymbol{x},{}^{\wedge}{}^{\wedge}|\mathbf{a\ book}|\{\lambda \boldsymbol{y}\ |\mathbf{finds}|(\boldsymbol{x},\boldsymbol{y}))\})$

…

$|\mathbf{seeks}|(|\beta|) \equiv (\lambda \boldsymbol{x}\ |\mathbf{tries}|(\boldsymbol{x},{}^{\wedge}{}^{\wedge}|\beta|\{\lambda \boldsymbol{y}\ |\mathbf{finds}|(\boldsymbol{x},\boldsymbol{y}))\})$

(8.9b) $|\ \mathbf{seeks}\ | = (\lambda \mathfrak{V}_{\boldsymbol{s}((\boldsymbol{et})\boldsymbol{t})}\ (\lambda \boldsymbol{x}\ |\mathbf{tries}|(\boldsymbol{x},{}^{\wedge}\mathfrak{V}\{\lambda \boldsymbol{y}\ |\mathbf{finds}|(\boldsymbol{x},\boldsymbol{y}))\})$

(8.10) Opaque verbs: revised type assignment

Category	(Extension) Type
TV	$(\boldsymbol{sq})(\boldsymbol{et})$

(8.11) Opaque verbs: revised meaning combination

Construction	Corresponding Polynomial (ITL)	Corresponding Polynomial (Ty2)
F_{obj}	$G_{obj}(\alpha,\beta) = C_{\text{app}}(\alpha, C_{\text{cap}}(\beta))$ [$= \alpha(\hat{}\beta)$]	$G_{obj}(\alpha,\beta) = C_{\text{app}}(\alpha, C_{\text{abs}}(\boldsymbol{i},\beta))$ [$= \alpha(\boldsymbol{\lambda i}\ \beta)$]

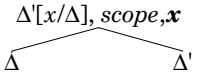
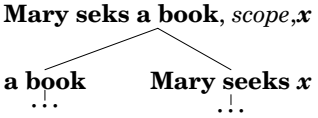
(8.11) Transitive verbs: revised lexical translation

Item	ITL	Ty2
seeks	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \lvert\mathbf{tries}\rvert(x,\hat{}\ \mathcal{Q}\{\boldsymbol{\lambda y}\ \mathbf{F}(x,y)\}))$ $(\mathbf{F}\in Con_{\boldsymbol{e(et)}})$	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathbf{T}_i(x, \boldsymbol{\lambda j}\ \mathcal{Q}_j(\boldsymbol{\lambda y}\ \mathbf{F}(x,y)))))$
finds	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}\{\boldsymbol{\lambda y}\ \mathbf{F}(x,y)\}))$	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}_i(\boldsymbol{\lambda y}\ \mathbf{F}_i(x,y))))$
likes	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}\{\boldsymbol{\lambda y}\ \mathbf{L}(x,y)\}))$	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}_i(\boldsymbol{\lambda y}\ \mathbf{L}_i(x,y))))$
is	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}\{\boldsymbol{\lambda y}\ (x = y)\}))$	$(\boldsymbol{\lambda}\mathcal{Q}\ (\boldsymbol{\lambda x}\ \mathcal{Q}_i(\boldsymbol{\lambda y}\ (x = y))))$

(8.9a) **Mary is looking for a** [certain] **book on Clinton.**

(b) $(\exists x)\ [\ \lvert\mathbf{book\ on\ Clinton}\rvert(x) \wedge \lvert\mathbf{tries}\rvert(\mathbf{m},\hat{}\ \mathbf{F}(\mathbf{m},x))]$

(8.10) Scope construction

Construction	Rule(s)	Example
$F_{scope,x}(\Delta,\Delta') =$  $(\boldsymbol{x}\in Var_{\boldsymbol{e}})$	$(F_{pred,x}$,NP,S,S)	$F_{scope,x}$(**a book**,**Mary seeks** x) = 

(8.10) Variables in the lexcion

Item	ITL	Ty2
$\boldsymbol{x}$	$(\boldsymbol{\lambda P}\ \boldsymbol{P}(x))$	$(\boldsymbol{\lambda P}\ \boldsymbol{P}(x))$

(8.11) Scope: meaning combination

Construction	Corresponding Polynomial (ITL and Ty2)
$F_{scope,x}$	$G_{scope,x}(\alpha,\beta) = C_{\text{app}}(\alpha, C_{\text{abs}}(\boldsymbol{x},\beta))$ $[= \alpha(\boldsymbol{\lambda x}\ \beta)]$

(8.10) $(\boldsymbol{\lambda}\mathcal{Q}\ [\ (\exists j)\ [j<i \wedge (\forall k)\ (\forall k')\ [\ j\leq k\leq k'\leq i \rightarrow \mathcal{Q}_k(\boldsymbol{\lambda x}\ \mathcal{Q}_{k'}(\boldsymbol{\lambda y}\ x\leq y))]]$

$\wedge\quad (\exists j)\ [j>i \wedge (\forall k)\ (\forall k')\ [\ i\leq k\leq k'\leq j \rightarrow \mathcal{Q}_k(\boldsymbol{\lambda x}\ \mathcal{Q}_k(\boldsymbol{\lambda y}\ x\leq y))]]]$

(8.11) **The temperature is ninety and <u>it</u> is rising.**