SYNTAX AND SEMANTICS OF PLURAL

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The analysis of singular and plural has been a rather neglected topic in transformational grammar. Because of the marginal interest in semantic phenomena the number distinction has been handled as a feature like <±human> or gender. Furthermore, it has been assumed that the number-feature is inherent in the noun rather than the noun phrase (Chomsky 1967, Postal 1966, Rosenbaum 1968, Perlmutter 1968 - I can find no later accounts of a different persuasion).

In this paper I want to investigate the number distinction from a semantic point of view. Since Montague's work provides the only framework so far in which an explicit semantic representation can be accomplished, I will present my investigation as an extension of Montague's "Proper Treatment of Quantification " (hence PTQ). PTQ provides a complete treatment of syntax and semantics. This 'vertical completeness' has the consequence that a large number of linguistic phenomena is not incorporated in the 'fragment' - among them the singular/plural distinction.

To incorporate the number distinction on the syntactic as well as the semantic level in PTQ one could postulate singular versus plural nouns. This is the way in which Mike Bennett (1972) has extended PTQ to the plural. Bennett derives plural nouns from singular nouns syntactically, but assumes the corresponding semantic rule to be the identity mapping. Renate Bartsch (1972), on the other hand, even proposes that plural nouns translate into expressions that are of a different semantic type than singular nouns.

In this paper, however, singular and plural will be treated as a feature of the quantifier rather than the noun. This has the syntactic advantage over Bennett's solution that no cooccurrence restrictions are necessary in order to prevent forms like *every girls. Semantically it has the advantage that a singular noun and a distributive plural noun are translated into expressions of the same type and can thus be handled by the same general rules.

Let us begin with the distinction between distributive plurals versus collective plurals. Sentence

1) All the girls walked

is an example for a distributive plural, while

2) All the girls gathered

is an example for a collective plural. The sentence

3) All the boys lifted the piano

is ambiguous between a collective and a distributive reading. On the collective reading, all the boys lifted the piano together. Thus it would be false to entail from this reading that 'a_0 lifted the piano', 'a_1 lifted the piano', ... etc. where a_0, a_1 etc. are members of the set of boys in question. On the distributive reading, however, we have to obtain such entailments, since on this reading each boy lifts the piano by himself.

Let us define the translation of a distributive plural similar to Montague's singular noun phrases. For example, a girl translates in PTQ as

4) $\hat{P}\bigvee x[girl'(x) \wedge P\{x\}]$.

Now the plural of a girl is girls. For the plural we want to insure that girl' holds at least for two individual concepts. This is expressed in formula

5) $\hat{P}\bigvee x \bigvee y[\neg(x=y) \wedge girl'(x) \wedge girl'(y) \wedge P\{x\} \wedge P\{y\}]$

Note that (5) is an appropriate translation for a distributive plural since it entails (via simplification) that of each girl the property denoted by P holds. In order to have a more simple notation we abbreviate (5) as

6) $\hat{P}\bigvee_2[girl'(x) \wedge P\{x\}]$.

In order to implement collective plurals, however, we have to define a new kind of verbs as well as a new kind of noun phrases. A verb like the intransitive gather, for example, does not take subjects that denote single individuals, but only subjects that denote a group or a set of individuals. Therefore the translation of gather should be a function that maps sets of individual concepts, i.e. arguments of type $\langle\langle s,e\rangle,t\rangle$, into truthvalues. Thus the verb gather should be semantically of type $\langle\langle\langle s,e\rangle,t\rangle,t\rangle$.

However, a function of type $\langle\langle\langle s,e\rangle,t\rangle,t\rangle$ has no corresponding category in the syntax of PTQ. (This is a point Mike Bennett overlooked in his extension on plural. Otherwise the semantics of the here presented treatment of collective plurals parallel Mike Bennett's approach). The reason that $\langle\langle\langle s,e\rangle,t\rangle,t\rangle$ has no corresponding expression among the syntactic categories lies in the way in which Montague defines the function f that maps the syntactic categories into types of intensional logic. f is defined as follows:

$f(e) = e$

$f(t) = t$

$f(A/B) = f(A//B) = \langle\langle s,f(B)\rangle,f(A)\rangle$ whenever $A,B \in CAT$.

Therefore, instead of defining gather' as a function from sets of individual concepts to truth-values, we will define it as a function from properties of individual concepts into truthvalues (the property of individual concepts is the intension of sets of individual concepts!). Thus gather' will range over variables P,Q of type $\langle s, \langle\langle s,e\rangle,t\rangle\rangle$. The meaning postulate

7) $\Box[\delta(P) \leftrightarrow \delta_*({}^\vee P)]$, where δ is an $\overline{IV}$ (i.e. a verb like gather, collide, be similar etc.)

will lower expressions like gather'(P) from a set of properties of individual concepts to a set of sets of individual concepts. Indeed, we can lower $\delta(P)$ to $\delta_*({}^\vee M)$, i.e. sets of individuals, since verbs that take collective plural terms as subject (or object) seem to be always extensional. We will therefore adopt the following meaning postulate:

8) $\Box[\delta(P) \leftrightarrow \delta_*({}^\vee M)]$, where δ is an $\overline{IV}$.

We are using here the same technique Montague employed when he postulated a meaning postulate that lowers for example walk'(x) to $walk_*'(u)$.

According to our discussion a verb like gather will be of the syntactic category t/(t///e), which is abbreviated as $Cat_{\overline{IV}}$. The semantic type of expressions of $Cat_{\overline{IV}}$ is $\langle\langle s,\langle\langle s,e\rangle,t\rangle\rangle,t\rangle$. Furthermore, we define the variable R of type $\langle s,\langle\langle s,\langle\langle s,e\rangle,t\rangle\rangle,t\rangle\rangle$, which ranges over properties of properties of individual concepts. By means of R we define the translation of the collective pronoun $they_n$:

9) collective $they_n$ translates as $\hat{R}R\{P_n\}$, where P_n is a variable of type $\langle s,\langle\langle s,e\rangle,t\rangle\rangle$ defined as $(\hat{y}[x_n=y])$.

Collective $they_n$ is the sole member of the set $B_{\overline{T}}$, where $\overline{T}$ = t///e. The derivation of the translation of

$they_n$ gather

will run as follows (- once all the rules are supplied)

$\hat{R}R\{P_n\}({}^\wedge gather')$

${}^\wedge gather'\{P_n\}$

$gather'(\hat{y}[x_n=y])$

$gather'_*(\hat{u}[v_n=u])$

After this discussion of the semantic properties of distributive versus collective plural noun phrases let us turn to the syntactic rules for handling plural. R. Thomason (1972) suggested to derive quantified T-phrases from CN-phrases via a rule of functional application (rather than via a basic as in PTQ). According to Thomason, a term like a girl is analyzed as

$$\begin{array}{c} \text{a girl} \\ \diagup \quad \diagdown \\ \text{a} \qquad \text{girl} \end{array}$$

where a is of category T/CN. a(n) translates into $\hat{Q}\hat{P}\bigvee x[Q\{x\} \wedge P\{x\}]$. Thus a girl translates as

$$\hat{P}\bigvee x[\text{girl}'(x) \wedge P\{x\}]$$

which is identical to the result of Montague's original rule F_2. Implementing Thomason's suggestion we define two new basic categories:

10) $B_{T/CN} = \left\{ \begin{array}{l} \text{every}°, \text{each}°, \text{the}°, \text{some}°, \text{a(n)}°, \text{any}° \\ \text{all*}, \text{both*}, \text{the*}, \text{some*}, \emptyset\text{*}, \text{any*} \end{array} \right\}$

11) $B_{\overline{T}/CN} = \{\text{all, both, the, some}, \emptyset\}$

(where $\emptyset$ stands for the plural of the indefinite article, '°' indicates singular, '*' indicates distributive plural and no superscript at all (as in (11)) indicates collective plural.)

The syntactic rules that combine quantifiers with common nouns to form noun phrases are

12) S_2(i): If $q \in B_{T/CN}$ and $\zeta \in P_{CN}$ then $F_1(q,\zeta) \in P_T$ and
  a) if $q = p°$, then $F_1(p°,\zeta) = p\zeta$.
  b) if $q = p*$, then $F_1(p*,\zeta) = p\zeta'$, where ζ' is the morphological plural of ζ.

S_2(ii): If $q \in B_{\overline{T}/CN}$ then $F_2(q,\zeta) \in P_{\overline{T}}$, where $F_2(q,\zeta) = q\zeta'$ and ζ' is the morphological plural of ζ.

In order to account for verb agreement we shorten rule S_4 in PTQ to

13) S_4: If $\alpha \in P_T$ and $\delta \in P_{IV}$ or $\alpha \in P_{\overline{T}}$ and $\delta \in P_{\overline{IV}}$, then $F_4(\alpha,\delta) \in P_t$, where $F_4(\alpha,\delta) = \alpha\delta$.

and extend rule S_{17} to

14) S_{17}: If $\phi \in P_t$, such that $\phi = (\alpha\delta)$, where $\alpha \in P_T$ and $\delta \in P_{IV}$ or $\alpha \in P_{\overline{T}}$ and $\delta \in P_{\overline{IV}}$, then $F_{11}(\alpha\delta)$, $F_{12}(\alpha\delta)$, $F_{13}(\alpha\delta)$, $F_{14}(\alpha\delta)$, $F_{15}(\alpha\delta)$ and $F_{16}(\alpha\delta) \in P_t$, where $F_{11}(\alpha\delta) = \alpha\delta'$ and

δ' is the result of replacing the first verb in δ by

a) its third person singular present, if $\alpha \in B_T$ or $\alpha = F_1(p^\circ, \zeta)$ (where $\zeta \in P_{CN}$) or $\alpha = F_9(\beta, \gamma)$ (where $\beta, \gamma \in P_T$) or $\alpha = \{$he, she, it$\}$;

b) and otherwise by its third person plural present.

$F_{12}(\alpha\delta) = \alpha\delta''$ and δ'' is the result of replacing the first verb in δ by

a) it's negative third person singular present, if if $\alpha \in B_T$ or $\alpha = F_1(p^\circ, \zeta)$ or $\alpha = F_9(\beta, \gamma)$ or $\alpha = \{$he, she, it$\}$;

b) and otherwise by its negative third person plural present.

According to the new rules (12), (13) and (14) the sentence

15) John doesnt't like all girls

can be analyzed as follows:

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John doesn't like all girls                 F12a
            |
      John like all girls                   F4
     /              \
John           like all girls               F5
              /         \
          like        all girls             F1
                      /     \
                   all*     girl
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The translation rules corresponding to S_2, S_4, and S_{17} are

16) T_2: If $q \in B_{T/CN}$ and $\zeta \in P_{CN}$ and q, ζ translate into q', ζ', respectively, then $F_1(q, \zeta)$ translates into $q'(\hat{}\,\zeta')$.

If $q \in B_{T/CN}$ and $\zeta \in P_{CN}$ and q, ζ translate into q', ζ', respectively, then $F_2(q, \zeta)$ translates into $q'(\hat{}\,\zeta')$.

T_4 corresponding to rule (13) is like in PTQ. T_{17} corresponding to (14) is

17) If $\phi \in P_t$, where ϕ translates as ϕ', then $F_{11}(\phi)$ translates as ϕ', $F_{12}(\phi')$ translates as $\neg\phi'$,

$F_{13}(\phi')$ translates as $W(\phi')$, $F_{14}(\phi')$ translates as $\neg W(\phi')$, $F_{15}(\phi')$ translates as $H(\phi')$, $F_{16}(\phi')$ translates as $\neg H(\phi')$.

As far as the translations of the quantifiers mentioned under (10) and (11) are concerned, we will only give a tentative translation of all* and all. (For a more comprehensive analysis of quantifiers consult R. Hausser (1974)).

18) all* $\in B_{T/CN}$ translates into $\hat{Q}\hat{P}\bigwedge x[Q\{x\} \rightarrow P\{x\}]$

19) all $\in B_{\overline{T}/CN}$ translates into $\hat{Q}\hat{R}\bigwedge x R\{\hat{y}[P\{x\} \rightarrow x=y]\}$

The rules developed so far allow to translate a sentence like

20) All girls such that they gather giggle

(where gather is of category $\overline{IV}$ and giggle of category IV). (20) can be analyzed as follows:

20')

All girls such that they gather giggle, F_{11b}

all girls such that they gather giggle, F_4

all girls such that they gather — giggle, F_2

girl such that they gather, $F_{3,0}$

girl — they_0 gather

Note that they_0 is the collective pronoun defined in (9) above. The translation of (20') is derived as follows:

20'') $\hat{R}R\{\hat{y}[x_0=y]\}(\hat{\ }\text{gather}')$

$\hat{x}_0[\text{girl}'(x_0) \wedge \text{gather}'(\hat{y}[x_0=y])]$

$\hat{P}\bigwedge x[[\text{girl}'(x) \wedge \text{gather}'(\hat{y}[x=y])] \rightarrow P\ x\ ]$

$\bigwedge x[[\text{girl}'(x) \wedge \text{gather}'(\hat{y}[x=y])] \rightarrow \text{giggle}'(x)]$

Example (20) demonstrates that noun phrases of category T (i.e. all girls) can be correferential with noun phrases of category $\overline{T}$ (i.e. they). Consider also

21) All girls such that they giggle gather

which translates into

21'') $\bigwedge x[[\text{girl}(x) \wedge \text{giggle}'(x)] \rightarrow \text{gather}'(\hat{y}[x=y])]$

(In the corresponding analysis of (21) rule F_2 has to change 'he giggle' (where 'he' is a distributive pronoun to 'they giggle' - a necessary surface adjustment we omitted in (12) above).

In addition to the translation of a collective quantifier (i.e. (19) above) we have to give the translation for collective conjunctions of noun phrases. Montague does not state the rules for a (distributive) conjunction of noun phrases, because they would involve syntactic plural (on part of the verb phrase). This restriction does not apply to the present extension. Indeed, the rules F_{11}-F_{16} (see(14)) are already adjusted to handle noun phrase conjunctions in subject position. The new rule for distributive noun phrase conjunction as well as disjunction is

22) If $\alpha, \beta \in P_T$, then $F_8(\alpha,\beta) \in P_T$ and $F_9(\alpha,\beta) \in P_T$, where $F_8(\alpha,\beta)$ = α and β and $F_9(\alpha,\beta)$ = α or β.

The corresponding translation rule is

23) If $\alpha, \beta \in P_T$ and α, β translate into α', β', respectively, then α and β translates into $\hat{P}[\alpha'(P) \wedge \beta'(P)]$ and α or β translates into $\hat{P}[\alpha'(P) \vee \beta'(P)]$.

The syntactic rule for collective conjunctions of noun phrases is

24) If $\alpha, \beta \in P_T$, where α, β are not of the form every ζ or each ζ ($\zeta \in P_{CN}$), then $F_8^*(\alpha,\beta) \in P_{\overline{T}}$, where $F_8^*(\alpha,\beta)$ = α and β.

The corresponding translation rule is

25) If $\alpha, \beta \in P_T$ and α, β translate into α', β', respectively, then $F_8^*(\alpha,\beta) \in P_{\overline{T}}$ and $F_8^*(\alpha,\beta)$ translates into $\hat{R}[R\{\hat{x}\ \alpha'(\hat{z}[x=z]) \vee \beta'(\hat{z}[x=z])\}]$.

Note that the input to (24) and (25) are distributive noun phrases, i.e. noun phrases of category T.

According to (25) the sentence

26) A boy and a girl collided

(where collide $\in P_{\overline{IV}}$) translates as

$$\hat{R}[R\{\hat{x}\ \hat{P}\vee y[boy'(y) \wedge P\{y\}](\hat{z}[z=x]) \vee \hat{P}\vee w[girl'(w) \wedge P\{w\}](\hat{z}[x=z])\}](^\wedge collide')$$

which reduces to

$$collide'\{\hat{x}\ \vee y[boy'(y) \wedge y=x] \vee \vee w[girl'(w) \wedge w=x]\}$$

Also sentences like

27) John mixed the bulbs and planted them

where mix is an IV/$\overline{T}$-phrase and plant is an IV/T-phrase won't pose any problem in our extension once we provide the (straightforward) adjustments in $S_5(T_5)$ and $S_{14}(T_{14})$.

28) If $\delta \in P_{IV/T}$ and $\beta \in P_T$ or $\delta \in P_{IV/\overline{T}}$ and $\beta \in P_{\overline{T}}$, then $F_5(\delta,\beta) \in P_{IV}$, where $F_5(\delta,\beta) = \delta\beta$ if β does not have the form $\begin{Bmatrix} he_n \\ they_n \end{Bmatrix}$ and $F_5\left(\delta, \begin{Bmatrix} he_n \\ they_n \end{Bmatrix}\right) = \delta\begin{Bmatrix} him \\ them \end{Bmatrix}$

The corresponding translation rule is

29) If $\delta \in P_{IV/T}$ and $\beta \in P_T$ or $\delta \in P_{IV/\overline{T}}$ and $\beta \in P_{\overline{T}}$, and δ,β translate into δ',β', respectively, then $F_5(\delta,\beta)$ translates into $\delta'(^\wedge\beta')$.

S_{14} in PTQ is replaced by

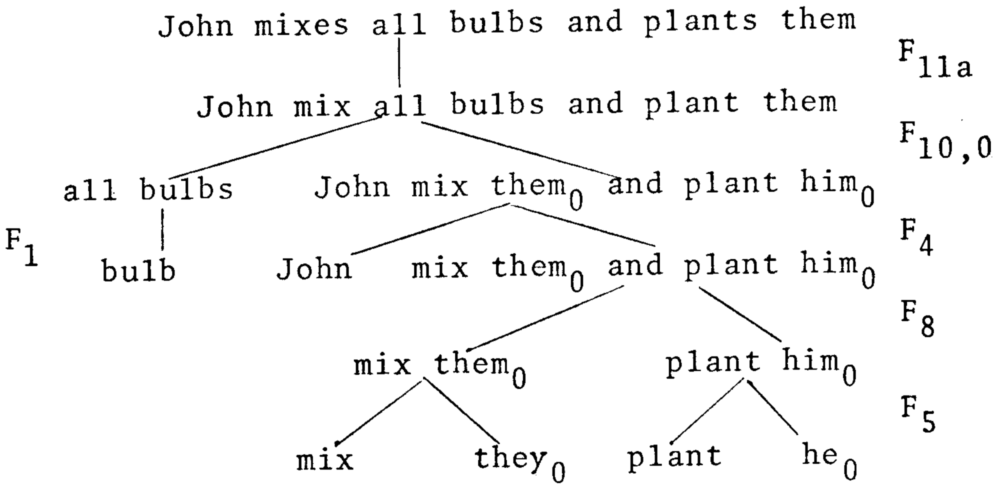
30) If $\alpha \in P_T$ and $\phi \in P_t$, then $F_{10,n}\ (\alpha,\phi) \in P_t$, where either
(i) $\alpha \in B_T$ or α has the form $F_1(p°,\zeta)$ - where $\zeta \in P_{CN}$ - or $\alpha = F_9(\beta,\gamma)$ - where $\beta,\gamma \in P_T$ - and $F_{10,n}$ comes from ϕ by replacing the first occurrence of he_n or him_n by α and all other occurrences of he_n or him_n by $\{he, she, it\}$ or $\{her, she, it\}$, respectively, according as the gender of the first B_{CN} or B_T in α is $\{$masc., fem., or neuter$\}$;
(ii) α has the form $F_1(p^*,\zeta)$ or $F_2(p,\zeta)$ - where $p^* \in B_{T/CN}$, $p \in B_{\overline{T}/CN}$ and $\zeta \in P_{CN}$ -, and $F_{10,n}$ comes from ϕ by replacing the first occurrence of he_n, him_n, $they_n$, or $them_n$ by α and all other occurrences of he_n, him_n, $they_n$ or $them_n$ by *they* or *them*, respectively.
(iii) $\alpha = he_k$ and $F_{10,n}(\alpha,\phi)$ comes from ϕ by replacing all occurrences of he_k, him_k, $they_k$ or $them_k$ by he_n, him_n, $they_n$, or $them_n$, respectively.

The corresponding translation rule (i.e. T_{14} in PTQ) is changed to

31) If $\alpha \in P_T$, $\phi \in P_t$, and α,ϕ translate into α', ϕ', respectively, then $F_{10,n}(\alpha,\phi)$ translates into $\alpha'(x_n\phi')$ or $\alpha'(P_n\phi')$ depending on whether the first variable in ϕ is he_n (him_n) or $they_n$ ($them_n$).

Note that our new rules of quantification (i.e. (30) and (31)) introduce only noun phrases of category T, but not of category $\overline{T}$. The mechanism of this approach can be seen in the translation of sentences (27), which is analyzed as:

32)



The translation of (32) is derived as follows:

32") $\hat{P}P\{{}^\wedge j\}(\hat{z}[mix'(\hat{R}R\{\hat{y}[y=x_0]\}(z) \wedge plant'(\hat{P}P\{x_0\})(z)])$

which reduces to

$mix'({}^\wedge j, \hat{R}R\{\hat{y}[y=x_0]\}) \wedge plant'({}^\wedge j, \hat{P}P\{x_0\})$

rule of quantification:

$\hat{P}\bigwedge x[bulb'(x) \rightarrow P\{x\}]({}^\wedge mix'({}^\wedge j, \hat{R}R\{\hat{y}[y=x_0]\}) \wedge plant'({}^\wedge j, \hat{P}P\{x_0\})$

$\bigwedge x[bulb'(x) \rightarrow mix'({}^\wedge j, \hat{R}R\{\hat{y}[y=x]\}) \wedge plant'({}^\wedge j, \hat{P}P\{x\})$

Thus the translation of <u>all bulbs</u> binds the 'x_0' occurring in the translation of <u>$they_0$</u> as well as of <u>he_0</u>.

In order to derive sentences like

33) all boys (each) played the piano and (then) lifted it (together).

we have to make a little adjustment in the rules for the conjunction of verbphrases, i.e. S_{12} and T_{12} in PTQ. The reason is that in (33) we conjoin an IV-phrase (play) and an $\overline{IV}$-phrase (lift). S_{12} in PTQ is replaced by

34) If $\gamma, \delta \in P_{IV}$ or $P_{\overline{IV}}$, then $F_8(\gamma,\delta)$, $F_9(\gamma,\delta) \in P_{IV}$.

The translation rule T_{12} in PTQ is replaced by

35) If $\gamma \in P_{\overline{IV}}$ and $\delta \in P_{IV}$ and γ,δ translate into γ',δ' respectively, then γ and δ translates into $\hat{x}[\gamma'(\hat{y}[x=y]) \wedge \delta'(x)]$.

If $\gamma \in P_{IV}$ and $\delta \in P_{\overline{IV}}$, then γ and δ translates into $\hat{x}[\gamma'(x) \wedge \delta'(\hat{y}[y=x])]$.

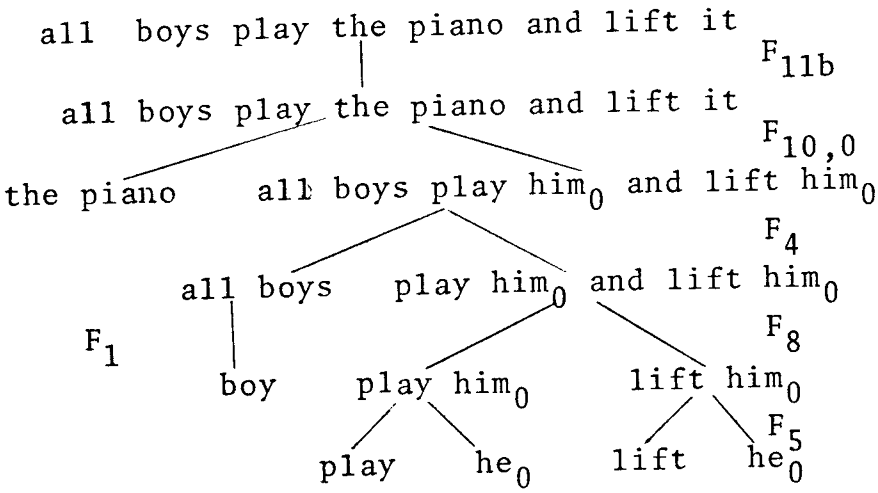
If $\gamma \in P_{IV}$ and $\delta \in P_{IV}$, then γ and δ translate into $\hat{x}[\gamma'(x) \wedge \delta'(x)]$.
If $\gamma \in P_{\overline{IV}}$ and $\delta \in P_{\overline{IV}}$, then γ and δ translate into $\hat{x}[\gamma'(\hat{y}[y=x]) \wedge \delta'(\hat{z}[z=x])]$

and similarily for <u>or</u>.

Note that the output of (34) are simply IV-phrases (and not $\overline{\text{IV}}$-phrases - no matter what kind of verbs were conjoined). Thus the output of (34) combines simply with a <u>distributive</u> noun phrase to form a sentence.

We can now analyze sentence (33) as follows:

36)



The translation of (36) runs as follows:

36") $play'(\hat{P}P\{x_0\})$; $lift'(\hat{P}P\{x_0\})$

The new rule T_{12} (see 35 above) generates

$\hat{y}[play'(\hat{P}P\{x_0\})(\hat{z}[z=y]) \wedge lift'(\hat{P}P\{x_0\})(y)]$

T_4 results in

$\bigwedge x[boy'(x) \rightarrow [play'(\hat{z}[z=x], \hat{P}P\{x_0\}) \wedge lift'(x, \hat{P}P\{x_0\})]]$

Finally, application of T_{14} (see 31 above) gives:

$\bigvee y[\bigwedge w[piano'(w) \leftrightarrow w=y] \wedge \bigwedge x[boy'(x) \rightarrow [play'(\hat{z}[z=x], \hat{P}P\{y\}) \wedge lift'(x, \hat{P}P\{y\})]]]$.

In order to implement plural into PTQ we defined the following new sets of basic expressions:

$B_{T/CN} = \left\{ \begin{array}{l} \text{every°, each°, the°, some°, a(n)°, any°} \\ \text{all*, both*, the*, some*, Ø*, any*} \end{array} \right\}$

$B_{T/CN} = \{\text{all, both, the, some, Ø}\}$

$B_{\overline{T}}$ = $\{\text{they}_n\}$

$B_{\overline{IV}/T}$ = $\{$mix, correlate, adress,...$\}$

$B_{IV/\overline{T}}$ = $\{$lift, prepare, form,...$\}$

$B_{\overline{IV}}$ = $\{$gather, collide, be numerous, marry, be similar, ...$\}$

Furthermore, we replaced S_2 (in PTQ) by (12), T_2 by (16), S_4 by (13), S_5 by (28), T_5 by (29), S_{12} by (34), T_{12} by (35), S_{13} by (22) and (24), T_{13} by (23) and (25), S_{17} by (14) and T_{17} by (17).

By making number a feature of the quantifier rather than the noun we arrived at a straightforward and formally explicit extension of PTQ, that handles correference between collective and distributive plural noun phrases.

Footnote:

1) The reason is that the formation of restrictive relative clauses in PTQ cannot handle sentences like

John watered some of the tulips and all of the roses that bloomed.

(on the reading, where the relative clause modifies both, tulips and roses.)

Thus it is necessary to provide a new treatment for both, the formation of restrictive relative clauses (for arbitrary long conjunctions of headnouns) and the independent quantification of multiple headnouns. It is this latter rule that would account for the surface adjustment (he giggle → they giggle) in (21).

For a complete treatment of restrictive relative clauses with multiple headnouns see R. Hausser (1974).

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