Binding Structures in English and Japanese:

A Categorical Approach*

Sosei ANIYA

0. Introduction

This paper deals with similarities and differences between English and Japanese with respect to binding structures such as question, relative, focus, and topic constructions. Instances of the constructions we will be concerned with are given below.

(1) English[1]

a. What did Soseki put into the box? (Question)

b. the frog which Soseki put into the box (Relative)

c. It was the frog that Soseki put into the box (Focus)

d. This frog Soseki put into the box (Topic)

(2) Japanese

a. sooseki wa hako ni nani o ireta (Question)

b. sooseki ga hako ni ireta kaeru (Relative)

c. sooseki ga hako ni ireta no wa kaeru da (Focus)

d. kono kaeru wa sooseki ga hako ni ireta (Topic)

It will be shown that all of the English examples are instances of binding and so are the Japanese counterparts except (2a), the question. The English and Japanese binding structures are analyzed on the basis of Recursive Categorical Syntax originated by Brame (1984, 1985). The theory is not based on phrase-structure rules, underlying-surface distinctions, tree-structures, and transformational rules of any kind. Instead, the theory includes mechanisms such as: Word Induction, a connector by which words are joined together, thus phrases, clauses, and sentences are induced; Suffixation, a connector of another sort, which creates words by combining suffixes with root-forms, and Variable Continuation, a device which accounts for 'unbounded' dependency relations seen in constructions involving wh-words.[2] These central mechanisms and other ideas in Categorical Grammar will be explained but not exhaustively since space is limited.

1. A Sketch of The Theory

Within our model, natural language is taken to be a category in the sense of category theory as a branch of contemporary mathematics, thus the name Categorical Grammar. We shall begin with the definition of Category below.[3]

(3) Def. A Category C consists of the following:

(i) A collection Ob(C) of objects called C-objects.

(ii) A collection Ar(C) of arrows called C-arrows.

(iii) A (possibly null) collection Hom (a, b) of C-arrows for each pair (a, b) of C-objects.

(iv) A composite function $g^\circ f$ for each pair of C-arrows $(f^\circ g)$ with $cod(f) = dom(g)$ such that $dom(g^\circ f) = dom(f)$ and $cod(g^\circ f) = cod(g)$. This can be pictured as in (3.1) below.

(3.1)

$$\begin{tikzcd} a \arrow[r, "f"] \arrow[dr, "g^\circ f"'] & b \arrow[d, "g"] \\ & c \end{tikzcd}$$

(v) Associativity of composite arrows, i.e. given the following arrows with indicated domains and codomains:

$a \xrightarrow{f} b$, $b \xrightarrow{g} c$, $c \xrightarrow{h} d$, then $h^\circ(g^\circ f) = (h^\circ g)^\circ f$ whenever the products are defined, i.e. when we can compose h with $g^\circ f$ and $h^\circ g$ with f, we get identical results so that the diagram below commutes.

(3.2)

$$\begin{tikzcd}[column sep=huge, row sep=huge]
a \arrow[r, shift left, "h\circ(g\circ f)"] \arrow[r, shift right, "(h\circ g)\circ f"'] \arrow[d, "f"'] \arrow[dr, "g\circ f" near end] & d \\
b \arrow[r, "g"'] \arrow[ur, "h\circ g" near start] & c \arrow[u, "h"']
\end{tikzcd}$$

(vi) An identity arrow Ib for each C-object b, i.e. Ib:b→b exists for each b such that the following equations hold.

$Ib \circ f = f$

$g \circ Ib = g$

for all C-arrows f and g with cod(f)=b and dom(g)=b. The following diagram illustrates the equation.

(3.3)

$$\begin{tikzcd}
a \arrow[r, "f"] \arrow[dr, "f"'] & b \arrow[d, "Ib"] \arrow[dr, "g"] & \\
& b \arrow[r, "g"'] & c
\end{tikzcd}$$

To bring the above point home, let us introduce some examples of primitive words.

(4) Primitive Nullary Words

L^0_1:=‹sleep, V›	L^0_4:=‹Mary, D›	L^0_7:=‹spacecraft, N›
L^0_2:=‹egg, N›	L^0_5:=‹table, N›	L^0_8:=‹Neptune, D›
L^0_3:=‹John, D›	L^0_6:=‹yellow, A›	

(5) Primitive Unary Words

$L^1{}_1$:=‹eat, V,D› $L^1{}_4$:=‹to, T,V›

$L^1{}_2$:=‹the, D,N› $L^1{}_5$:=‹see, V,D›

$L^1{}_3$:=‹try, V,T› $L^1{}_6$:=‹on, P,D›

(6) Primitive Binary Words

$L^2{}_1$:=‹persuade, V,D,P› $L^2{}_3$:=‹consider, V,D,A› $L^2{}_5$:=‹land, V,D,P›

$L^2{}_2$:=‹put, V,D,P› $L^2{}_4$:=‹believe, V,D,T›

The examples in (4) do not take (or select) arguments, thus the name primitive 'nullary' words. Primitive words which select one argument are called primitive 'unary' words. And those which take two arguments are named primitive 'binary' words. There may be words which choose more than two arguments, but we do not go into this issue at this moment. As mentioned above, Categorical Grammar does not have recourse to mechanisms such as phrase structure rules in transformational grammar. Then what device(s) would be employed to generate strings of words? One possible answer is given below.

(7) Induced Lexicon (Brame, 1985:Def. 2.3)

Def. LEX is the smallest set satisfying the following conditions:[4)]

(i) If $L_i \in LEX_\circ$, then $L_i \in LEX$.

(ii) If $L_i{}^n = \langle x, \phi, \psi_1, \ldots, \psi_n\rangle \in LEX$ and $L_j{}^m = \langle y, \psi_1\sigma, \theta_1, \ldots, \theta_m\rangle \in LEX$, for $n \geq 1$, $m \geq 0$, then $\langle x-y, \phi\psi_1\sigma, \theta_1, \ldots, \theta_m, \psi_2, \ldots, \psi_n\rangle \in LEX$.

The above mechanism is called Word Induction. It is sometimes aptly called 'inductive glue'. The initial component x in $\langle x, \phi, \psi_1, \ldots, \psi_n\rangle$, for example, is a member of $PHON_\circ$. The second component, in this case ϕ, is termed the intrinsic category. The third component, here $\langle\psi_1, \ldots, \psi_n\rangle$, is designated the argument category.

Word Induction (or 'inductive glue') is activated if the argument category of a lexical item is the same type as the head of the intrinsic category of another lexical item. This effect can be illustrated as in (8), where the association line shows that the two categories are the same type.

(8) $\langle x, \phi, \psi\rangle (\langle y, \psi\sigma, \theta\rangle) = \langle x-y, \phi\psi\sigma, \theta\rangle$

To make it concrete, let us now show some derivations taking the above primitive words.

(9) a. $L^1_4(L^1_1)$=‹to, T, V› (‹eat, V, D›)=‹to-eat, TV, D›

b. $L^1_2(L^0_2)$=‹the, D, N› (‹egg, N›)=‹the-egg, DN›

c. $L^1_4(L^0_1)$=‹to, T, V› (‹sleep, V›)=‹to-sleep, TV›

We can induce more complex examples, of course.

(10) a. ‹eat, V, D› (‹the-egg, DN›)=‹eat-the-egg, VDN›

b. ‹try, V, T› (‹to-sleep, TV›)=‹try-to-sleep, VTV›

c. ‹persuade-John, VD, T› (‹to-sleep, TV›) = ‹persuade-John-to-sleep, VDTV›

d. ‹try-to, VT, V› (‹persuade-John-to-sleep, VDTV›) = ‹try-to-persuade-John-to-sleep, VTVDTV›

e. ‹consider-John, VD, A› (‹yellow, A›) = ‹consider-John-yellow, VDA›

f. ‹try-to, VT, V› (‹consider-John-yellow, VDA›) = ‹try-to-consider-John-yellow, VTVDA›

g. ‹try-to-persuade-Mary, VTVD, T› (‹to-consider-John-yellow, TVDA›) = ‹try-to-persuade-Mary-to-consider-John-yellow, VTVDTVDA›

At this point we introduce two diagrams below. The first one is the counterpart of picture (3.1), and the other is that of (3.2).

(11)

$$\begin{tikzcd}
\langle \text{sleep}, V \rangle \arrow[r, "{\langle \text{to}, T, V \rangle}"] \arrow[dr] & \langle \text{to-sleep}, TV \rangle \arrow[d, "{\langle \text{try}, V, T \rangle}"] \\
& \langle \text{try-to-sleep}, VTV \rangle
\end{tikzcd}$$

(12)

$$\begin{tikzcd}[column sep=huge, row sep=huge]
\langle \text{sleep}, V\rangle \arrow[r, "{\langle \text{to-try-to}, TVT, V\rangle}"] \arrow[d, "{\langle \text{to}, T, V\rangle}"'] \arrow[dr, "{\langle \text{try-to}, VT, V\rangle}" near end] & \langle \text{to-try-to-sleep}, TVTV\rangle \\
\langle \text{to-sleep}, TV\rangle \arrow[r, "{\langle \text{try}, V, T\rangle}"'] \arrow[ur, "{\langle \text{to-try}, TV, T\rangle}" near start] & \langle \text{try-to sleep}, VTV\rangle \arrow[u, "{\langle \text{to}, T, V\rangle}"']
\end{tikzcd}$$

The above diagrams show that we are indeed dealing with a model which satisfies the conditions of the Category.

Our next concern is Suffixation. The definition follows.

(13) Suffixation (See Brame (1985: Def. 4.1))

Def. If $L_j = \langle x, \sigma, \psi_1, \ldots, \psi_m\rangle \in LEX_\circ$ and $L^s = \langle y, \phi, \sigma\rangle \in LEX^{suf}$, then $\langle xy, \phi\sigma, \psi_1, \ldots, \psi_n\rangle \in LEX_\circ$.

In order to show Suffixation at work, we first present some examples from the suffix lexicon. (The superscript $^\circ$ designates present, and $^-$ indicates past.)

(14) a. $\langle s, 3T^\circ\ V\rangle$ b. $\langle ing, T^{prog}, V\rangle$ c. $\langle ed, T^-, V\rangle$ d. $\langle ed, T^{perf}, V\rangle$

Now some examples of the concatenation procedure are in order.

(15) a. $\langle s, 3T^\circ, V\rangle (\langle persuade, V, D, T\rangle) = \langle persuades, 3T^\circ V, D, T\rangle$

b. $\langle ing, T^{prog}, V\rangle (\langle see, V, D\rangle) = \langle seeing, T^{prog}V, D\rangle$

c. $\langle ed, T^-V\rangle(\langle believe, V, D, T\rangle) = \langle believed, T^-V, D, T\rangle$

d. $\langle ed, T^{perf}, V\rangle (\langle try, V, T\rangle) = \langle tried, T^{perf}V, T\rangle$

It is now conceivable that the auxiliary system can be developed straightforwardly. Here are some examples.

(16) a. $\langle is, 3T^\circ V, T\rangle$

b. $\langle is, 3T^\circ V, T^{prog}\rangle$

c. $\langle are, 2T^\circ V, T\rangle$

d. $\langle are, 2T^\circ V, T^{prog}\rangle$

i. $\langle have, V, T^{perf}\rangle$

j. $\langle has, 3T^\circ V, D\rangle$

k. has, $3T^\circ V, T^{perf}\rangle$

l. $\langle had, T^-V, T^{perf}\rangle$

e. ‹be, V, T^{prog}›
f. ‹be, V, T^{pass}›
g. ‹been, $T^{perf}V$, T^{prog}›
h. ‹have, $IT^{\circ}V$, D›
m. ‹will, $T^{\circ}V$, V›
n. ‹would, $T^{-}V$, V›
o. ‹am, $IT^{\circ}V$, T^{prog}›
p. ‹was, $3T^{-}V$, T^{prog}›

So far so good. But we have not produced sentences yet. We know that English includes lexical items which are intrinsically subjects. Given below are some examples, where symbol $ indicates subject type.

(17) a. ‹I, $DI, IT°›
b. ‹I, $DI, IT^{-}›
c. ‹he, $D3, $3T^{\circ}$›
d. ‹he, $D3, $3T^{-}$›
e. ‹she, $D3, $3T^{\circ}$›
f. ‹she, $D3, $3T^{-}$›

With the above developments, we can now induce sentences. (The concatenation procedures are left out for simplification and only the result is shown here.)

(18) a. ‹I-am-trying-to-sleep, DIIT^{\circ}VT^{prog}VTV$›
b. ‹he-has-tried-to-persuade-Mary-to-go, $D33$T^{\circ}VT^{perf}VTVDTV$›
c. ‹she-has-been-persuading-John-to-put-the-egg-on-the-table, 33T^{\circ}VT^{perf}VT^{prog}VDTVDPDN$›
d. ‹she-has-been-trying-to-persuade-John-to-try-to-eat-the-egg, 33T^{\circ}VT^{perf}VT^{prog}VTVDTVTVDN$›

One might ask at this point: Right, but words such as *you, John, the boy*, etc. can also become subjects. How do you account for that? Well, that can be taken care of in a simple and straightforward way. A subject function is given to a word! This motivates the following formula.

(19) Subject Identity Word
‹Λ, $, D_n, $_nT^x$›

The uppercase Greek Λ designates the identity word whose intrinsic category is the subject type $. The subscript $_n$ is a variable ranging over I, first person, 2, second person, and 3, third person. The superscript ^{x} is another variable ranging over $^{\circ}$, present, and $^{-}$, past.

Given the above subject identity word together with the determiners in (20), we can now induce sentences as pictured in (21).

(20) a. ‹you, D2› b. ‹Mary, D3› c. ‹the, D3, 3N›

(21) a. ‹you-are-eating-the-egg, $D22$T^{\circ}VT^{prog}VDN$›

b. ‹Mary-will-be-persuading-John-to-go-to-sleep,
$D33T°VVT^{prog}VDTVTV›

c. ‹the-boy-is-trying-to-see-the-rainbow, $D33N3T°VT^{prog}VTVDN›

We now wish to introduce Variable Continuation, a key to binding structures. Consider the following examples.

(22) a. what to see

b. What to try to see

c. What to try to persuade the linguist to try to see

b. What to wish to try to persuade the linguist to try to see

Intuitively, we know that the object of *see* and the wh-operator *what* are related. In other words, the wh-word of the question type *what* is the object of *see*. Another characteristic observed here is that such wh-operators act at a distance as mentioned above. To account for these features, the following mechanism is introduced.

(23) Variable Continuation (Brame, 1985: Def. 3.1)

Def. (i) If $L_i \in LEX^{x}_{\circ}$[5], then $L_i \in LEX$.

(ii) If $\langle x, \phi, \psi X\sigma \rangle \in LEX$ and $\langle y, \psi\theta\sigma, \alpha_1, \ldots, \alpha_n \rangle \in LEX$, $n \geq 0$, then $\langle x, \phi, \psi\theta\sigma \rangle \in LEX$.

The meaning of the above definition becomes clear as the reader examines the lexical specification of *what* in (24), words induced by Word Induction in (25) and the desired string of words produced as the result of Variable Continuation coupled with Word Induction.

(24) ‹what, $^{?}{}_{x}D$, TX $_{x}D$›[6)]

(25) a. ‹to-see, TV $_{x}D$›

b. ‹to-try-to-see, TVTV $_{x}D$›

c. ‹to-try-to-persuade-the-linguist-to-try-to-see, TVTVDNTVTV $_{x}D$›

d. ‹to-wish-to-try-to-persuade-the-linguist-to-try-to-see,
TVTVTVDNTVTV $_{x}D$›

(26) a. ‹what-to-see $^{?}{}_{x}D$TV $_{x}D$›

b. ‹what-to-try-to-see, $^{?}{}_{x}D$TVTV $_{x}D$›

c. ‹what-to-try-to-persuade-the-linguist-to-try-to-see,
$^{?}{}_{x}D$TVTVTVDNTVTV $_{x}D$›

2. English Binding Structures

We are now in a positoin to look into English binding structures such as those in (1). Let us take up the question first. Given below are the lexical specifications of the relevant words.

(27) What did Soseki put into the box?[7]

a. ‹what, ${}^{?}{}_{x}D$, T^{x}, $\$X\ {}_{x}D$›
b. ‹did, $T^{-}V$›
c. ‹Λ, \$, D_{n}, ${}_{n}T^{x}$›
d. ‹Soseki, D›
e. ‹put, V, D, P›
f. ‹into, P, D›
g. ‹the, D, N›
h. ‹box, N›

Now the Word Induction comes into play and we obtain the desired result as in (28c). (Henceforth the lexical entries and concatenation procedure are simplified so far as circumstances permit.)

(28) a. ‹what-did, ${}^{?}{}_{x}DT^{-}V$, $\$X\ {}_{x}D$›
b. ‹Soseki-put-into-the-box, $\$DTV\ {}_{x}DPDN$›
c. ‹what-did-Soseki-put-into-the-box, ${}^{?}{}_{x}DT^{-}V\$DTV\ {}_{x}DPDN$›

In the case of the relative (1b), we see that the binding involves three items.

(29) the frog which Soseki put into the box
a. ‹the, ${}_{x}D$, N, R ${}_{x}D$›[8]
b. ‹frog, N›
c. ‹which, R ${}_{x}D$, $\$X\ {}_{x}D$›

The simplified combining procedure can be shown as:

(30) a. ‹the-frog-which, ${}_{x}DNR\ {}_{x}D$, $\$X\ {}_{x}D$›
b. ‹Soseki-put-into-the-box, $\$DT^{-}V\ {}_{x}DPDN$›
c. ‹the-frog-which-Soseki-put-into-the-box,${}_{x}DNR{}_{x}D\$DT^{-}V{}_{x}DPDN$›

(1c) involves, among others, the focus identity word whose lexical specification includes the symbol Γ, the focus type as illustrated in (31a).

(31) It was the frog that Soseki put into the box
a. ‹Λ, Γ, ${}_{x}D$, T^{x}, ${}_{x}D$›
b. ‹it, ${}_{x}D$›
c. ‹was, $T^{-}V$›
d. ‹that, R ${}_{x}D$, $\$X\ {}_{x}D$›

As depicted in (32c) below the binding here involves *it,the,that*, and the object of *put* i.e. ${}_{x}D$, a free determiner.

(32) a. ‹it-was-the-frog-that, $\Gamma\ {}_{x}DT^{-}V\ {}_{x}DNR\ {}_{x}D$, $\$X\ {}_{x}D$›

b. ‹Soseki-put-into-the-box, $\$DT^{-}V\ {}_{x}DPDN$›

c. ‹it-was-the-frog-that-Soseki-put-into-the-box, $\Gamma\ {}_{x}DT^{-}V\ {}_{x}DNR\ {}_{x}D\$T^{-}V\ {}_{x}DPDN$›

The key to the focus structure (1d) is the topic identity word whose intrinsic category Δ symbolizes the focus type.

(33) this frog Soseki put into the box

a. ‹$\Lambda, \Delta,\ {}_{x}D,\ \$X\ {}_{x}D$› b. ‹this, ${}_{x}D$, N›

By Word Induction, we obtain the following.

(34) a. ‹$\Lambda,\ \Delta,\ {}_{x}D,\ \$X\ {}_{x}D$› (‹this, ${}_{x}D$, N›)=‹this, $\Delta\ {}_{x}D$, N, $\$X\ {}_{x}D$›

b. ‹this-frog, $\Delta\ {}_{x}DN$, $\$X\ {}_{x}D$›

c. ‹Soseki-put-into-the-box, $\$DT^{x}V\ {}_{x}DPDN$›

d. ‹this-frog-Soseki-put-into-the-box, $\Delta\ {}_{x}DN\$DT^{-}V\ {}_{x}DPDN$›

In the next section, we consider the Japanese counterparts.

3. Japanese Binding Structures

Before proceeding to the main discourse of this section, it is necessary to go into another type of Word Induction and Variable Continuation. The definitions follow.

(35) Word Induction

(i) If $L_i \in LEX_o$, then $L_i \in LEX$.

(ii) If $L_i^n := \langle x, \psi_1\sigma, \theta_1, \ldots, \theta_m\rangle \in LEX$ and $L_i^m := \langle \psi_n, \ldots, \psi_1, \phi, y\rangle \in LEX$, for $n \geq 1$, $m \geq 0$, then $\langle x-y, \phi\psi_1\sigma, \theta_1, \ldots, \theta_m, \psi_2, \ldots, \psi_n\rangle \in LEX$

(36) Variable Continuation

(i) If $L_i \in LEX_o^{x}$, then $L_i \in LEX$.

(ii) If $\langle y, \psi\theta\sigma, \alpha_1, \ldots, \alpha_n\rangle \in LEX$ and $\langle \psi X\sigma, \phi, x\rangle \in LEX$, $n \geq 0$, then $\langle \psi\theta\sigma, \phi, x\rangle \in LEX$.

Word Induction (35) together with Variable Continuation (36) accounts for cases where the right-to-left induction takes place.

Let us now examine the Japanese examples in (2). Japanese questions such as (2) are not instances of binding. This phenomenon will be shown below. But first let us consider the lexical entries of the relevant words.

(37) sooseki wa hako ni nani o ireta

a. ‹sooseki, D› e. ‹D, L^{oc}, ni›[10]
b. ‹D, ^{R}D, wa›[9] f. ‹D, O^{acc}, o›[11]
c. ‹Λ, \$, ^{x}D, T^{x}› g. ‹nani, $D^{?}$›
d. ‹hako, DN› h. ‹O^{acc}, L^{oc}, $T^{-}V$, ireta›

The derivation with respect to Word Induction (35) is pictured below.

(38) a. (‹sooseki, D›) ‹D, ^{R}D, wa›=‹sooseki-wa, ^{R}DD›
b. ‹Λ, \$, ^{x}D, T^{x}› (‹sooseki-wa, ^{R}DD›)=‹sooseki-wa, \$ ^{R}DD, T^{x}›
c. (‹hako, DN›) ‹D, L^{oc}, ni›=‹hako-ni, $L^{oc}DN$›
d. (‹nani, $D^{?}$›) ‹D, O^{acc}, o›=‹nani-o, $O^{acc}D^{?}$›
e. ‹hako-ni-nani-o-ireta, $T^{-}VL^{oc}DNO^{acc}D^{?}$›
f. ‹sooseki-wa, \$ ^{R}DD, T^{x}› (‹hako-ni-nani-o-ireta, $T^{-}VL^{oc}DNO^{acc}D^{?}$›)=‹sooseki-wa-hako-ni-nani-o-ireta, \$ $^{R}DDT^{-}VL^{oc}DNO^{acc}D^{?}$›

Japanese questions optionally take *ka* , which might be specified, as ‹\$, Q, ka›. An example follows.

(39) sooseki wa hako ni nani o iremashita ka
(‹sooseki-wa-hako-ni-nani-o-iremashita, \$ $^{R}DDT^{-}VL^{oc}DNO^{acc}D^{?}$›)‹\$, Q, ka› = ‹sooseki-wa-hako-ni-nani-o-iremashita-ka, Q\$$^{R}DDT^{-}VL^{oc}DNO^{acc}D^{?}$›

As we can see Variable Continution does not come into play in the above derivations since the requirement (36ii) is not satisfied. Unlike the English *what* as specified in (24), the Japanese question word *nani* does not include $_{x}D$, a free determiner in its intrinsic category nor does it select a variable type X together with a free determiner $_{x}D$ as its argument category. It follows from this that the Japanese question under consideration is not an instance of binding.

Let us move on to the relative (2b). As is well-known Japanese does not exhibit relative pronouns. The head of the relative plays a crucial role in binding here. Given below are the lexical entries of the essential items.

(40) sooseki ga hako ni ireta kaeru
a. ‹D, ^{A}D, ga›[12] b. ‹\$X $_{x}D$, $_{x}D$, kaeru›

The derivation can be shown as:

a. $(\langle \text{sooseki}, D\rangle)\langle D, {}^{A}D, \text{ga}\rangle=\langle \text{sooseki-ga}, {}^{A}DD\rangle$

b. $\langle \Lambda, \$, {}^{x}D, T^{x}\rangle(\langle \text{sooseki-ga}, {}^{A}DD\rangle)=\langle \text{sooseki-ga}, \$^{A}DD, T^{x}\rangle$

c. $(\langle \text{hako-ni}, L^{oc}DN\rangle)\langle O^{acc}, L^{oc}, T^{-}V, \text{ireta}\rangle = \langle \text{hako-ni-ireta}, T^{-}VL^{oc}DN\ {}_{x}O^{acc}\rangle$

d. $\langle \text{sooseki-ga}, \$\ {}^{A}DD, T^{x}\rangle(\langle \text{hako-ni-ireta}, T^{-}VL^{oc}DN\ {}_{x}O^{acc}\rangle) = \langle \text{sooseki-ga-hako-ni-ireta}, \$\ {}^{A}DDT^{-}VL^{oc}DN\ {}_{x}O^{acc}\rangle$

e. $(\langle \text{sooseki-ga-hako-ni-ireta}, \$\ {}^{A}DDT^{-}VL^{oc}DN\ {}_{x}O^{acc}\rangle)=\langle \$X\ {}_{x}D, {}_{x}D, \text{kaeru}\rangle=\langle \text{sooseki-ga-hako-ni-ireta-kaeru}, {}_{x}D\$\ {}^{A}DDT^{-}VL^{oc}DN\ {}_{x}O^{acc}\rangle$

It might be worthwhile to mention here that the Japanese focus counterpart (2c) is rather close to English pseudo-cleft sentence *What Soseki put into the box was the frog*. In either case, however, binding is clearly involved. Thus we proceed to (2c). Below we give the relevant words with lexical specifications.

(42) sooseki ga hako ni ireta no wa kaeru da

a. $\langle \$X\ {}_{x}D, {}_{x}D, \text{no}\rangle$

b. $\langle \Lambda, \Phi, {}^{R}D, T^{x}\ X\ {}_{x}D\rangle$

c. $\langle D, T^{\circ}\ V, \text{da}\rangle$

(42b) is the specification for a focus identity word whose intrinsic category is depicted by the symbol Φ, the focus type. Of importance here is that the first argument category is specified as ${}^{R}D$. This should be so because the above focus sentence involves a contrastive focus marked by *wa* which indicates a relative determinative word.

Let us picture the induction procedure below.

(43) a. $(\langle \text{sooseki-ga-hako-ni-ireta}, \$\ {}^{A}DDT^{\circ}\ VL^{oc}DN\ {}_{x}O^{acc}\rangle)\langle \$X\ {}_{x}D, {}_{x}D, \text{no}\rangle=\langle \text{sooseki-ga-hako-ni-ireta-no}, {}_{x}D\$\ {}^{A}DDT^{\circ}\ VL^{oc}DN\ {}_{x}O^{acc}\rangle$

b. $(\langle \text{sooseki-ga-hako-ni-ireta-no}, {}_{x}D\$\ {}^{A}DDT^{\circ}\ VL^{oc}DN\ {}_{x}O^{acc}\rangle)\langle D, {}^{R}D, \text{wa}\rangle = \langle \text{sooseki-ga-hako-ni-ireta-no-wa}, {}^{R}D\ {}_{x}D\$\ {}^{A}DDT^{\circ}\ VL^{oc}DN\ {}_{x}O^{acc}\rangle$

c. $\langle \Lambda, \Phi, {}^{R}D, T^{x}\ X\ {}_{x}D\rangle(\langle \text{sooseki-ga-hako-ni-ireta-no-wa}, {}^{R}D\ {}_{x}D\$\ {}^{A}DDT^{\circ}\ VL^{oc}DN_{x}O^{acc}\rangle) = \langle \text{sooseki-ga-hako-ni-ireta-no-wa}, \Phi\ {}^{R}D_{x}D\$^{A}DDT^{\circ}VL^{oc}DN_{x}O^{acc}, T^{x}X_{x}D\rangle$

d. $(\langle \text{kaeru}, {}_{x}D\rangle)\langle D, T^{\circ}\ V, \text{da}\rangle=\langle \text{kaeru-da}, T^{\circ}\ V\ {}_{x}D\rangle$

e. $\langle \text{sooseki-ga-hako-ni-ireta-no-wa}, \Phi\ {}^{R}D\ {}_{x}D\$\ {}^{A}DDT^{\circ}\ VL^{oc}DN$

$_{x}O^{acc}$, T^{x} X $_{x}D$›)‹kaeru-da, $T^{\circ}V_{x}D$› = ‹sooseki-ga-hako-ni-ireta-no-wa-kaeru-da, $\Phi\ {}^{R}D_{x}D\$^{A}DDT^{\circ}VL^{oc}DN_{x}O^{acc}T^{\circ}\ V_{x}D$›

Let us now analyze the last item of concern in this section. It seems to be the case that the locus of topic construction is not *wa*. What makes a topic a topic is rather the topic identity word. Its intrinsic category is the topic type designated here by the uppercase Greek Δ. The topic identity word selects *wa* with relative determinative function as its argument category as shown in (44b).

(44) a. ‹kono, $DG^{\rightarrow}$, D› b. ‹Λ, Δ, ^{R}D, \$X $_{x}D$›

The above word *kono* can be thought of as a compound word which consists of *ko*, a deictic determiner and *no*, a genitive morpheme. The *no* can be specified as ‹D | $G^{\rightarrow}$, no | D›[13]. The superscript → here is intended to designate the direction of the head word in the sense of traditional grammar.

With the above developments we obtain the derivation of the Japanese topic construction as illustrated below.

(45) a. ‹kono, $DG^{\rightarrow}$, D›(‹kaeru, $_{x}DN$›)=‹kono-kaeru, $DG^{\rightarrow}\ _{x}DN$›

b. (‹kono-kaeru, $DG^{\rightarrow}\ _{x}DN$›)‹D, ^{R}D, wa› = ‹kono-kaeru-wa, $^{R}DDG^{\rightarrow}\ _{x}DN$›

c. ‹Λ, Δ, ^{R}D, \$X $_{x}D$›(‹kono-kaeru-wa, $^{R}DDG^{\rightarrow}\ _{x}DN$›) = ‹kono-kaeru-wa, Δ $^{R}DDG^{\rightarrow}\ _{x}DN$, \$X $_{x}D$›

d. ‹sooseki-ga-hako-ni-ireta, \$ $^{A}DDT^{-}VL^{oc}D\ _{x}O^{acc}$›

e. ‹kono-kaeru-wa, Δ $^{R}DDG^{\rightarrow}\ _{x}DN$, \$X $_{x}D$›(‹sooseki-ga-hako-ni-ireta, \$ $^{A}DDT^{-}VL^{oc}D\ O_{x}^{acc}$›)=‹kono-kaeru-wa-sooseki-ga-hako-ni-ireta, Δ $^{R}DDG^{\rightarrow}\ _{x}DN\$\ ^{A}DDT^{-}VL^{oc}D\ _{x}O^{acc}$›

4. Summary

We first introduced a brief framework of Recursive Categorical Syntax to familiarize the reader with the theory. Following the spirit of the theory, we have analyzed some binding structures in English and Japanese. We have chosen question, relative, focus, and topic constructions as representatives. In the course of our discussion, it was shown that unlike English the Japanese question we dealt with are not instances of binding. The rest of the Japanese examples are indeed instances of binding just like their English conterparts as we have seen.

FOOTNOTES

* I would like to thank Carol Rinnert for comments and suggestions. I am solely responsible for any errors and shortcomings in this article.

1) See Brame (1978:50) for more examples.

2) The following examples illustrate the point at issue. (See Brame, 1985:146) The object of *see* is bound to the wh-operator. As we can see the binding here works at a distance.
   a. What to see
   b. What to try to see
   c. What to persuade Keiko to see
   d. What to persuade Keiko to try to see
   e. What to try to persuade Keiko to try to see

3) The following definition is extracted from Brame (1984).

4) The LEX_o in condition (i) is defined as follows (See Brame, 1984):
   $LEX_o := \{L_1, L_2, \ldots, L_n \mid L_i = <x, f> \text{ for some } x \in PHON_o, f \in FUNC_o\}$
   The $PHON_o$, a phonetic or orthographic vocabulary, is a finite set and defined as $PHON_o := \{sleep, try, to, kick, the, in, John, \ldots, fun, \Lambda\}$. And the $FUNC_o$ is defined as $FUNC_o := \{\langle\phi, \psi\rangle, \langle\sigma, \theta\rangle, \ldots, \langle\delta, \tau\rangle\}$, where $\phi, \psi, \sigma, \theta, \ldots, \delta, \tau \in CAT_o$. The CAT_o is in turn definied as follows:
   Primitive Natural Language Categories or Parts of Speech
   $CAT_o := \{N, V, P, D, T, \ldots, 1\}$

5) LEX_o^x is taken to be as a finite set of variable words.

6) $_xD$ symbolizes the category of free determiners. Its phonetic or orthographic content is the identity P-word Λ, which functions as an identity under P-word concatenation, i.e. $\Lambda - x = x = x - \Lambda$. (Brame, 1985:147)

7) We also have a non-binding question structure such as *Did Soseki put the frog into the box?* One solution for such question structures would be an identity question word of the following type: $<\Lambda, Q, T^x, \$>$, where the intrisic category Q is the question type.

8) The reader might question the intended binding depicted by the subscript, x, i.e. *the* is associated with the relative determiner *which*. Historically, *the* is derived from the shortened from of *that*. Thus we belive that *the* is the most appropriate candidate for the binding involved here.

9) This *wa* includes 'relative determinative' function which is the key to so called contrastive and topic constructions involving *wa*. See Aniya (1987;59ff) for the

definition of the 'relative determinative' function of *wa*.

10) The symbol L^{oc} designates locative function.

11) The item O^{acc} symbolizes accusative function.

12) This *ga* includes 'absolute determinative' function, the foundation of deictic and definite use of *ga*. See Aniya (1987;58ff) for details.

13) We now add the condition (iii) to Word Induction (35).

(iii) If $L_i = <x, \psi_1\sigma, \theta_1, \ldots, \theta_m> \in LEX$ and $L_j = <\psi_n, \ldots, \psi_1 \mid \phi, y \mid \varepsilon_1, \ldots, \varepsilon_k> \in LEX$ and $L_k := <z, \gamma\varepsilon_1, \beta_1, \ldots, \beta_j> \in LEX$, then $<x-y-z, \psi_1\sigma\phi\gamma\varepsilon_1, \theta_1, \ldots, \theta_m, \phi_2, \ldots, \phi_n, \beta_1, \ldots, \beta_n, \varepsilon_2, \ldots, \varepsilon_k> \in LEX$.

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