Chapter 4

Composition

The possibility of conjunction offers one of the best criteria for the initial determination of phrase structure.
—*Syntactic Structure* Noam Chomsky, 1957:36

Conjunctions like “and” and “or” appear happy to combine any pair of categories just so long as they are of the same type, to yield a category of that same type:

(1) a. Gabbitas [[walks]$_{S\backslash NP}$ and [talks]$_{S\backslash NP}$]$_{S\backslash NP}$.
b. Gabbitas [[walks]$_{S\backslash NP}$ and [chews gum]$_{S\backslash NP}$]$_{S\backslash NP}$.
c. Gabbitas [[bought]$_{(S\backslash NP)/NP}$ and [sold]$_{(S\backslash NP/)NP}$]$_{(S\backslash NP)/NP}$ a car..
d. Gabbitas [[bought]$_{(S\backslash NP)/NP}$ and [sold my brother]$_{(S\backslash NP)/NP}$]$_{(S\backslash NP)/NP}$ various books.
e. Gabbitas [[gave]$_{((S\backslash NP)/NP)/NP}$ or [sold]$_{((S\backslash NP)/NP)/NP}$]$_{((S\backslash NP)/NP)/NP}$ my brother various books.
(etc.)

We must therefore write the category for conjunctions as follows:

(2) and := $(\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} : \lambda p \lambda q . p \sqcap q$

—where T is S or any function into S, and $\sqcap$ is the pointwise recursive extension of logical conjuntion $\wedge$ to functions of any valency into S (Partee and Rooth, 1983).

As in any theory of coordination, category (2) itself must be excluded as a value for T, to disallow the following:

(3) a. *John walks and and and talks.
b. *John walks and stalks and and talks.

The $\star$-type slashes mean that the conjunction category can *only* combine by the application rules (4), so that (1c) can be derived as follows

(4)
$$
\begin{array}{ccccc}
\text{Gabbitas} & \text{bought} & \text{and} & \text{sold} & \text{a car} \\
\hline
NP^{\uparrow} & (S\backslash NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & (S\backslash NP)/NP & NP^{\uparrow} \\
: \lambda p.p\,gabbitas & : \lambda x\lambda y.bought\,x\,y & : \lambda p\lambda q.p \sqcap q & : \lambda x\lambda y.sold\,x\,y & : \lambda p.p\,(a\,car) \\
 & & \multicolumn{2}{c}{\overline{((S\backslash NP)/NP)\backslash((S\backslash NP)/NP)}^{>}} & \\
 & & \multicolumn{2}{c}{\lambda q\lambda x\lambda y.sold\,x\,y \wedge q\,x\,y} & \\
 & \multicolumn{3}{c}{\overline{(S\backslash NP)/NP}^{<}} & \\
 & \multicolumn{3}{c}{: \lambda x\lambda y.sold\,x\,y \wedge bought\,x\,y} & \\
 & \multicolumn{4}{c}{\overline{S\backslash NP : \lambda y.sold\,(a\,car)\,y \wedge bought\,(a\,car)\,y}^{<}} \\
\multicolumn{5}{c}{\overline{S : sold\,(a\,car)\,gabbitas \wedge bought\,(a\,car)\,gabbitas}^{>}}
\end{array}
$$

However, conjunction can also apply to things that are neither words nor traditional constituents, like “might sell” in the following example:

(5) a. I bought and might sell a car.
b. I gave or will send those boys these books.

The reasoning behind the conjunction category (2) forces us to believe that “might sell” must have the same syntactic type as “bought”, namely that of a transitive verb, $(S\backslash NP)/NP$. However, we cannot combine “might”, $(S\backslash NP)/VP$, and “sell”, VP/NP using either of the application rules (4). We need another rule from the family of rules of function composition:

4.1 Combining Categories II: Composition

The following rules of functional composition will be needed:

(6) MERGE IIA: THE COMPOSITION RULES

a. Forward Composition:

$$X/_{\diamond}Y : f \quad Y/Z : g \quad \Rightarrow \quad X/Z : \lambda z.f\,(g\,z) \qquad (>\mathbf{B}\ )$$

b. Backward Composition:

$$Y\backslash Z : g \quad X\backslash_{\diamond}Y : f \quad \Rightarrow \quad X\backslash Z : \lambda z.f\,(g\,z) \qquad (<\mathbf{B}\ )$$

c. Forward Crossing Composition:

$$X/_{\times}Y : f \quad Y\backslash Z : g \quad \Rightarrow \quad X\backslash Z : \lambda z.f\,(g\,z) \qquad (>\mathbf{B}_{\times})$$

d. Backward Crossing Composition:

$$Y/Z : g \quad X\backslash_{\times}Y : f \quad \Rightarrow \quad X/Z : \lambda z.f\,(g\,z) \qquad (<\mathbf{B}_{\times})$$

These rules conform to the Combinatory Projection Principle (5) in applying to strictly adjacent categories, consistent with the directionality of the governing category $X|Y$ and projecting the type and directionality of the argument(s) $|Z$

onto the result.

The $\diamond$- and $\times$–type slashes on the governing functor X/Y or $X\backslash Y$ mean that only categories whose slash is compatible with that type can combine by them. In particular, the conjunction category (2) cannot do so. The unrestricted slashes on the secondary functor Y/Z or $Y\backslash Z$ mean that any slash-type is compatible. (However, the CPP says that the type is inherited by the result X/Z or $X\backslash Z$.)

The unrestricted $/$ and $\backslash$ slashes on the lexical categories of the modals and infinitivals mean that they can act as the governing category in rules of composition, allowing the following derivation for (5):[1]

(7)

$$
\begin{array}{cccccc}
\text{I} & \text{bought} & \text{and} & \text{might} & \text{sell} & \text{a car} \\
\hline
NP^{\uparrow} & (S\backslash NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & (S\backslash NP)/VP & VP/NP & NP^{\uparrow} \\
:\lambda p.p\,me & :\lambda x\lambda y.bought\,x\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p\lambda y.possible\,(p\,y) & :\lambda x\lambda y.sell\,x\,y & :\lambda p.p\,(a\,car) \\
 & & & \multicolumn{2}{c}{\overline{\qquad\qquad\qquad\qquad\qquad}{>}\mathbf{B}} & \\
 & & & \multicolumn{2}{c}{(S\backslash NP)/NP : \lambda x\lambda y.possible\,(sell\,x\,y)} & \\
 & \multicolumn{4}{c}{\overline{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{<>}} & \\
 & \multicolumn{4}{c}{(S\backslash NP)/NP : \lambda x\lambda y.possible\,(sell\,x\,y)\wedge bought\,x\,y} & \\
 & \multicolumn{5}{c}{\overline{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{<}} \\
 & \multicolumn{5}{c}{S\backslash NP : \lambda y.possible\,(sell\,(a\,car)\,y)\wedge bought\,(a\,car)\,y} \\
\multicolumn{5}{c}{\overline{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{>}} & \\
\multicolumn{5}{c}{S : possible\,(sell\,(a\,car)\,me)\wedge bought\,(a\,car)\,me} & \\
\end{array}
$$

This amounts to saying that, grace of the forward composition rule (6a), “might sell” is a *constituent*, on an even footing with the transitive verb, even if traditional notions of constituency don’t recognize it as such.

To allow (5) under a similar argument, we also need the following similarly CPP-compliant “level 2” generalization of the composition rules to allow composition into bivalent dependent functors $(Y|Z)|W$:

1. There is quite a lot going on in the logical forms, the details of which we will pass over for now. From now on we also abbreviate the successive forward and backward applications of the conjunction category as a single combinationindexed $<>$.

(8) MERGE IIB: THE LEVEL 2 COMPOSITION RULES

a. Forward Level 2 Composition:

$$X/_{\diamond}Y : f \quad (Y/Z)|W : g \quad \Rightarrow \quad (X/Z)|W : \lambda w\lambda z.f\,(g\,w\,z) \qquad (>\mathbf{B}^2\ )$$

b. Backward Level 2 Composition:

$$(Y\backslash Z)|W : g \quad X\backslash_{\diamond}Y : f \quad \Rightarrow \quad (X\backslash Z)|W : \lambda w\lambda z.f\,(g\,w\,z) \qquad (<\mathbf{B}^2\ )$$

c. Forward Level 2 Crossing Composition:

$$X/_{\times}Y : f \quad (Y\backslash Z)|W : g \quad \Rightarrow \quad (X\backslash Z)|W : \lambda w\lambda z.f\,(g\,w\,z) \qquad (>\mathbf{B}^2_{\times})$$

d. Backward Level 2 Crossing Composition:

$$(Y/Z)|W : g \quad X\backslash_{\times}Y : f \quad \Rightarrow \quad (X/Z)|W : \lambda w\lambda z.f\,(g\,w\,z) \qquad (<\mathbf{B}^2_{\times})$$

The first of these rules, $>\mathbf{B}^2$, allows the following derivation for (**??**b):

(9)

$$\begin{array}{ccccccc}
\text{I} & \text{gave} & \text{or} & \text{will} & \text{send} & \text{these boys} & \text{those books} \\
\hline
NP^{\uparrow} & ((S\backslash NP)/NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & (S\backslash NP)/VP & (VP/NP)/NP & NP^{\uparrow} & NP^{\uparrow} \\
: \lambda p.p\,me & : \lambda x\lambda w\lambda y.past\,(give\,w\,x\,y) & : \lambda p\lambda q.p \sqcup q & : \lambda p\lambda y.predicted\,(p\,y) & : \lambda x\lambda w\lambda y.send\,w\,x\,y & : \lambda p.p\,(these\,boys) & : \lambda p.p\,(those\,books)
\end{array}$$

$$\frac{(S\backslash NP)/VP \quad (VP/NP)/NP}{((S\backslash NP)/NP)/NP : \lambda x\lambda w\lambda y.predicted\,(send\,w\,x\,y)}{>\mathbf{B}^2}$$

$$\frac{}{((S\backslash NP)/NP)/NP : \lambda x\lambda w\lambda y.predicted\,(send\,w\,x\,y) \vee past(give\,w\,x\,y)}{<>}$$

$$\frac{}{(S\backslash NP)/NP : \lambda w\lambda y.predicted\,(send\,w\,(those\,boys)\,y) \vee past(give\,w\,(these\ boys)\,y)}{<}$$

$$\frac{}{S\backslash NP : \lambda y.predicted\,(send\,(thosebooks)\,(these\,boys)\,y) \vee past(give\,(thosebooks)\,(these\ boys)\,y)}{<}$$

$$\frac{}{S : predicted\,(send\,(thosebooks)\,(these\,boys)\,me) \vee past(give\,(thosebooks)\,(these\ boys)\,me)}{>}$$

It will become important later to note that repeated application of the above rules can derive categories of unboundedly high valency, because X in the governing functor can itself be a functor, as it is unboundedly Since the inclusion of second-order composition $\mathbf{B}^2$ allows derived syntactic types of unboundedly high valency, to avoid increasing expressive power, the variable T in the above category must be restricted to syntactic categories of bounded valency.

We can therefore thing of coordinating categories as schematizing over a large but bounded list of specific categories.

Modals like “might” are a variety of adjunct to the VP. It is perhaps not surprising that standard adjuncts like “tomorrow” can also compose with transitive verbs (via the backward crossing composition rule (6d)) in the “Heavy NP Shift” construction (10), and that the result of the composition, having the same type $(S\backslash NP)/NP$ as the transitive verb, can coordinate with it, as in (11).

(10)

$$\begin{array}{ccccc}
\text{I} & \text{might} & \text{sell} & \text{tomorrow} & \text{a very heavy book} \\
\hline
NP^{\uparrow} & (S\backslash NP)/VP & VP/NP & VP\backslash VP & NP^{\uparrow} \\
:\lambda p.p\,me & :\lambda p\lambda y.possible\,(p\,y) & \lambda x\lambda y.sell\,x\,y & :\lambda p\lambda y.tomorrow\,p\,y & :\lambda p.p\,(a\,book)
\end{array}$$

$$\frac{VP/NP \quad VP\backslash VP}{VP/NP : \lambda x\lambda y.tomorrow\,(sell\,x)\,y} <\mathbf{B}_{\times}$$

$$\frac{}{(S\backslash NP)/NP : \lambda x\lambda y.possible\,(tomorrow\,(sell\,x)\,y)} >\mathbf{B}$$

$$\frac{}{S\backslash NP : \lambda y.possible\,(tomorrow\,(sell\,(a\,book))\,y)} <$$

$$\frac{}{S : possible\,(tomorrow\,(sell\,(a\,book))\,me)} >$$

This rearrangement is a case of "scrambling" canonical order, which in English is restricted to adjuncts The next chapter will show that other languages allow much more general scrambling.

Again, "might sell tomorrow" has the status of a constituent with the syntactic type of a transitive verb in the derivation above, so we should not be surprised to find that it can undergo coordination:

(11)

$$\begin{array}{ccccccc}
\text{I} & \text{bought} & \text{and} & \text{might} & \text{sell} & \text{tomorrow} & \text{a very fast car} \\
\hline
NP^{\uparrow} & (S\backslash NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & (S\backslash NP)/VP & VP/NP & VP\backslash VP & NP^{\uparrow} \\
:\lambda p.p\,me & :\lambda x\lambda y.bought\,x\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p\lambda y.possible\,(p\,y) & :\lambda x\lambda y.sold\,x\,y & :\lambda p\lambda y.tomorrow\,p\,y & :\lambda p.p\,(a\,car)
\end{array}$$

$$\frac{}{VP/NP : \lambda x\lambda y.tomorrow\,(sell\,x)\,y} <\mathbf{B}_{\times}$$

$$\frac{}{(S\backslash NP)/NP : \lambda x\lambda y.possible\,(tomorrow\,(sell\,x)\,y)} >\mathbf{B}$$

$$\frac{}{(S\backslash NP)/NP : \lambda x\lambda y.possible(tomorrow\,(sell\,x)\,y) \wedge bought\,x\,y} <\!\!>$$

$$\frac{}{S\backslash NP : \lambda y.possible(tomorrow\,(sell\,(a\,car))\,y) \wedge bought\,(a\,car)\,y} <$$

$$\frac{}{S : possible(tomorrow\,(sell\,(a\,car))\,y) \wedge bought\,(a\,car)\,me} >$$

(Note that no requrement of structural parallelism of coordinands, of the kind stipulated by Goodall (1987); **?**, and others is necessary. The only constraint is the like-type requirement of the schema (2).)

However, in order to prevent overgeneration of examples like (14) via an analogous scrambling derivation, we must assume that the type raised NP arguments that we schematize as $NP^{\uparrow}$ must in English be of the general form $T\backslash_{\diamond\star}(T/NP)$, incompatible with crossing composition. In particular, the dative argument of ditransitives must be $VP\backslash_{\diamond\star}(VP/NP)$.[2]

(12) $*$I will

$$\begin{array}{ccc}
\text{give} & \text{flowers} & \text{my very heavy friends.} \\
\hline
(VP/NP)/NP & VP\backslash_{\diamond\star}(VP/NP) & (VP/NP)\backslash_{\diamond\star}((VP/NP)/NP) \\
\hline
 & & *{*}*
\end{array}$$

2. We shall see below that cased arguments in other languages that allow "scrambled" word order, such as Japanese and German, are less restricted in this way.

This is a reflex of a general observation about English NP components and English fixed word-order, rather than a stipulation specific to Heavy NP shift: *all* nominal functors have to have this restriction to reflect the fact that English nominal word order is more rigid than verbal, excluding the following:

(13) $$\begin{array}{lcccc} *\text{He was} & \text{a} & \text{little} & \text{who said he worked on the railways} & \text{man} \\ \hline & NP^{\uparrow}/N & N/_{\diamond\star}N & N\backslash_{\diamond\star}N & N \\ \hline & & & & *** \end{array}$$

We shall see in the next chapter that other languages such as German are less restricted in this respect.

The particle-verb constructions like *call up*, *show off* etc., that are so astonishingly abundant in English seem similarly to exclude "light" objects such as pronouns when the particle is medial:

(14) a. I called the girl.
b. I called the girl/her up.
c. I called up the girl/#her.

What about coordinate sentences like the following?

(15) a. I caught and you cooked a fish.
b. I gave and you sold old books to the library

By the logic of the argument so far, since "I caught" and "you cooked" can coordinate to yield something that combines with an object to yield a sentence, they must be syntactically typable in the same sense as "might sell" in (7) and the VP in (**??**b). In fact by this logic they must be *consituents* of type S/NP, despite the fact that there is no traditional name for that type in English. (We might be encouraged in this believe by the fact that languages like Latin that decline transitive verbs according to person and number ("amo, amas, amat," etc.) actually lexicalize such elements as "I like, you like, he/she/it likes," etc.

Similarly, "I gave" and "you sold" must be constituents of type $(S/PP)/NP$.

FROM MINIMALISM7.

Because what we were thinking of as arguments are now seen to be adjunct-like functions, they can do everything functions can do. In particular, like adjuncts, they can compose by the composition rules (6). We immediately predict several varieties of so called "non-constituent" coordination, including "Right Node-Raising" (15a):[3]

3. We continue to abbreviate the forward and backward applications of the conjunction category as a single combination, indexed $<>$.

(16)
$$\begin{array}{cccccc}
\text{I} & \text{caught} & \text{and} & \text{you} & \text{cooked} & \text{a fish} \\
S/(S\backslash NP) & (S\backslash NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & S/(S\backslash NP) & (S\backslash NP)/NP & S\backslash(S/NP) \\
:\lambda p.p\,me & :\lambda x\lambda y,caught\,x\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p.p\,you & :\lambda x\lambda y.cooked\,x\,y & :\lambda p.p\,(a fish) \\
\multicolumn{2}{c}{\overline{S/NP:\lambda x.caught\,x\,me}\,{>}\mathbf{B}} & & \multicolumn{2}{c}{\overline{S/NP:\lambda x.cooked\,x\,you}\,{>}\mathbf{B}} & \\
\multicolumn{5}{c}{\overline{S/NP:\lambda x.caught\,x\,me\wedge cooked\,x\,you}\,{<}{>}} & \\
\multicolumn{6}{c}{\overline{S:caught\,(a fish)\,me\wedge cooked\,(a fish)\,you}\,{<}}
\end{array}$$

Similarly, by the level 2 rule:

(17)
$$\begin{array}{ccccccc}
\text{I} & \text{gave} & \text{and} & \text{you} & \text{sold} & \text{old books} & \text{to the library} \\
S/(S\backslash NP) & ((S\backslash NP)/PP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & S/(S\backslash NP) & ((S\backslash NP)/PP)/NP & NP^{\uparrow} & PP^{\uparrow} \\
:\lambda p.p\,me & :\lambda x\lambda w\lambda y,gave\,w\,x\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p.p\,you & :\lambda x\lambda w\lambda y,sold\,w\,x\,y & \lambda p.p\,(old\,books) & \lambda p.p\,(to\,(the\,library)) \\
\multicolumn{2}{c}{\overline{(S/PP)/NP:\lambda x\lambda w.gave\,w\,x\,me}\,{>}\mathbf{B}^{2}} & & \multicolumn{2}{c}{\overline{S/NP:\lambda x\lambda w.sold\,w\,x\,you}\,{>}\mathbf{B}^{2}} & & \\
\multicolumn{5}{c}{\overline{S/NP:\lambda w.gave\,w\,(old\,books)\,me\wedge sold\,w\,(old\,books)\,you}\,{<}{>}} & & \\
\multicolumn{7}{c}{\overline{S:gave\,(to\,(the\,library))\,(old\,books)\,me\wedge sold\,(to\,(the\,library))\,(old\,books)\,you}\,{<}}
\end{array}$$

The non-standard coordinating constituents of type S/NP involved in Right Node-Raising can also be unbounded, formed by composition across complement boundaries:

(18)
$$\begin{array}{cccccccc}
\text{I} & \text{caught} & \text{and} & \text{you} & \text{said} & \text{you} & \text{cooked} & \text{a fish} \\
S/(S\backslash NP) & (S\backslash NP)/NP & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & S/(S\backslash NP) & (S\backslash NP)/S & S/(S\backslash NP) & (S\backslash NP)/NP & S\backslash(S/NP) \\
:\lambda p.p\,me & :\lambda x\lambda y,caught\,x\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p.p\,you & :\lambda s\lambda y.said\,s\,y & :\lambda p.p\,you & :\lambda x\lambda y.cooked\,x\,y & a fish \\
\multicolumn{2}{c}{\overline{S/NP:\lambda x.caught\,x\,me}\,{>}\mathbf{B}} & & \multicolumn{2}{c}{\overline{S/S:\lambda s.said\,s\,you}\,{>}\mathbf{B}} & \multicolumn{2}{c}{\overline{S/NP:\lambda x.cooked\,x\,you}\,{>}\mathbf{B}} & \\
& & & \multicolumn{4}{c}{\overline{S/NP:\lambda x.said\,(cooked\,x\,you)\,you}\,{>}\mathbf{B}} & \\
\multicolumn{7}{c}{\overline{S/NP:\lambda x.caught\,x\,me\wedge said\,(cooked\,x\,you)\,you}\,{<}{>}} & \\
\multicolumn{8}{c}{\overline{S:caught\,(a fish)\,me\wedge said\,(cooked\,(a fish)\,you)\,you}\,{<}}
\end{array}$$

(The potentially unbounded nature of such constituents of type S/NP will also be important when we turn to the left-extracting *wh*-constructions in chapter 9.)

Remarkably, we also immediately capture the (in traditional terms non-constituent) phenomenon of argument-adjunct cluster coordination, (18) in Chapter 1, as in Figure **??** (TODO).[4]

(19)
$$\begin{array}{ccccccc}
\text{I} & \text{gave} & \text{Ike} & \text{a bike} & \text{and} & \text{Adlai} & \text{a train} \\
S/(S\backslash NP) & ((S\backslash NP)/NP)/NP & ((S\backslash NP)/NP)\backslash(((S\backslash NP)/NP)/NP) & (S\backslash NP)\backslash((S\backslash NP)/NP) & (\mathrm{T}\backslash_{\star}\mathrm{T})/_{\star}\mathrm{T} & ((S\backslash NP)/NP)\backslash(((S\backslash NP)/NP)/NP) & (S\backslash NP)\backslash((S\backslash N \\
:\lambda p.p\,me & :\lambda x\lambda w\lambda y.gave\,w\,x\,y & :\lambda p\lambda w\lambda y.p\,w\,ike\,y & :\lambda p\lambda y.p\,(a\,bike)\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p\lambda w\lambda y.p\,w\,adlai\,y & :\lambda p\lambda y.p\,(a\,tr \\
& & \multicolumn{2}{c}{\overline{(S\backslash NP)\backslash(((S\backslash NP)/NP)/NP):\lambda p\lambda y.p\,(a\,bike)\,ike\,y}\,{<}\mathbf{B}} & & \multicolumn{2}{c}{\overline{(S\backslash NP)\backslash(((S\backslash NP)/NP)/NP):\lambda p\lambda y.p\,(a\,train)\,adlai\,y}} \\
& & \multicolumn{5}{c}{\overline{(S\backslash NP)\backslash(((S\backslash NP)/NP)/NP):\lambda p\lambda y.p\,(a\,train)\,adlai\,y\wedge p\,(a\,bike)\,ike\,y}} \\
& \multicolumn{6}{c}{\overline{S\backslash NP:\lambda y.gave\,(a\,train)\,adlai\,y\wedge gave\,(a\,bike)\,ike\,y}\,{<}} \\
\multicolumn{7}{c}{\overline{S:gave\,(a\,train)\,adlai\,me\wedge gave\,(a\,bike)\,ike\,me}\,{<}}
\end{array}$$

4. Cf. Dowty (1985/1988); Steedman (1985).

(20)

$$\begin{array}{ccccccc}
\text{I} & \text{saw} & \text{Ike} & \text{on Monday} & \text{and} & \text{Adlai} & \text{onWednesday} \\
\hline
S/(S\backslash NP) & (S\backslash NP)/NP & (S\backslash NP)\backslash((S\backslash NP)/NP) & (S\backslash NP)\backslash(S\backslash NP) & (\mathrm{T}\backslash_\star \mathrm{T})/_\star \mathrm{T} & (S\backslash NP)\backslash((S\backslash NP)/NP) & (S\backslash NP)\backslash(S\backslash NP) \\
:\lambda p.p\,me & :\lambda x\lambda y.saw\,x\,y & :\lambda p\lambda y.p\,ike\,y & :\lambda p\lambda y.(on\,monday)\,p\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p\lambda y.p\,adlai\,y & :\lambda p\lambda y.(on\,wednesday)\,p\,y
\end{array}$$

$$\frac{\text{Ike} \quad \text{on Monday}}{(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p\lambda y.(on\,monday)\,p\,ike\,y}{<}\mathbf{B} \qquad \frac{\text{Adlai} \quad \text{onWednesday}}{(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p\lambda y.(onwednesday)\,p\,adlai\,y}{<}\mathbf{B}$$

$$\overline{(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p\lambda y.(onwednesday)\,p\,adlai\,y \wedge (on\,monday)\,p\,ike\,y}\ {<}{\Diamond}{>}$$

$$\overline{S\backslash NP : \lambda y.(onwednesday)\,saw\,adlai\,y \wedge (on\,monday)\,saw\,ike\,y}\ {<}$$

$$\overline{S : (onwednesday)\,saw\,adlai\,me \wedge (on\,monday)\,saw\,ike\,y, me}\ {<}$$

(21)

$$\begin{array}{ccccccc}
\text{I} & \text{told} & \text{Ike} & \text{that it was raining} & \text{and} & \text{Adlai} & \text{that it was snowing} \\
\hline
S/(S\backslash NP) & ((S\backslash NP)/S')/NP & ((S\backslash NP)/S')\backslash(((S\backslash NP)/S)/NP) & (S\backslash NP)\backslash((S\backslash NP)/S') & (\mathrm{T}\backslash_\star \mathrm{T})/_\star \mathrm{T} & ((S\backslash NP)/S')\backslash(((S\backslash NP)/S')/NP) & (S\backslash NP)\backslash((S\backslash NP)/S') \\
:\lambda p.p\,me & :\lambda x\lambda w\lambda y.told\,w\,x\,y & :\lambda p\lambda w\lambda y.p\,w\,ike\,y & :\lambda p\lambda y.p\,raining\,y & :\lambda p\lambda q.p\sqcap q & :\lambda p\lambda w\lambda y.p\,w\,adlai\,y & :\lambda p\lambda y.p\,snowing\,y
\end{array}$$

$$\frac{\text{Ike} \quad \text{that it was raining}}{(S\backslash NP)\backslash(((S\backslash NP)/S')/NP) : \lambda p\lambda y.p\,raining\,ike\,y}{<}\mathbf{B} \qquad \frac{\text{Adlai} \quad \text{that it was snowing}}{(S\backslash NP)\backslash(((S\backslash NP)/S')/NP) : \lambda p\lambda y.p\,snowing\,adlai\,y}{<}\mathbf{B}$$

$$\overline{(S\backslash NP)\backslash(((S\backslash NP)/S')/NP) : \lambda p\lambda y.p\,snowing\,adlai\,y \wedge p\,raining\,ike\,y}\ {<}{\Diamond}{>}$$

$$\overline{S\backslash NP : \lambda y.told\,snowing\,adlai\,y \wedge told\,raining\,ike\,y}\ {<}$$

$$\overline{S : told\,snowing\,adlai\,me \wedge told\,raining\,ike\,me}\ {<}$$

Examples (23-21 can be seen as strong conformation of our assumption, following Montague, that all arguments, including proper names, should have the syntactically and semantically type-raised categories.

4.2 Discussion

The above discussion requires us to rethink the traditional notion of constituence. If strings like "might sell", "I caught", and "Adlai a train" are typable by the grammar as $(S\backslash NP)/NP$, S/NP, and $(S\backslash NP)\backslash(((S\backslash NP)/NP)/NP)$ for purposes of coordination, then they must be possible constituents of canonical sentences as well. For example, as well as the standard derivation (22) for the simple transitive "I saw Esau", we must allow a non-standard derivation like (23):[5]

(22)

$$\begin{array}{ccc}
\text{I} & \text{saw} & \text{Esau} \\
\hline
S/(S\backslash NP) : \lambda p.p\,me & (S\backslash NP)/NP : \lambda x\lambda y, saw\,x\,y & (S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p.p\,esau
\end{array}$$

$$\overline{S\backslash NP : \lambda y.saw\,esau\,y}\ {<}$$

$$\overline{S : saw\,esau\,me}\ {>}$$

5. Note that the transitive object needs two distinct syntactic types, although their semantics is the same. We return to this point in the next chapter.

(23)

$$
\begin{array}{ccc}
\text{I} & \text{saw} & \text{Esau} \\
\overline{S/(S\backslash NP) : \lambda p.p\,me} & \overline{(S\backslash NP)/NP : \lambda x \lambda y, saw\,x\,y} & \overline{S\backslash(S/NP) : \lambda p.p\,esau} \\
\multicolumn{2}{c}{\underline{\hspace{20em}}{>}\mathbf{B}} & \\
\multicolumn{2}{c}{S/NP : \lambda x.saw\,x\,me} & \\
\multicolumn{3}{c}{\underline{\hspace{30em}}{<}} \\
\multicolumn{3}{c}{S : saw\,esau\,me}
\end{array}
$$

In this connection, it might be pointed out in defense of this position that the traditional tests for constiutuency, namely lexical substitutability, ability to undergo movement, ability to undergo coordination, and ability to be marked as an intonational phrase, are mutually inconsistent (Jacobson, 2006), and in the case of the last two, on the side of the present definition, rather than the traditional one.

In more positive support of our proposal, it might also be pointed out that it seems to give us an account of apparent discontinuity under coordination that does not require discontinuity in rules of grammar, such as movement, deletion, multidominance, or transderivational parallel structure constraints.

Exercise : We just saw that “I saw Esau” has two CCG derivation structures: the first, a traditional right-branching structure (22); the second a non-standard left-branching on (23). On the same logic, example (12) of chapter 2 must have an entirely left-branching derivation as well as the right-branching one shown there. How many other derivations does that sentence have? (Hint: quite a lot.) Can you justify the alternative non-standard constituents the derivations give rise to in terms of coordination? Are there any that you are doubtful about?