Coordination and constituency

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1 Coordination in Categorial Grammar

1.1 Introduction

Coordination is a syntactic construction that probably occurs in all languages.[1] That is one of the reasons coordination is of interest to general linguistics. In this thesis I focus on this phenomenon in Dutch, but I am convinced that many results can be generalized to other languages as well.

Coordination is a notion that covers a wide range of phenomena. These phenomena can be filed in two classes: initial coordination and non-initial coordination.[2] Initial coordination is manifested, if both conjuncts are preceded by a conjunction. In Dutch, examples of such pairs of conjunctions are *en...en* ('and...and'), *of...of* ('or...or'), *zowel...als* ('both...and'), and *noch...noch* (neither...nor'). We will not pay attention to this kind of coordination in this study. When it comes to non-initial coordination, the conjuncts have a conjunction in the middle, or rather, there is a conjunction between the last and the penultimate conjunct. Examples of such conjunctions in Dutch are *en* ('and'), *maar* ('but'), *want* ('because'), *of* ('or'), and *noch* ('nor'). We are mainly concerned with the conjunction *en*, but most claims that are made with respect to *en* also hold for the other conjunctions.

In this study, we follow the claim made in *Algemene Nederlandse Spraakkunst* (1984) with respect to the syntactic equality of the conjuncts.

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1 Oirsouw R.R. van (1987: 1)

2 Paardekooper (1971: 359-361) quoted by De Vries (1992: 13).

> "In de inleiding tot dit hoofdstuk werd er al op gewezen dat taalelementen, willen ze in nevenschikkend verband gecombineerd kunnen worden, gelijkwaardig moeten zijn. Hiermee wordt allereerst bedoeld dat de leden van een nevenschikking syntactisch gelijkwaardig zijn: ze moeten elk afzonderlijk de functie van het geheel kunnen vervullen."
> *In the introduction to this chapter, it was mentioned that expressions must be equivalent, in order to be combined in coordinate constructions. First of all, this means that the members of a coordination are syntactically equivalent: they must each be able to take the place of the whole.*
> Algemene Nederlandse Spraakkunst (1984: 1080)

In section 1.1.1, the coordinations to be discussed are shortly introduced. The coordinations are *Right Node Raising*, *Forward Conjunction Reduction*, *Gapping* and combinations of these three. These coordinations all appear to demand syntactical equivalence, and in this study, we provide a grammar that accounts for these coordinations.

Nevertheless, there is a relatively large set of counterexamples to this claim, which I will call *asymmetrical coordinations*. Some of them involve coordination of expressions with unlike syntactical status, while others involve different internal structure of the coordinates. I will address to these asymmetrical coordinations in section 1.1.2.

In section 1.1.3, I present the outline of this thesis.

1.1.1 Coordination phenomena to be described

In this study, we focus on three kinds of coordinations, *Right Node Raising*, *Forward Conjunction Reduction*, and *Gapping*. The reason for this is that these coordinations have led to rejection of transformational accounts, in favour of accounts that imply a differently organized syntax.[3] Categorial grammar is a theory that is supposed to supply an account of these coordination phenomena on the basis of a flexibly organized syntax. But as we will see in the course of this

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[3] See Zwarts (1986).

study, such a flexible syntax is not unproblematic, and raises a number of new questions and problems. After discussing these problems, I present a categorial grammar that exhibits less flexibility in syntax, and is nonetheless descriptively adequate. We will continue this exposition in section 1.1.3. First we turn to the three coordinations, mentioned above.

Right Node Raising is a phenomenon which coordinates two expressions, followed by a joint right part. Right Node raising is exemplified in the sentences (1) and (2).

1. **Bobby bedacht** en **Boris vermeed** de combinatie
   Bobby contrived (the combination) and Boris avoided the combination

2. **Viktor bewondert** en **Boris haat** briljante tegenstanders
   Viktor admires (brilliant opponents) and Boris hates brilliant opponents

Forward Conjunction Reduction is a coordination of two expressions, preceded by a joint left part. For this reason the phenomenon is also called *Left Node Raising*. This coordination is exemplified in the sentences (3) and (4).

3. Gheorghiu verkocht **de schaakpartij aan zijn tegenstander** en **zijn ziel aan de duivel**
   Gheorghiu sold the chess game to his opponent and (Gheorghiu sold) his soul to the devil

4. Bobby won **alle partijen in de voorronde** en **de helft van de partijen in de finale**
   Bobby won all games in the qualifying round and (Bobby won) half of the games in the final

The two phenomena can also make their appearance together, as is shown in example (5).

5. ..., dat de arbiter na de wedstrijd **Bobby met bestraffende** en **Boris met lovende** woorden heeft toegesproken.
‘... that the arbiter after the match Bobby with reproaching and Boris with praising words has spoken to’
... that after the match the arbiter has spoken to Bobby in reproaching words and to Boris in praising words

Besides Right Node raising and Forward Conjunction Reduction, we also pay attention to Gapping. In a Gapping construction, the first conjunct is a complete sentence, while the second conjunct consists of one or more remnants. The structure of both conjuncts is supposed to be the same, but some of the parts of the second conjunct are gapped, under identity with items in the first conjunct. These items are printed in italics in the examples (6) and (7).

6. Jan *heeft* een boek *aan Marie gegeven* en Piet een plaat
‘Jan has a book to Marie given and Piet a record’
Jan has given a book to Marie and Piet (has given) a record (to Marie)

7. Karel *mag beslissen* welke jongens *er mee gaan* en Max welke meisjes
Karel may decide which boys are coming along and Max which girls

Finally, examples will be discussed at the end of chapter 3, in which both Gapping and Right Node Raising are involved. One such example is shown in (8). The gapped items are printed in italics, while the ‘raised’ part is printed in bold type.

8. Barbara *heeft* het zure en Simon het zoete **snoepje gegeten**
‘Babara has the sour and Simon the sweet candy eaten’
Barbara has eaten the sour candy and Simon the sweet candy

We discuss asymmetrical coordination in the next section and turn to the outline of this thesis in section 1.1.3.

1.1.2 Asymmetrical coordination

In this section, I am going into phenomena of *asymmetrical coordinations*. These kinds of coordination do not meet the general starting point of most analyses of coordination, namely parallelism of the conjuncts. This is also one of the starting points of this study. Therefore, I present the various asymmetrical coordinations, without discussing possible categorial accounts. Asymmetrical coordination can be divided in the following classes.

a. Coordination of expressions with different categorial status;
b. SGF-coordination;
c. Coordination of Verb final and verb second clauses;
d. Gapping, RNR and scrambling the second conjunct;
e. Unbalanced coordination or extremely balanced coordination.

a. Coordination of expressions with different categorial status

Although coordination almost always appears to demand equal categorial status of the conjuncts, some exceptions to this claim were observed by Sag, Gazdar, Wasow and Weisler, in their joint paper *Coordination and how to distinguish categories*.

9. Pat is either stupid or a liar (*either* AP *or* NP)
10. Pat is a republican and proud of it (NP *and* AP)
11. Pat remembered the appointment and that it was important to be in time (NP *and* CP)
12. Coordination and how to distinguish categories (NP *and* VP)
    Sag, Gazdar, Wasow and Weisler (1985)

This phenomenon seems rather productive, not only in English but also in Dutch. As Van Zonneveld notes, the translations of these English examples in Dutch are without any doubt grammatical.

13. Pat is ofwel stom ofwel een leugenaar (*ofwel* AP *ofwel* NP)
14. Pat is een VVD-er en er trots op (NP *en* AP)
15. Pat herinnerde zich de afspraak en dat het belangrijk was om er op tijd te zijn (NP *en* CP)
16. Nevenschikking en hoe categorieën te onderscheiden (NP *en* VP)
    Van Zonneveld (1992)

A few nice examples were observed by Sue Blackwell.[4] I would like to mention two.

17. One word of warning: read the programme before the play begins as the saga of Max and Ella may not otherwise seem either funny or to make sense (*either* AP *or* VP)
(from a theatre review in the Holborn and City Guardian, 14th Jan 1988)

18. Much was removed from the castle by a human chain of staff, soldiers and Prince Andrew ... (N, N *and* NP)
(the Boston Sunday Globe, 22nd November 1992)

These examples of coordination of expressions of unlike categories are hard to account for in a categorial grammar. According to Nerbonne (p.c.), there is an NP-analysis for sentence (18), because *staff* is a mass noun and *soldiers* is plural. Hendriks (to appear) presents a solution in the framework of the Lambek-calculus. She introduces an operator $\vee$ which functions as a weakening operator. Every expression of category X is also a member of category $X \vee Y$. So, in example (10) above, the expression *a republican* is of category NP, and therefore of category $NP \vee AP$. At the same time, the expression *proud of it* is of category AP, and therefore of category $AP \vee NP$. This category is equivalent to $NP \vee AP$, and thus the coordination of the two is licensed. This kind of coordination, after weakening of the conjuncts, is lexically restricted. It only leads to valid derivations, if there is an expression which takes expressions of category $X \vee Y$ as arguments. In example (10), the derivation can be completed, because *is* is categorized as $(NP\backslash S)/(NP \vee AP)$. The solution brought up by Hendriks is compatible with the treatment of coordination, pursued in this thesis, as far as parallelism of the conjuncts is concerned. Hendriks' derivation of example (10) is presented in (19).

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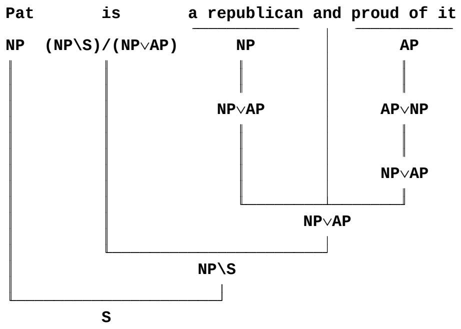
4 In February 1993 the Norwegian linguist Janne Johannessen started an e-mail query in *Linguist* on asymmetrical coordination. Sue Blackwell gave the examples below in connection with this query.

19.



b SGF-coordination

SGF-coordination is short for Subject Gap in Fronted finite verb coordination. In *SGF-constructions*, the first conjunct contains an inverted subject and tensed verb, while the second conjunct lacks a subject. This missing subject should occupy the first position in the second conjunct. This phenomenon was first observed by Höhle (1983), and in the late eighties and early nineties elaborated by Wunderlich (1988), again Höhle (1990), Zwart (1991), Heycock and Kroch (1992), and Van Zonneveld (1992), among others.

20. **In den Wald ging der Jäger** und **fing einen Hasen**
‘Into the forest the hunter went and caught a hare’
The hunter went into the forest and caught a hare
Höhle (1983), Wunderlich (1988)

21. **Wenn jemand nach Hause kommt** und **sieht da den Gerichtsvollzieher vor der Tür**, ...
‘When someone to home comes and sees there the bailiff in front of the door,...’
When someone comes home and sees the bailiff at the door,...
Höhle (1990)

22. **Das Gepäck ließ er fallen** und **rannte zum Hinterausgang**
‘The luggage let he drop and ran to the rear-exit’
He dropped the luggage and ran to the rear-exit
Heycock and Kroch (1992)

23. **Na Zwolle rijdt deze trein verder als intercity naar Groningen** en **zal alleen stoppen te Assen**
‘After Zwolle rides this train further as intercity to Groningen and will only stop in Assen’
After Zwolle, this train will go on as intercity to Groningen and it will only stop in Assen
Zwart (1991)

24. **Daarna kwam hij bij ons aan de tafel staan** en **schonk de wijn in**
‘After that came he with us at the table stand and poured the wine in’
After that he came standing at our table and poured out the wine
Algemene Nederlandse Spraakkunst (1984: 1195)

25. **Opeens stonden al die zoontjes van de intens-burgerlijke Brugse middenstand in lichterlaaie**, **ontpopten zich als duiveltjes** en het bleek dat we middenin de hardste kern van Club Brugge stonden
‘Suddenly stood all those sons of the intensely bourgeois Bruges’ middle class in flames, turned out to be little devils, and it appeared that we were in the middle of the hard core of Club Bruges’
Suddenly all those sons of the intensely bourgeois Bruges’ middle class were ablazed, they turned out to be little devils, and it appeared that we were caught in the middle of Club Bruges’ hard core
Van Zonneveld (1992: 157) (quoting Youp van ’t Hek’s column in NRC/Handelsblad, August 21, 1992)

The missing subject of the second conjunct doesn’t always have to be identical to the subject of the first conjunct. There are also cases where the subject of the second conjunct has to be identified with the object of the first conjunct (example (26)), and cases where the subject of the first conjunct has to be identified with the object of the second conjunct (example (27)).

26. **Deze foto zag ik gisteren in de krant staan**, maar **is zeker drie jaar oud**
‘This picture saw I yesterday in the newspaper stand, but is certainly three years old’
This picture I saw in the newspaper yesterday, but is at least three years old
Van Zonneveld (1992)

27. **Jan zijn kaas is niet te eten** en **koop ik dus niet meer**
‘Jan his cheese is not to eat and buy I therefore no more’
Jan’s cheese is not fit to eat and I therefore don’t buy it anymore

In the above examples, only subjects can be deleted under identity with the object of the first conjunct. One cannot delete objects under identity with the object of the first conjunct. This is shown in the examples (28) and (29), below.

28. Die Briefmarken hat Claus gekauft und will sie jetzt wieder verkaufen
‘The stamps has Claus bought and wants them again sell’
Claus has bought the stamps and he wants to sell them again

29. * Claus hat die Briefmarken gekauft und hat Barbara sofort wieder verkauft
‘Claus has the stamps bought and has Barbara immediately again sold’
Claus has bought the stamps and Barbara has sold them immediately after that
Heycock and Kroch (1992)

Finally, there are cases where missing objects in the second conjunct yield grammatical results. These are the ones, where the missing object is identified with the subject of the first conjunct. This is shown in example (30).

30. Na Zwolle zal deze trein alleen stoppen te Assen en moet je dus niet nemen als je in Meppel moet zijn.
‘After Zwolle will this train only stop in Assen and must you not take if you in Meppel must be’
After Zwolle, this train will only stop in Assen, so you must not take it if you have to go to Meppel
Zwart (1991)

c Verb final / verb second coordination

In German and Dutch, it appears to be possible to coordinate verb final clauses with verb second clauses. The examples I give are due to Höhle (1990) and Van Zonneveld (1992).

31. **Wenn jemand nach Hause kommt** und **da steht der Gerichtsvollzieher vor der Tür**,.....
‘When someone to home comes and there stands the bailiff before the door,.....’
When someone comes home and the bailiff is at the door,...
Höhle (1990)

32. **Als je gepakt wordt** en **je bent al veroordeeld geweest**, dan hang je
‘If you caught are and you are already convicted been, then hang you.’
If you are caught and you have already been convicted before, then you hang
Van Zonneveld (1992)

d Scrambling the second conjunct

Another kind of asymmetric coordination arises in cases Wunderlich (1988) observed. In German, it appears to be quite correct to apply Gapping and/or Right Node Raising, together with some sort of scrambling of the second conjunct. I present three examples adopted from Wunderlich (1988). In all three examples, we see some kind of scrambling in the second conjunct, and we see RNR, Gapping, and combined Gapping/RNR respectively in the examples (33), (34), and (35).

33. a. **Max tritt für die große** und **Anna tritt für die kleine** Lösung ein
b. Max tritt für die große und für die kleine Lösung tritt Anna ein
Max supports the major solution and Anna supports the minor solution

34. Den Korb hat die Tante in das Haus gelegt und in den Hof geworfen der Onkel den Sack
The aunt placed the basket in the house and the uncle threw the bag in the inner yard

35. In das Haus hat die Tante den Korb und den Sack in den Hof geworfen der Onkel
The aunt threw the basket in the house and the uncle threw the bag in the inner yard
Wunderlich (1988)

e Unbalanced coordination or extremely balanced coordination

In this section I mention two cases in which case marking appears to be the main issue, i.e. (36) and (37). In (36) a coordination of two pronouns and an NP is at stake, which could function as a subject of a sentence, although the first pronoun appears in object case.

36. Me and you and a dog named Boo (were travelling and living off the land)

The second example is one with *extraordinary balanced coordination*.[5] In this kind of coordination, all pronouns in a certain position receive the same wrong case marking, like in (37). This example is due to Jorge Hankamer, who mentioned it, answering a Linguist-query of Janne Johannessen on this subject, February 1993.

37. Him and me ate it all

Although some of these asymmetrical coordinations appear to be quite productive, this doesn't mean that the general starting point of treating coordinations as parallel structured expressions, is not correct. In my opinion, the phenomena to be described in this thesis, Right Node Raising, Forward Conjunction Reduction, Gapping, and combinations of these, all appear to rely heavily on parallelism.

We now turn to the outline of this thesis, in section 1.1.3.

1.1.3 Outline of this thesis

This thesis is divided in three chapters. Chapter 1 is mainly concerned with introducing categorial grammar, and with previous accounts of coordination in categorial grammar. In section 1.2, we start however, with a discussion of the transformational approach of coordination. We briefly discuss the arguments Zwarts (1986) brought up against a transformational account of coordination. In fact, Zwarts' arguments rejected transformational syntax, in favour of more flexible syntactic approaches. Categorial grammar is such a flexible framework.

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5 This notion is due to Johannessen (1993), who presents research on a minimalist account of coordination. Among others she investigates unbalanced coordinations and extraordinary coordinations.

In section 1.3, I introduce the categorial framework. We discuss the components of categorial grammar. Furthermore we pay attention to specific lexical category assignments in Dutch, with special attention to subjects, subordinate clauses and finite verbs. After this, we discuss the categorial hierarchy, starting from the applicative AB-grammar, to the extremely flexible Lambek-calculus. Also systems beyond the Lambek-calculus will be mentioned.

Because of its special interest to this study, a detailed introduction of product rules and the Coordination Rule is presented.

In section 1.4, early accounts of coordination in categorial grammar are discussed. Work in this area by Dowty[6] and Steedman[7] is focused. In section 1.5, we conclude that these early accounts lack descriptive adequacy because of the extremely overgenerating grammars that were used by the three authors.

Coordination has been one of the arguments for a flexible approach to syntax. In categorial grammar, this meant that much research has been undertaken in the Lambek-calculus, introduced by Lambek in the late fifties and the early sixties.[8] In chapter 2, we discuss the advantages and disadvantages of flexible categorial systems. I argue that flexibility does more harm than good, when used as a descriptive tool for Dutch. Four arguments against flexibility lead to the claim that for an adequate categorial account of coordination in Dutch, we need a Product-based Applicative Categorial Grammar (PACG).

In chapter 3, the PACG is introduced in detail. An important feature of this grammar is that it consists of a universal part and a language specific part. The universal grammar is built up from unrestricted application and product rules. The language specific grammar rules are subjected to syntactic restrictions.

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6 Dowty (1988).

7 Steedman (1985) and Steedman (1990).

8 Lambek (1958) and Lambek (1961).

In chapter 3, we compare the PACG to Mary Wood's *Thursday Grammar*.[9] Besides some evident similarities, there are noteworthy differences which we pay attention to. Section 3.4 deals with the matter of *constituency*. This notion loses its meaning in flexible categorial grammars, that is grammars in which rules for Functional Composition and Type Lifting are valid. I argue that within the PACG, *constituency* still is a meaningful notion. In section 3.5, some cautious efforts are made to let the PACG account for Gapping and related phenomena.

After the bibliography, a summary in Dutch is presented.

1.2 Transformational approach to coordination

In the framework of transformational grammars coordination phenomena have led to explanations that assign an important role to movement transformations. The question especially has been how surface coordinations could be derived from an underlying source, in cases where the coordinates do not have constituent status. Transformations have been proposed that derive such sequences from conjoined sentences. Most attention has been paid to the movement transformations *Forward Conjunction Reduction* (FCR) or *Left Peripheral Deletion*, and *Right Node Raising* (RNR) or *Right Peripheral Deletion*. They are considered to account for the surface structures. The theoretical question that arises is what the status of the moved sequence is. Taking into account that transformations only can be applied to constituents, the hypothesis was stated that RNR is a necessary and sufficient condition for constituency. The necessary condition implies that if two coordinated sentences have a sequence of words in common which is a constituent, then RNR can be applied.[10] Bresnan (1976) proved that RNR is not a

[9] Wood (1988).

[10] Postal (1974) was the first to claim that Right Node Raising was a necessary condition for constituency.

necessary condition for constituency.[11] This leaves us with the second condition. This one implies that if RNR is applied, the rule always involves a constituent. That is: if RNR is applied, it is applied to constituents. This condition is also clearly wrong, as we shall see in the course of this section. In addition, Levine (1985) notes that RNR doesn't involve displacement at all. According to him, there is consensus on the phrase structure for RNR, which would be something like (38). But for a displaced constituent β to be co-indexed with a gap t_β, t_β should c-command β.[12] As is clear from Reinhart's definition of c-command (Reinhart (1981)), t_β doesn't c-command β.

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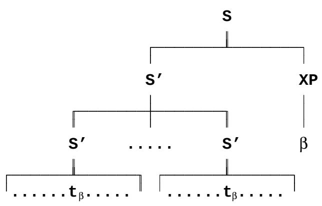

Zwarts (1986) states on the basis of these results that the traditional view on sentential structure has to be abandoned.[13] Below, a brief discussion of his argumentation is presented.

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[11] Bresnan claims that:

> "Right Node Raising is a sufficient but not a necessary test for constituency, as I have pointed out elsewhere (Bresnan (1974))"
> Bresnan (1976: 493)

[12] Levine uses Reinhart's definition of c-command:

> "Node A c-commands node B iff the binding node α_1 most immediately dominating A either dominates B or is immediately dominated by a node α_2 which dominates B, and α_2 is of the same category type as α_1."
> Levine (1985: 495) quoting Reinhart (1981: 612)

[13] Zwarts concludes at the end of his consideration about the developments of the views on coordination:

> "Dergelijke constateringen geven voedsel aan de gedachte dat (...) het traditionele beeld van de zinsbouw op hinderlijke wijze een algemene theorie over coördinatie in de weg staat. En daarmee rijst opnieuw de knellende vraag of we niet radicaal moeten breken met de overgeleverde inzichten inzake constituentenstructuur."
> Zwarts (1986: 39)
> In translation:
> *These statements encourage the idea that (...) the traditional picture of sentential structure inconveniently stands in the way of a general theory on coordination. And this gives rise to the pinching question, whether we should radically do away with the traditional insights on constituent structure.*

Within a transformational grammar, coordination relates to sentences for which the rewriting rule **S** $\rightarrow$ **S and S** is available. There could also be other rewriting rules for conjoining constituents, but a problem arises with non-constituent coordination. In that case, the coordination will have to be transformed from a coordination of sentences.

The sentences (39a) and (40a) are supposed to be derived from (39b) and (40b) by the transformation *Right Node Raising* (RNR), because the sequences *Bobby bedacht* (Bobby contrived) and *Boris vermeed* (Boris avoided), *Viktor bewondert* (Viktor admires) and *Boris haat* (Boris hates) are no constituents.

39. a. **Bobby bedacht** en **Boris vermeed** de combinatie
    b. Bobby bedacht de combinatie en Boris vermeed de combinatie
    Bobby contrived (the combination) and Boris avoided the combination

40. a. **Viktor bewondert** en **Boris haat** briljante tegenstanders
    b. Viktor bewondert briljante tegenstanders en Boris haat briljante tegenstanders
    Viktor admires (brilliant opponents) and Boris hates brilliant opponents

Another movement transformation, introduced in transformational grammar to account for coordination of non-constituents, is *Forward Conjunction Reduction* (FCR). The sentences (41a) and (42a) are the result of applying FCR to the sentences (41b) and (42b). This rule is necessary within the transformational framework, because *de schaakpartij aan zijn tegenstander* (the chess game to his opponent), *zijn ziel aan de duivel* (his soul to the devil), *alle partijen in de voorronde* (all games in the qualifying round) and *de helft van de partijen in de finale* (half of the games in the final) are not considered constituents.

41. a Gheorghiu verkocht **de schaakpartij aan zijn tegenstander** en **zijn ziel aan de duivel**.
    b Gheorghiu verkocht de schaakpartij aan zijn tegenstander en Gheorghiu verkocht zijn ziel aan de duivel.
    Gheorghiu sold the chess game to his opponent and (Gheorghiu sold) his soul to the devil

42. a Bobby won **alle partijen in de voorronde** en **de helft van de partijen in de finale**.
    b Bobby won alle partijen in de voorronde en Bobby won de helft van de partijen in de finale.
    Bobby won all games in the qualifying round and (Bobby won) half of the games in the final

The adequacy of the RNR rule is denied in Zwarts (1986: chapter 1). In the first place the contraction of the joint right part is sometimes obligatory but sometimes it isn't. In the sentences (39) and (40) the contraction is optional, while in example (43) the contraction is obligatory.

43. a. **Jip floot** en **Janneke neuriede** op dezelfde toonhoogte.
  * b. Jip floot op dezelfde toonhoogte en Janneke neuriede op dezelfde toonhoogte.
    Jip whistled and Janneke hummed at equal pitch

In the second place, the meanings of the contraction and the supposed source sometimes differ (see example (44)).

44. a. Jip gaf Janneke en Janneke gaf Jaap boeken die verdacht veel op elkaar leken.
    b. Jip gaf Janneke boeken die verdacht op elkaar leken en Janneke gaf Jaap boeken die verdacht veel op elkaar leken.
    Jip gave Janneke and Janneke gave Jaap books that resembled each other suspiciously

Nevertheless, extreme claims have been made as to the nature of RNR. RNR would be a *necessary* and *sufficient* condition on constituency. The first claim was refuted by Bresnan (1976), who shows that the joint items can be a genuine constituent, while the transformation as such yields an ungrammatical result (see example (45)).

45. * Jack believes but Jill doesn't believe *Jeremiah is a spy*

The second claim, about RNR being a sufficient condition on constituency, is refuted in example (46) which shows a grammatical instance of the RNR-transformation, but in which the joint items in traditional terms do not form a constituent.

46. Jan leende maar zijn vrouw gaf later het boek aan hun kleindochter
'Jan lent but his wife gave later the book to their granddaughter'
Jan lent but his wife later on gave the book to their granddaughter

Now that it is clear that RNR is not a sufficient condition on constituency, it cannot be considered a movement transformation. Zwarts (1986) suggests that the traditional view on syntactic structure and constituency must be thrown overboard, and that it must be replaced by a flexible grammar with a more liberal interpretation of the notion *constituent*. In his dissertation Zwarts provides this by means of the categorial grammar framework.

The application of the rule FCR is also not unproblematic. In the first place, up to now, it appeared to be impossible to define the exact range of this rule, and secondly this rule not infrequently leaves us with extremely complicated analyses of basically simple coordinations. Thus sentence (47) can only be accounted for with the help of the rules RNR and FCR, if one sticks to the view that *Bobby met bestraffende* (Bobby with reproaching) is not a genuine constituent. In flexible categorial grammars, the category of this expression is calculated by means of Functional Composition and Type Lifting. Dowty (1988) calls these sequences *phantom constituents*, and Steedman (1990) refers to them as 'non- standard' constituents. In flexible categorial grammars the sequence *Bobby met bestraffende* is considered a constituent. In the categorial grammar presented in chapter 3 this sequence lacks constituenthood.

47. a. ..., dat de arbiter na de wedstrijd Bobby met bestraffende en Boris met lovende woorden heeft toegesproken.
'... that the arbiter after the match Bobby with reproaching and Boris with praising words has spoken to'
... that after the match the arbiter has spoken to Bobby in reproaching words and to Boris in praising words.
(RNR applied to 47b)

47. b. ..., dat de arbiter na de wedstrijd Bobby met bestraffende woorden heeft toegesproken en Boris met lovende woorden heeft toegesproken.
'... that the arbiter after the match Bobby with reproaching words has spoken to and Boris with praising words has spoken to'
... that after the match the arbiter has spoken to Bobby in reproaching words and has spoken to Boris in praising words.
(FCR applied to 47c)

c. ..., dat de arbiter na de wedstrijd Bobby met bestraffende woorden heeft toegesproken en dat de arbiter na de wedstrijd Boris met lovende woorden heeft toegesproken.
'... that the arbiter after the match Bobby with reproaching words has spoken to and that the arbiter after the match Boris with praising words has spoken to'
... that after the match the arbiter has spoken to Bobby in reproaching words and that after the match the arbiter has spoken to Boris in praising words.

In the categorial framework we pursue at the moment, the syntactical analysis of sentence (47a) shows a simple coordination of equivalent constituents. No underlying, or deep, structures are supposed on which movement transformations would be applied. Coordination can only occur if the expressions involved have the same category. In other words: Identical categorial status seems to be called for when coordinating two or more expressions. We can formulate this as follows:

48. **Coordination hypothesis**
Identical categorial status of expressions is a necessary condition on coordination.

In section 1.1.2 we encountered several classes of counter examples, for which identical categorial status seemed not be a necessary condition on coordination. But we argued that some of these phenomena could nevertheless be treated as coordinations of likes, by introducing the weakening operator.

In the next section, I introduce the categorial framework. The components of categorial grammar, the subject of category assignment, categorial rules and hierarchy of categorial systems, and some rules of special interest to this study will pass in review.

1.3 Categorial Grammar

1.3.1 Introduction

In this section, I discuss the major principles of categorial grammar (section 1.3.2). I present an overview of the categorial grammar rules that have been proposed throughout the years. Categorial grammars are hierarchically ordered, and the ordering is connected with the presence or absence of the various rules. I sketch the hierarchy of categorial grammars, starting with a purely applicative grammar, the so called **AB**-grammar, named after Ajdukiewicz (1935) and Bar-Hillel (Bar-Hillel, Gaifman and Shamir (1960)), and concluding with the grammar **LPCE**, that is the **L**-grammar, named after Lambek (1958, 1961), supplemented with rules for *Permutation*, *Contraction* and *Expansion* (section 1.3.4).

This chapter provides the notions on which the discussions in the following chapters are based. I will take a stand on some issues in Dutch syntax, for example concerning the categorization of main clauses and subordinate clauses (section 1.3.3). Furthermore, I will argue that Dutch is a language with disharmonic structures. Especially, the verb clustering in Dutch is responsible for these disharmonic structures. This leads necessarily to the introduction of a Disharmonic Composition Rule in a categorial syntax for Dutch, despite the claim that verb clustering might to a large extent be accounted for in the lexicon.[14] We discuss this issue in section 1.3.5.

In section 1.3.6, I present the product rules, that play a prominent role in this study. In section 1.3.7, I address to the extraordinary status of the coordination rule in categorial grammar, and finally in section 1.3.8, I present the outlines of the grammar I propose in chapter 3.

The categorial notation used in this study, is the Lambek notation. This means that arguments will be notated below the slash. X/Y is a right looking function,

---

[14] Cf. Moortgat (1988) and Hoeksema (1991).

which applies to arguments of category Y. The resultant has category X. B\A is a left looking function, which applies to arguments of category B to yield an A.

1.3.2 The components of categorial grammar

Categorial grammars are formal systems for the description of languages. Categorial grammars consist of rules of how words and sequences of words are put together to result in well formed complex expressions. The categories that are assigned to lexical items contain the information of how the expressions can be combined with other word sequences to yield well formed expressions. The information includes what the resulting category of the combined expression is. In this way, for example, expressions of the category that is traditionally called VP (for example *wins*), are encoded for combining with a noun of category NP (for example *Kasparov*) to yield a well formed expression of the category S (sentence, for example *Kasparov wins*). We say that the grammar recognizes the sequence *Kasparov wins* as a sentence of the language.

There are several correspondences between phrase structure grammar and categorial grammar. Thus, Standard categorial grammar, the applicative AB-grammar to be discussed below, is equivalent to context free phrase structure grammar. There are also numerous differences. One important difference is the function/argument structure in categorial grammar. Some categories act as functions, whereas others act as arguments. Functions are applied to their arguments, and in this way a mathematical ordering of expressions is established. Another difference is the infinite number of categories in categorial grammar. This can be drawn from the definition of categories in categorial grammar, as we will show below. In some categorial systems there is a limited use of categories, for example in applicative grammars. But in more flexible categorial grammars, like the Lambek-calculus, no limit can be imposed on the complexity of categories.

The notion of *Categorial Grammar* is laid down in the following definition, adopted from Levelt (1973).

49. **Categorial Grammar**
A categorial grammar for language L consists of five elements:
a. a *vocabulary* V, that contains all the words of the language L to be described;
b. a set of *basic categories* C_b, in which a special element **s** (for sentence) appears;
c. *category formation rules* R_i, that state how complex categories are derived from the basic categories;
d. a *lexical function* F, that assigns one or more categories to all words in the vocabulary;
e. a *syntax* Z, consisting of rules designating how a sequence of expressions is recognized as a complex well formed expression, and what category this expression has;

As an illustration, I present a categorial grammar for language L_1, consisting of the set of sentences {Kasparov wins, Short wins, Kasparov beats Short, Short beats Kasparov}.

50. $CG(L_1)$ = (V, C_b, $R_{1,2}$, F, Z)
a. V = {Kasparov, Short, wins, beats}
b. C_b = {s, n}
c. R_1 : If X and Y are categories, then Y\X is a category
R_2 : If X and Y are categories, then X/Y is a category
d. F : Kasparov ⇒ n
Short ⇒ n
wins ⇒ n\s
beats ⇒ (n\s)/n
e. Z : 1. Y Y\X ⇒ X
2. X/Y Y ⇒ X

The recursive definition of *category* in (50c) indicates that there are infinitely many categories, of which only four are used in $CG(L_1)$. These categories are **s**, **n**, **n\s**, and **(n\s)/n**.

In categorial grammar, the ideas of Frege (1892) that expressions of a language can be divided in complete and incomplete expressions have been incorporated. Incomplete expressions are those linguistic items that need other linguistic material to reach completion. Complete expressions do not have this need. In categorial grammar, this Fregean notion has its equivalent in the notion *function*. Incomplete expressions correspond with *functions*, or *functors*; complete expressions correspond to members of basic categories. These can only function as *arguments*.

The categories **s** and **n** in the grammar CG(L_1) are the basic categories. The functor category **n\s** must be read as ‘looks for an expression of category **n** to the left, to form an expression of category **s**’. This description can be compared to the mathematical notion of *function*. A function assigns a value to each argument. The function **f** in the formula $f(x)=x^2$ assigns to each argument **x** of a certain domain, the function value x^2. Accordingly, **n\s** is a function that assigns the function value **s** to each argument **n**. Function categories are often called *unsaturated expressions*, because these expressions are looking for arguments. Observe that in CG(L_1) **s** and **n** are the only categories for complete expressions. The other categories are, on the basis of R_1 and R_2, of the form Y\X or X/Y, and therefore unsaturated. The issue of functions as incomplete expressions is at a larger extent discussed in section 1.3.4.

The syntactical rules $\mathbf{Z_1: Y\ Y\backslash X \Rightarrow X}$ and $\mathbf{Z_2: X/Y\ Y \Rightarrow X}$ are called *application rules*. Z_1 is the rule for *Left Application* (LA) and Z_2 is the rule for *Right Application* (RA). The CG(L_1) analysis of the sentence *Kasparov beats Short* is given in (51).

```
51.      Kasparov  beats   Short
            n     (n\s)/n    n
            |              |____|RA
            |               n\s
            |_______________|LA
                    s
```

Grammars in which all function categories look for their arguments in the same direction, are called *unidirectional grammars*. The grammar CG(L_1) presented here makes use of both left oriented and right oriented function categories. Therefore, the grammar is called *bidirectional*. Grammars in which the functions are indifferent with respect to the direction the arguments have to be searched for, are called *non-directional*. For the description of languages with a free word order a non-directional categorial grammar is eminently suitable. Let L_1’ consist of all sentences of L_1, plus all permutations of those sentences. It is appears to be the case that all sentences of L_1’ can be described by the non-directional application rules of (52). The symbol ‘|’ is used as the non-directional fractional slash.

52. a. $X|Y\ Y \Rightarrow X$
    b. $Y\ X|Y \Rightarrow X$

This doesn't mean, however, that for every language L_α non-directional applicative systems recognize all permutations of grammatical sentences as well formed expressions of the language. This can easily be demonstrated with grammar $CG(L_2)$ below.

53. $CG(L_2)$ = $(V, C_b, R_{1,2}, F, Z)$
    a. V = {Kasparov, is, unbeatable}
    b. C_b = {s, n, a}
    c. R_1 : If X and Y are categories, then X|Y is a category
    d. F : Kasparov $\rightarrow$ n
    is $\rightarrow$ (s|n)|a
    unbeatable $\rightarrow$ a
    e. Z : 1. $Y\ X|Y \Rightarrow X$
    2. $X|Y\ Y \Rightarrow X$

These rules can recognize the sentences in (54), (55), (56), and (58) as well formed sentences of language L_2, but cannot account for the word orders in (57) and (59). The reason for this is that the function *is* and the first argument *unbeatable* are not adjacent to each other in (57) and (59). In both cases the noun *Kasparov* is in between the two expressions.

54. $[_n$Kasparov] $[_{(s|n)|a}$is] $[_a$unbeatable]
55. $[_n$Kasparov] $[_a$unbeatable] $[_{(s|n)|a}$is]
56. $[_{(s|n)|a}$is] $[_a$unbeatable] $[_n$Kasparov]
57. $[_{(s|n)|a}$is] $[_n$Kasparov] $[_a$unbeatable]
58. $[_a$unbeatable] $[_{(s|n)|a}$is] $[_n$Kasparov]
59. $[_a$unbeatable] $[_n$Kasparov] $[_{(s|n)|a}$is]

Languages that do not exhibit a completely free word order, but for which a non-directional syntax is used, can compensate for this with a so called *word order convention* (see Flynn (1985)). A word order convention is a general statement on the directionality of function categories. Flynn's idea behind word order conventions was to make generalizations as to which functors are right looking and which are left looking, rather then to stipulate the direction of each functor category in the lexicon. A word order convention in a highly general form is given in (60). The word order convention by Flynn is shown in (61).

60. **Word order convention (general)**
A function with the structure X looks for its argument to the left;
A function with a structure different from X looks for its argument to the right.

61. **Word order convention for English (Flynn)**
If some phrase φ is of category X|Y and φ contains a major category, then X|Y is to be regarded as Y\X. Otherwise, X|Y is to be regarded as X/Y.
Flynn (1985: 26)

In Flynn's terminology a *major category* is any category whose resultant category is **t** (or, adapting the notational convention in this section, **s**). With this word order convention, Flynn can make predictions about English word order (63), on the basis of the categorizations in (62). Flynn assigns the category $(s|n)_V$ to infinitivals, and he treats *tense* as an item with category $(s|(s|(s|n)))|(s|n)_V$.

62. every $\rightarrow$ (s|(s|n))|(s|n)
man $\rightarrow$ s|n
tense $\rightarrow$ $(s|(s|(s|n)))|(s|n)_V$
love $\rightarrow$ $(s|n)_V|(s|(s|n))$
Mary $\rightarrow$ s|(s|n)

Common nouns and verb phrases both have the category **s|n**, but should be distinguished. Therefore, Flynn uses a feature [+ verbal] to mark verb phrases (Flynn (1985: 33)).

```
63.          every      man            tense             love           Mary
     (s|(s|n))|(s|n)  s|n  (s|(s|(s|n)))|(s|n)v  (s|n)v|(s|(s|n))  s|(s|n)
             └────────┘              │              └──────────────┘
               s|(s|n)               │                    (s|n)v
                  │                  └─────────────────────┘
                  │                           s|(s|(s|n))
                  └─────────────────────────────┘
                                s
```

In (63), *every* and *love* are functors looking to the right for the argument, because these expressions do not contain major categories. The same holds for the functor *tense*. But in step three we are dealing with the functor category s|(s|(s|n)), which is a major category. It therefore looks for its argument, the subject, to the left.

Word order conventions didn't take root in the categorial enterprise. Most categorial treatments of languages with strict word orders, such as English and Dutch, make use of a directional categorial syntax. In this study I will do so as well. Strict word order is more naturally accounted for by a directional grammar. So, determiners are right-looking functors, and they are categorized as such, rather than to stipulate why a non-directional category should look to the right for its argument.

Another issue in categorial syntax is the assignment of categories. In (64), I present a list of categorizations I will use in this study, and the corresponding category in phrase structure grammar.

64.

Categories in categorial grammar	Categories in phrase structure grammar
S, B	S
(B/VP)\S, VP	VP
NP	NP
(B/VP)\(S/NP), NP\VP	TVP
N	N
NP/N	Det
N/N	A

Research in categorial grammar is mostly directed to defining syntactic calculi for the description of natural language phenomena. Not much attention is paid to initial category assignments of the lexical elements. The categories S, VP, NP and N are very common in categorial grammar, but the use of category B needs some additional explanation. Briefly, S and B correspond to matrix and subordinate clauses, respectively. I will address this issue in section 1.3.3. Furthermore, we will encounter the category NPs, which is an abbreviation of B/VP. The above categorizations imply two categories for verb phrases. In main clauses, the category for the verb phrase is (B/VP)\S, and in subordinate clauses, the category for the verb phrase is VP. In section 1.3.3 we return to this issue.

In earlier categorial work, for example Lambek (1958,1961), a categorial grammar is proposed, only using two basic categories, **s** and **n**. This approach is highly influenced by semantics, but also suffers from it. The category **s** is used for sentences, and the category **n** for proper nouns. Other categories are derived from these two, like **n\s**, the category for verb phrases. A proper noun together with a verb phrase constitutes a sentence. Expressions with the semantic type **n**, corresponding to the syntactic category **n**, refer to objects in the universe of discourse. Expressions with the semantic type **n\s**, corresponding to the syntactic category **n\s**, refer to sets of objects. So the expression *sleep* refers to the set of objects that are asleep. But many noun phrases, like *two men*, do not refer to objects, and therefore are not assigned the semantic type **n**. Because the expression *two men*, together with *sleep*, forms a sentence, the semantic type of *two men* is said to be **s/(n\s)**. The expression *two men* refers to the set of sets which contain at least two men. These categories can be assigned the syntactic category **np**. Because proper nouns have the same distributional properties as these expressions of category **np**, Montague (1973) treated all proper nouns as **np**. This would affect Lambek's grammar in such a way, that although there are only two basic categories, there is not one representative of the category **n**. In the remainder of this study, we will follow Montague's approach, and assign all proper nouns and noun phrases the category **np**. Categories will, furthermore, be notated in capitals, like **NP**. Transitive verbs will thus not be assigned the category **(n\s)/n**, as in Lambek's work, but the category NPs\(S/NP). The difference between NP and NPs will be explained in the next section, as well as the deviating bracketings.

1.3.3 Subject NP and subordinate clauses

The matter of the word order differences between Dutch main clauses and subordinate clauses gives rise to postulating multiple categories for the tensed verb (see Steedman (1983) and Houtman (1984)). As Steedman (1983) pointed out, these differences are justified by coordinations with *noch*. In example (65a), the coordination with *noch* of the two VP's is grammatical, whereas in (65b) this coordination is ungrammatical. On this ground, Steedman argues that the VP should be treated as a syntactical unit in subordinate clauses, but not in main clauses. In main clauses, the subject and the tensed verb should form a unit first.

65. a. ..., omdat Timman noch Short verslaat noch Karpov op remise houdt
‘..., because Timman nor Short beats nor Karpov on draw holds’
..., because Timman neither beats Short nor draws with Karpov

* b. Timman noch verslaat Short noch houdt Karpov op remise
‘Timman nor beats Short nor holds Karpov on draw’
Timman neither beats Short nor draws with Karpov

In main clauses the tensed (transitive) verb is assigned the category **(B/VP)\(S/NP)**, whereas in subordinate clauses, where the subject and the tensed verb are usually far apart, the tensed verb is assigned the category **NP\VP**. **B/VP** is in main clauses mostly abbreviated as **NPs** (subject NP). The category **B** is used for subordinate clauses (*bijzinnen* in Dutch), while **S** is used as the category for main clauses. This way we can account for the fact that in main clauses only main clause word orders are accepted, and in subordinate clauses only subordinate clause word orders.

```
66.   a.  De hond      bijt        de kat
           B/VP   (B/VP)\(S/NP)     NP
            |___________|            |
                S/NP                 |
                 |___________________|
                          S
```

The dog bites the cat

```
    * b.  De hond de kat      bijt
           B/VP     NP    (B/VP)\(S/NP)

67. * a.  De hond  bijt  de kat
           B/VP    NP\VP   NP

67.   b.  De hond  de kat  bijt
           B/VP      NP    NP\VP
            |         |_______|
            |             VP
            |_____________|
                  B
```

Although the question of assigning categories arises once in a while, the syntactic machinery and the applicability of various kinds of reduction schemes is more often subject to linguistic argumentation. In section 1.3.4, I will present a wide variety of categorial rule schemata that have found a place in the categorial tradition. I will also go into the hierarchy of categorial systems.

1.3.4 Rules and hierarchies

In this section I will present various categorial rules which have been motivated and defended in the categorial tradition. Depending on the presence or absence of categorial rules in a categorial grammar, we can make statements on the place of the grammar in the hierarchy of categorial grammars. We will successively discuss the various categorial grammar systems, beginning with the applicative grammar, named *AB-grammar*, after Ajdukiewicz (Ajdukiewicz (1935)) and Bar-Hillel (Bar-Hillel, Gaifman and Shamir (1960)). By adding Composition Rules, we reach the *K-grammar*, named after Karlgren (Karlgren (1978)). By adding Type Lifting rules to the K-grammar, the so called Free Categorial Grammar, or *F-grammar*, investigated by Cohen (Cohen (1967)), is established. Next, we turn to the *Lambek-calculus* (Lambek (1958), Lambek (1961)), presented as a Gentzen-style proof system. Finally, we discuss extensions of the Lambek-calculus.

a. AB-grammar

Putting incomplete expressions together with the linguistic material they need in the completion process, corresponds with applying functions to their arguments. This is called *Application*. Application is the basic rule of categorial grammar. In using a categorial syntax for Dutch, a language with a strict word ordering, we only investigate directional categorial rule systems in this study. As a consequence of this, we can distinguish two application rules, *Right Application* (RA) and *Left Application* (LA), laid down in (68) and (69), and exemplified in (70).

68. **Right Application (RA)**
    X/Y Y ⇒ X

69. **Left Application (LA)**
    Y Y\X ⇒ X

```
70.       Kasparov   verslaat   Short
             NPs    NPs\(S/NP)    NP
             |__________| LA       |
                 S/NP              |
                  |________________| RA
                          S
```

Kasparov beats Short

In Zwarts (1986) the hierarchy of categorial grammars is explored. A categorial grammar that only makes use of the application rules is called an *AB-grammar*, after Ajdukiewicz (1935) and Bar-Hillel, Gaifman & Shamir (1960).

b. K-grammar

With the application rules **RA** and **LA**, the arsenal of syntactic rules is by no means exhausted. It is also possible to consider grammars in which, under certain conditions, two functions can be put together to yield a complex function. This putting together of functions is called *Functional Composition*. Its result is analogous to the mathematical rules for multiplying fractions. But the composition of functions is only possible if the *denominator* (what is below the fractional slash) of the main function equals the *numerator* (what is above the fractional slash) of the subordinate function. The numerator of the composed function equals the numerator of the main function and the denominator of the composed function equals the denominator of the subordinate function. In contrast to the multiplication of fractions, functional composition in categorial grammar is not commutative.

In (71), the composition of (mathematical) functions is shown. In (72), I show how functional composition is performed in categorial grammar, and in (73) it is shown that unlike the mathematical rules for multiplying fractions (73a), functional composition is not commutative (73b).

71. **Composition of (mathematical) functions**
$(f \circ g)(x) \equiv f(g(x))$

72. Let **f** be X/Y, **g** be Y/Z, and **x** be Z.
f(g(x)) = X/Y (Y/Z (Z))
= X/Y (Y)
= X
(f∘g)(x) = (X/Y Y/Z) (Z)
= X/Z (Z)
= X

73. a. $\frac{1}{3} \cdot \frac{3}{4} = \frac{3}{4} \cdot \frac{1}{3} = \frac{1}{4}$
b. Let **f** and **g** be as in (72), then
(f∘g) = X/Z, and
(g∘f) is undefined, because the denominator of **g** doesn't equal the numerator of **f**.

Functional Composition can appear in harmonic and disharmonic variants. The condition that can be posed on the harmonic variant of functional composition, is that the direction of both functors has to be the same. If both functors are right oriented, we speak of *Right Composition* (RC). If both functors are left oriented, then the composition is referred to as *Left Composition* (LC). The harmonic composition rules are laid down in (74) and (75). We will discuss Disharmonic Composition in section 1.3.5.

74. **Right Composition (RC)**
X/Y Y/Z ⇒ X/Z

75. **Left Composition (LC)**
Z\Y Y\X ⇒ Z\X

The rules for functional composition allow for noun phrase analyses where the determiner can be joined with an adjective, and afterwards with a common noun (76). This is different from the standard analysis, in which the adjective and the common noun are put together first, and joined afterwards with the determiner (77). The rules for functional composition are motivated by coordination of incomplete expressions (see (78) and (79)).

```
76.      de   witte pion
        NP/N   N/N   N
         |_______|RC |
          NP/N       |
            |________|RA
                NP
```

the white pawn

```
77.      de   witte pion
        NP/N   N/N   N
         |      |____|RA
         |         N
         |_________|RA
             NP
```

```
78.      de   witte  en   de   zwarte pion
        NP/N   N/N    |  NP/N   N/N    N
         |______|RC   |   |______|RC  |
           NP/N       |     NP/N      |
             |________|______|        |
                   NP/N               |
                     |________________|RA
                            NP
```

the white and the black pawn

```
79.  Jan   beweert    dat  de ene schaker  wil    en   de andere schaker   kan  winnen
                           --------------          |    ----------------
     NPs  NPs\(S/B')  B'/B      B/VP      VP/VP    |         B/VP         VP/VP   VP
      |______|LA       |         |__________|RC    |          |____________|RC    |
       S/B'            |              B/VP         |              B/VP            |
        |              |               |___________|_______________|              |
        |              |                         B/VP                             |
        |              |                           |______________________________|RA
        |              |                                          B
        |              |__________________________________________|RA
        |                                B'
        |________________________________|RA
                      S
```

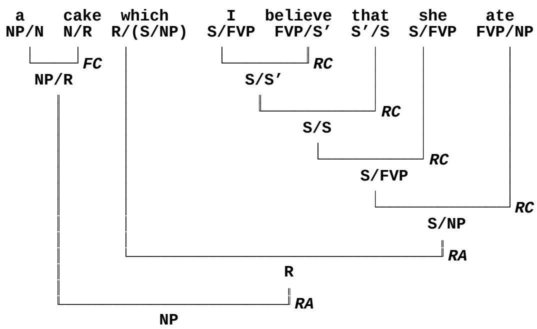
'Jan claims that the one chess player wants and the other chess player can win'
Jan claims that the one chess player wants to win and the other chess player is able to win

The standard motivations for Functional Composition, as Dowty notes, are extraction and unbounded dependencies.

> "[Functional Composition] is supposed to render the 'slash category' mechanism of GPSG unnecessary for describing long distance (extraction) dependencies, as we can instead analyze a gap-containing constituent such as a relative clause as a constituent missing a NP but otherwise put together, with the aid of functional composition, using the same categories as non-extraction constructions."
> Dowty (1988: 153)

Unbounded dependencies can straightforwardly be accounted for by Functional Composition, as Dowty shows (see example (80)).

80.



Dowty (1988: 154)

The categorial grammar using only rules for Application and Functional Composition is called *K-grammar*, named after Karlgren (1978). The combination of these two kinds of rules cedes the property that with every non-ambiguous expression only one syntactic structure is associated.

c. F-grammar

Besides the rules for Application and Functional Composition, there is the rule of *Category Raising* or *Type Lifting* (TL). This is not a reduction rule in the sense that two expressions of certain types are reduced to one expression of another type. Instead, it is a one-place type-changing rule. Type Lifting has two effects. In the first place it raises the *order* of the expression and secondly it induces a switch of function-argument relations. Before illustrating the consequences of

Type Lifting, I will first define the notion *order*.[15] In definition (81), the order of category X is denoted by **O(X)**, where C_b is the set of basic categories.

81. **Order**

O(X)	=	0, if $X \in C_b$;
O(X/Y)	=	O(Y\X) = O(X), if O(X) > O(Y);
O(X/Y)	=	O(Y\X) = O(Y)+1, if O(X) ≤ O(Y).

According to this definition the order of a verb phrase equals 1, and the order of determiners and adjectives equals 2.

82.
a. O(VP) = O(n\s) = O(n)+1 = 1
b. O(Det) = O(NP/N) = O((s/(n\s))/(s/n)) = O(s/(n\s)) = O(n\s)+1 = O(n)+2 = 2
c. O(A) = O((s/n)/(s/n)) = O(s/n)+1 = O(n)+2 = 2

Type Lifting is a type changing operation that raises the order of the expression. For proper nouns it is assumed that they can also function as noun phrases. Evidence for this is found in conjunctions of proper nouns and noun phrases. In example (83), it appears that the zero-order category **n** for proper nouns has to be raised to the second-order category **s/(n\s)** (=NP) for noun phrases. In (84), the Type Lifting rules are defined.

83.
```
Barbara           en  haar  broertje  schaken
   n              |   NPs/N    N       NPs\S
   |TL            |     |______|RA       |
s/(n\s) = NPs     |        NPs           |
   |______________|_________|            |
                 NPs                     |
                  |______________________|LA
                              S
```

Barbara and her little brother play chess

[15] In Van Benthem (1986), order is defined as below. In this definition **e** and **t** are the only basic categories. This definition is equivalent to the one in the text, if in (81) we consider **e** and **t** to be the only basic categories.
o(e) = **o**(t) = 0
o((a,b)) = max(**o**(a)+1,**o**(b))
Van Benthem (1986: 65)

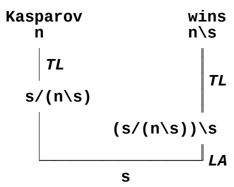
84. **Type Lifting (TL)**

a. X $\Rightarrow$ Y/(X\Y)

b. X $\Rightarrow$ (Y/X)\Y

Notice that the two slashes in these formulas have opposite directions. This means for example, that if (84) were unrestricted, we can always reverse function/argument relations. I illustrate this in example (85). Initially the noun *Kasparov* is the argument of *wins*. After lifting the category for *Kasparov* from **n** to **s/(n\s)** this item becomes a function over expressions of type **n\s**, in this case *wins*. After raising the type of *wins* we get the initial function-argument relation back.

85.



By adding the rules for Type Lifting to the K-grammar we establish the so called Free Categorial Grammar, or *F-grammar*, elaborated by Cohen (1967). It is obvious that the rules of Type Lifting, together with the rules for Functional Composition result in infinitely many syntactic analyses of each sentence of a language.

d. Lambek-calculus

The design of the Lambek-grammar is somewhat different from the grammars we described above. Lambek (1958,1961) presented his grammar as a calculus, that is, as a couple of axioms with some additional inference rules. These inference rules allow us to derive theorems from the axioms. In this section, I will show some examples of theorems which can be derived. But first of all, I will present the calculus Lambek originally proposed in (1958). After that, I give the Gentzen-style notation of the calculus, with which Lambek (1958) proved the decidability of the calculus. The Gentzen-style notation has become common in the categorial tradition.

86. **The Lambek-calculus**

Axioms

a $X \Rightarrow X$
b $(XY)Z \Rightarrow X(YZ)$
b' $X(YZ) \Rightarrow (XY)Z$

Inference rules

c if $XY \Rightarrow Z$ then $X \Rightarrow Z/Y$
c' if $XY \Rightarrow Z$ then $Y \Rightarrow X\backslash Z$
d if $X \Rightarrow Z/Y$ then $XY \Rightarrow Z$
d' if $Y \Rightarrow X\backslash Z$ then $XY \Rightarrow Z$
e If $X \Rightarrow Y$ and $Y \Rightarrow Z$ then $X \Rightarrow Z$

The first axiom states that the reduction relation is reflexive.[16] The other two axioms embody the associativity of concatenation. In chapter 3, I will make an explicit use of this associativity with respect to the product operator (i.e. the concatenation operator). The inference rules c and c' take care of the claim that in a given sequence XY, either X and Y can be the functor. This means that there is no rigid function/argument structure in the Lambek-calculus. The inference rules d and d' indicate the validity of application, whereas inference rule e embodies the transitivity of the reduction relation. The arrow '⇒' is, according to Lambek (1958), a relation between pairs of types, since he writes 'xy' for 'x.y'.

In Lambek (1958) it has been proved that the Lambek-calculus is decidable. This means that every theorem that is provable can be proved in finitely many steps. Furthermore, we can prove in finitely many steps that every other assertion is non-derivable. The status of every assertion can thus be proved in finitely many steps. For the decidability procedure Lambek used a Gentzen-style notation, equivalent to the notation above. The equivalence is proved in Lambek (1958). Instead of products, sequences of categories are used. Capitals refer to sequences of categories, whereas small characters refer to categories. Some sequences are referred to as U,x,V, where no distinction is made between (U,x),V and U,(x,V). This doesn't hurt, however, because of the associativity of the product operator in the Lambek-calculus (see the axioms (86b) and (86b')). The Lambek-calculus in Gentzen-style is presented in (87).

---

[16] The explanatory remarks are to a large extent adopted from Hoeksema (1983).

87. **The Lambek-calculus (Gentzen-style)**

Axiom

A $X \Rightarrow X$

Inference rules

I1	$T,Y \Rightarrow X \models T \Rightarrow X/Y$	Introduction
I2	$Y,T \Rightarrow X \models T \Rightarrow Y\backslash X$	Introduction
I3	$T \Rightarrow Y$ and $U,X,V \Rightarrow Z \models U,X/Y,T,V \Rightarrow Z$	Elimination
I4	$T \Rightarrow Y$ and $U,X,V \Rightarrow Z \models U,T,Y\backslash X,V \Rightarrow Z$	Elimination
I5	$U,X,Y,V \Rightarrow Z \models U,X{*}Y,V \Rightarrow Z$	Elimination
I6	$P \Rightarrow X$ and $Q \Rightarrow Y \models P,Q \Rightarrow X{*}Y$	Introduction

Cut

C	$T \Rightarrow X$ and $U,X,V \Rightarrow Y \models U,T,V, \Rightarrow Y$	Transitivity of derivations

The inference rules *I1* and *I2* introduce the slash operators / and \. The rules *I3* and *I4* eliminate the operators / and \. Rule *I5* eliminates the product operator and *I6* introduces the product operator. The cut rule *C* refers to the transitivity of derivations.

From this new set of axiom, inference rules and cut rule, we can derive lots of theorems. An important feature of the categorial rules, that were introduced in the previous section, is that these rules are not part of the Lambek-calculus as such, but can be proved to be theorems within the calculus. Thus, we can prove the derivability of *Right Application*, *Left Application*, *Right Composition*, *Left Composition* and *Type Lifting*, rules that were part of Cohen's Free Categorial Grammar (F-grammar, Cohen (1967)). We will present these proofs in (88) to (93).

At the top of the proofs only axioms are allowed as premises. We will also allow already proved theorems to appear at the top of a derivation, in order not to repeat these parts of the proof. We will, therefore, treat proven theorems as axioms. Each derivational step is marked by underlining the premises. The character in italics indicates which inference rule is responsible for the conclusion under the line. The derivation is completed when the theorem is written down as conclusion.

88. **Theorem T1: Right Application**

x/y y ⇒ x

Proof

x ⇒ x y ⇒ y

———————————— *I3*

x/y y ⇒ x

89. **Theorem T2: Left Application**

y y\x ⇒ x

Proof

y ⇒ y x ⇒ x

———————————— *I4*

y y\x ⇒ x

90. **Theorem T3: Right Composition**

x/y y/z ⇒ x/z

Proof

z ⇒ z x/y y ⇒ x (T1)

—————————————————— *I3*

x/y y/z z ⇒ x

—————————— *I1*

x/y y/z ⇒ x/z

91. **Theorem T4: Left Composition**

z\y y\x ⇒ z\x

Proof

z ⇒ z y y\x ⇒ x (T2)

—————————————————— *I4*

z z\y y\x ⇒ x

—————————— *I2*

z\y y\x ⇒ z\x

92. **Theorem T5: Type Lifting 1**

x ⇒ (y/x)\y

Proof

y/x x ⇒ y (T1)

——————————— *I2*

x ⇒ (y/x)\y

93. **Theorem T6: Type Lifting 2**

$x \Rightarrow y/(x\backslash y)$

Proof

$x\ x\backslash y \Rightarrow y$ (T2)

———————————— *I1*

$x \Rightarrow y/(x\backslash y)$

Other rules are provable which are not part of the F-grammar discussed before. Among these are the *Geach Rules*, also called *Division (main functor)*.[17] Furthermore, the theorems *Associativity*, *Division (subordinate functor)*, *Strong Composition*, *Strong Division* and the *Dekker Paradox* are provable. All these rules have left and right duals. Each time, we will only prove one of them.

94. **Theorem T7: Associativity**

$(z\backslash x)/y \Rightarrow z\backslash(x/y)$

Proof

$y \Rightarrow y \quad z\ z\backslash x \Rightarrow x$ (T2)

—————————————————— *I3*

$z\ (z\backslash x)/y\ y \Rightarrow x$

——————————————— *I1*

$z\ (z\backslash x)/y \Rightarrow x/y$

———————————— *I2*

$(z\backslash x)/y \Rightarrow z\backslash(x/y)$

95. **Theorem T8: Geach Rule 1**

$x/y \Rightarrow (x/z)/(y/z)$

Proof

$x/y\ y/z \Rightarrow x/z$ (T3)

————————————— *I1*

$x/y \Rightarrow (x/z)/(y/z)$

---

[17] Cf. Moortgat (1988).

96. **Theorem T9: Division (subordinate functor) 1**
y/z ⇒ (x/y)\(x/z)

Proof
x/y y/z ⇒ x/z (T3)
——————————— *I2*
y/z ⇒ (x/y)\(x/z)

97. **Theorem T10: Strong Composition**
a\(b\c) c\d ⇒ a\(b\d)

Proof
a ⇒ a b\c c\d ⇒ b\d (T4)
—————————————————— *I4*
a a\(b\c) c\d ⇒ b\d
——————————— *I2*
a\(b\c) c\d ⇒ a\(b\d)

98. **Theorem T11: Strong Division**
x/y ⇒ (x/(z\y))/z

Proof
x/y y ⇒ x (T1) z z\y ⇒ y (T2)
———————————————————— *C*
x/y z z\y ⇒ x
————————— *I1*
x/y z ⇒ x/(z\y)
—————————— *I1*
x/y ⇒ (x/(z\y))/z

99. **Theorem T12: Dekker's paradox**
x/x ⇒ (y/(x\y))/x **and** y/y ⇒ (y/(x\y))/x

Proof
x/x x ⇒ x (T1) x x\y ⇒ y (T2)   y/y y ⇒ y (T1) x x\y ⇒ y (T2)
– *C*
——————————————————— *C*
x/x x x\y ⇒ y   y/y x x\y ⇒ y
————————— *I1*   —————————————— *I1*
x/x x ⇒ y/(x\y)   y/y x ⇒ y/(x\y)
—————————— *I1*   ———————————————— *I1*
x/x ⇒ (y/(x\y))/x   y/y ⇒ (y/(x\y))/x

In the examples below, I will present some applications of the theorems T7 to T12.

```
100.     Barbara     is         gek       op   Simon
           NPs   NPs\(S/AP)     AP/PP      PP/NP  NP
            └───────┘LA           │T8         │     │
              S/AP                │           │     │
               │          (AP/NP)/(PP/NP)     │     │
               │                  └──────────┘RA    │
               │                      AP/NP         │
               │                        └──────────┘RA
               │                              AP
               └─────────────────────────────┘RA
                               S
```

Barbara is fond of Simon

```
101.     Barbara     is      gek       op          Simon
           NPs   NPs\(S/AP)  AP/PP     PP/NP         NP
            └───────┘LA       │          │T9          │
              S/AP            │   (AP/PP)\(AP/NP)     │
               │              └──────────┘LA          │
               │                 AP/NP                │
               │                   └─────────────────┘RA
               │                            AP
               └───────────────────────────┘RA
                               S
```

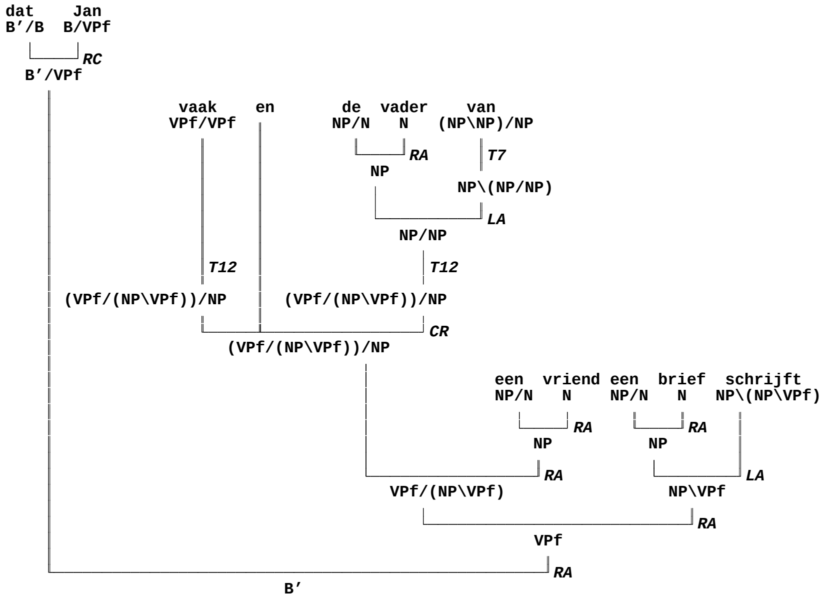
```
102.     dat   Barbara  het  ijsje  aan  Simon   gegeven      heeft
         B'/B   B/VPf   NP/N   N   PP/NP  NP  PP\(NP\VPp)  VPp\VPf
          └──────┘RC     └─────┘RA   └─────┘RA   └─────────────┘T10
           B'/VPf          NP         PP        PP\(NP\VPf)
             │             │          └─────────────┘LA
             │             │                NP\VPf
             │             └──────────────────┘LA
             │                        VPf
             └───────────────────────┘RA
                       B'
```

‘that Barbara the ice-cream to Simon given has’
that Barbara has given the ice-cream to Simon

```
103.     Barbara    heeft      een  ijsje gegeten
           NPs   NPs\(S/VPp)  NP/N   N   NP\VPp
            └───────┘LA         └────┘RA    │
              S/VPp               NP        │
               │T11               │         │
         (S/(NP\VPp))/NP          │         │
                 └────────────────┘RA       │
                   S/(NP\VPp)               │
                      └────────────────────┘RA
                                S
```

‘Barbara has an ice-cream eaten’
Barbara has eaten an ice-cream

104. *



Theorem T12 poses a major problem for natural language grammars based upon the Lambek-calculus. The theorem claims that the categories of two arbitrary modifiers X/X and Y/Y can be transposed to one and the same category. In chapter 2 we will discuss this outcome in relation to the claim that coordination requires to a large extent parallelism of the conjuncts. Sentence (104) shows an analysis of ungrammatical coordination that nevertheless satisfies the parallelism requirement.

e. Beyond the Lambek-calculus

There are, furthermore, systems beyond the Lambek-calculus, of which I mention *LP*, *LPC* and *LPCE*. The system *LP* is obtained by adding a permutation rule to the Lambek-grammar. This rule says that whenever from a string Σ of categories we can derive some category X, we can also derive X from permutations of Σ. Or in a more formal notation:

105. **Permutation**
$T \Rightarrow X$, if permute (T,P) and $P \Rightarrow X$

From this permutation scheme, more specific permutation rules can be derived, like the ones in (106). As Moortgat (1988: 83-85) shows, this rule is needed for the derivation of sentences with a fronted wh-element (107). This wh-element is an argument to the left of the functor it must be composed with, while the functor itself is right looking. The argument category NP has to be lifted, and according to (106b) it can be lifted to the category S/(S/NP).

106. **Permutation duals**
a. X ⇒ Z\Y if X ⇒ Y/Z
b. X ⇒ Y/Z if X ⇒ Z\Y

```
107.     a.  (I know) John is related to Sue
                      _________________
                             S/NP        NP
                              |__________|RA
                                    S

         b.  (I know)   who      John is related to
                        NP       __________________
                        |TL+(40b)       S/NP
                      S/(S/NP)           |
                        |________________|RA
                                S
```

To arrive at LPC, LP is extended with a contraction rule (108). A particular instance of the contraction rule, Substitution, is shown in (109) and exemplified in (110), an example with a parasitic gap.

108. **Contraction**
U,X ⇒ Y if U,X,X ⇒ Y

109. **Substitution**
Y/Z (Y\X)/Z ⇒ X/Z

```
110.     (the article)    which      John   filed          without           reading
                       (N\N)/(S/NP)  NP   (NP\S)/NP  ((NP\S)\(NP\S))/Ving  Ving/NP
                           |          |TL    |_________________|(43)          |
                           |       S/(NP\S)        (NP\S)/Ving                |
                           |          |                  |____________________|RC
                           |          |                       (NP\S)/NP
                           |          |_____________________________|RC
                           |                         S/NP
                           |__________________________|RA
                                  N\N
```

The last rule to mention in this section is *Expansion*. This is the opposite from *Contraction*. LPC extended with Expansion renders the grammar system LPCE. Expansion is defined in (111).

111. **Expansion**
$U,X,X \Rightarrow Y$ if $U,X \Rightarrow Y$

In the next section, we will discuss discontinuous dependencies, for which a Disharmonic Composition rule is needed. This Disharmonic Composition rule is not part of the grammar system L, but rather of LP. As permutation closure is undesirable for the grammar of Dutch, I will adopt some of the suggestions proposed by Hoeksema (1991).

1.3.5 Discontinuous dependencies

At this place it is useful to pay attention to verb clustering in Dutch. Categorial treatments of verb clustering seem to invoke disharmonious structuring.[18] On the assumption that only functors with like directionality may be composed, like in the Lambek-grammar, verb clustering couldn't be accounted for in categorial grammar. In Dutch, it appears necessary to use rules for disharmonious composition. Analyses with Disharmonic Composition appear to be a good alternative to verb raising analyses. Looking at example (113), we see that the transitive verb *te lezen* is a left looking function in last position. But between the function and its argument, there are several verbal elements which are right looking functors that have to be composed with the transitive verb. This Disharmonic Composition is defined in (112).

112. **Disharmonic Composition**
$X/Y \quad Z\backslash Y \quad\quad \Rightarrow Z\backslash X$

18 The first to discuss this issue extensively in categorial grammar was Steedman (Cf. Steedman (1985)).

```
113.    het  boek heeft  willen proberen te lezen
        NP/N  N   VP/VP  VP/VP   VP/VP    NP\VP
          └───┘RA   |      |       └────────┘DC
           NP       |      |          NP\VP
           |        |      └────────────┘DC
           |        |            NP\VP
           |        └──────────────┘DC
           |             NP\VP
           └───────────────┘LA
                  VP
```

'the book has want try to read'
has wanted to try to read the book

As Hoeksema (1991) notes, Disharmonic Composition is a rule that cannot apply without restrictions. If this were so, we would derive sentences like (114).

```
114.    man the  from Madrid
         N  NP/N    N\N
         |    └──────┘DC
         |       N\NP
         └────────┘LA
            NP
```

In fact, in grammars that already use Harmonic Composition and Type Lifting, adding Disharmonic Composition to the system would lead to permutation closure for all strings greater than two (Moortgat (1988: 90-91)). This means Disharmonic Composition cannot be an unrestricted rule of syntax in such grammars. As a matter of fact, there is evidence for treating verb clusters in Dutch as syntactic units and for accounting for the clustering itself in the lexicon. Presupposing that negation operates on syntactic units, there are two sources of evidence I would like to mention. The first is the impossibility of a negation operator within the cluster (115), implying that 'proberen te amuseren' (*try to amuse*) is not a syntactic unit. The second is the possibility of fronting verb clusters (116), implying that the whole verb cluster is a syntactic unit.

115. een man die zijn vrouw heeft (*niet) proberen te amuseren
'a man who his wife has not try to amuse'
a man who has not tried to amuse his wife
Hoeksema (1991: 76)

116.a Willen kopen heeft hij het niet
‘Want buy has he it not’
He didn’t want to buy it

b Laten zinken kunnen we die boot niet
‘Let sink can we that boat not’
We cannot let the boat sink

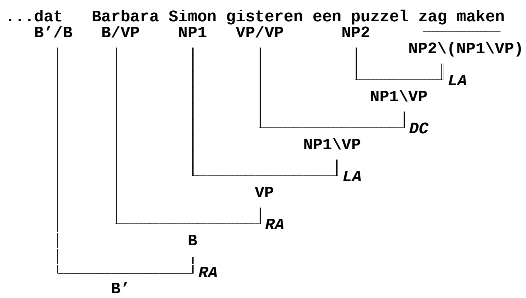
c Moeten werken hebben we nooit
‘Must work have we never’
We never had to work

d Gewacht hebben zal ie zeker niet
‘Waited have will he certainly not’
He certainly will not have waited

Hoeksema (1991: 77)

This opens the possibility of accounting for verb clusters in the lexicon. By doing so, we wouldn’t have to enrich the syntax with Disharmonic Composition rules. As example (117) shows, this would be an unfortunate mis-representation of Dutch grammar. When we incorporate adverbials in the VP, we will still be forced to have access to a rule of Disharmonic Composition in syntax. What we therefore have to do is restrict the rule to the largest extent to prevent over-generation (118).

117.



‘that Barbara Simon yesterday a puzzle saw make’
that Barbara saw Simon make a puzzle yesterday

118. **Disharmonic Composition (DC)**
X/VP $Y_i\backslash(...\backslash(Y_n\backslash VP))$ $\Rightarrow Y_i\backslash(...\backslash(Y_n\backslash X))$

As we will see in the next section, there are other possibilities to restrict the power of the grammar. By assigning a substantial role to the product operator and providing the grammar with the appropriate product rules, we are capable of getting along without highly overgenerating rules, like Functional Composition and Type Lifting. In the next section, I will discuss the product rules that play an important role in the main chapter of this study (chapter 3).

1.3.6 Product Formation

Product Formation is a categorial rule which forms a type X*Y from two adjacent types X and Y (in that order) (119). Although the rule is implicitly present in most categorial grammar systems,[19] mostly no practical use is made of the product rule. In this study the product operator is of great interest for the analysis of coordination phenomena.[20] In fact, the product formation rule makes it possible to use a string of constituents which itself is not necessarily a constituent, as input for other categorial rules, like the Coordination Rule. Reduction is postponed, without having to compute categories for these sequences by means of Type Lifting and Functional Composition. Therefore, by handling some coordination phenomena with the product operator, the claim is that coordination in many cases doesn't involve constituents, but only sequences of constituents.

119. **Product Formation (PF)**
X Y $\Rightarrow$ X*Y

So, in sentence (120) the sequences *de partij aan zijn tegenstander* (the game to his opponent) and *zijn ziel aan de duivel* (his soul to the devil) will not have to be treated as constituents. In a Lambek-grammar, sentence (120) can only be accepted by treating these sequences as constituents. But then, in a Lambek-grammar any sequence can be considered a constituent by means of Functional Composition and Type Lifting. The Lambek-analysis of (120) is presented in (121). The analysis proposed in this study, is presented in (124). Other product

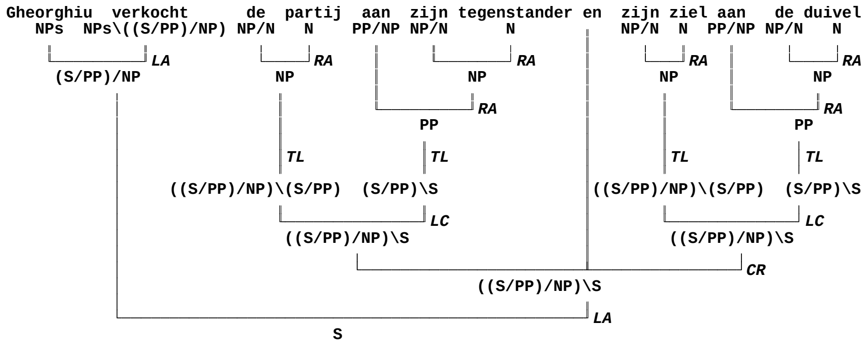
---

[19] An exception must be made for Lambek (1958) in which product formation is explicitly present.

[20] I discussed this earlier in Houtman (1988).

rules needed, are the *Product Associativity* (PA) and the derived reduction rule *Right Product Application* (RP), presented in (122)[21] and (123). These rules are discussed in chapter 3, section 3.2.

120. Gheorghiu verkocht de partij aan zijn tegenstander en zijn ziel aan de duivel
Gheorghiu sold the game to his opponent and his soul to the devil

121.


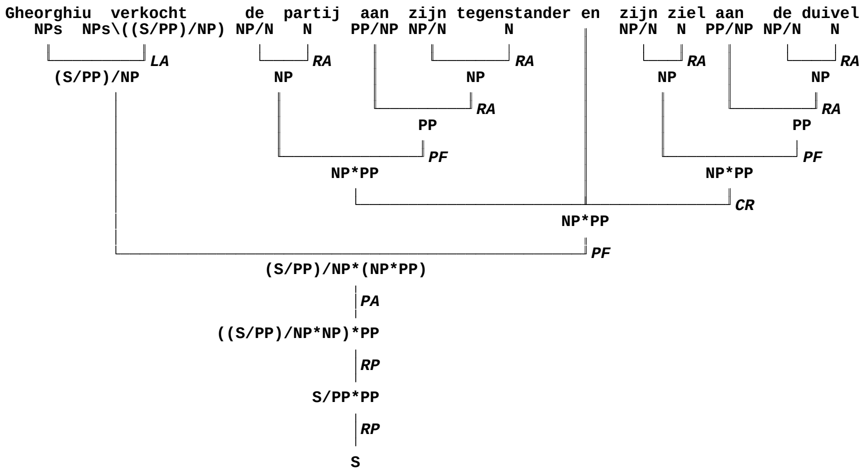
122. **Product Associativity (PA)**
(X*Y)*Z ⇔ X*(Y*Z)

123. **Right Product Application (RP)**
Γ*((X/Y)*Y)*Δ ⇒ Γ*X*Δ

---

[21] Using Lambek's convention of writing XY for X*Y (cf. Lambek (1958)), rule (122) is the same as the axioms (86.b) and (86.b') in section 1.3.4.d.

124.



1.3.7 The special status of the Coordination Rule

For coordinations several rule schemata have been proposed. In categorial grammar the most common treatment of coordination is assigning the polymorphic category (X\X)/X to the lexical item **and** (in Dutch **en**). This function looks to the right for an expression of type X, and yields an expression of type X\X. This function looks for an X to the left to yield an X. But it is also possible to treat coordinations *syncategorematically*, as we will do in this study.[22] By treating the conjunction syncategorematically, no category is assigned to the conjunction **en**. Instead, two or more expressions of category X, with a conjunction in between the last and the penultimate expression, can form another expression of category X (see (125)).

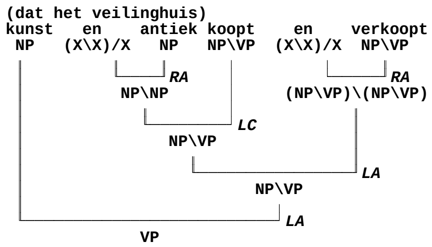
125. **Coordination Rule (CR)**
X^+ **en** X $\Rightarrow$ X

In this definition *en* is the syncategorematic link between two expressions of type X. The Kleene plus at the left conjunct indicates that the conjunction can be preceded by one or more expressions of category X.

---

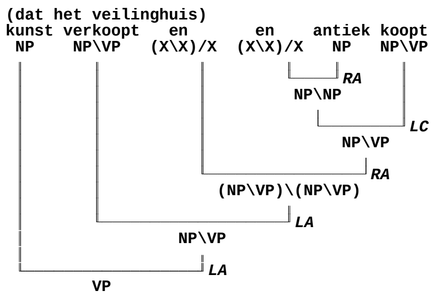
22 For other syncategorematic approaches to coordination, see also Chomsky (1957: 36) and Oehrle (1990: 415-416).

Assigning the category (X\X)/X to the conjunction has the undesirable effect that, after reducing the first X, other derivations can be made with X\X, before immediately reducing the second X. So, although the category (X\X)/X is meant to reduce an X to the right, immediately followed by reduction of another X to the left, this is by no means forced by the combinatorics. This is illustrated in example (126).

126.


‘(that the auction house) art and antiques buys and sells’
(that the auction house) buys and sells art and antiques

The undesirability of this analysis lies in the fact that sequences like *en antiek koopt* get the same categorial derivational status as arbitrary transitive verbs, while neither its distributional properties nor its possibility to be used in the passive form equals that of transitive verbs. In example (127), *en antiek koopt* of category NP\VP is coordinated with an ‘ordinary’ transitive verb like *verkoopt* which obviously causes ungrammaticality. Example (128) shows that *en antiek koopt* cannot be passivized as transitive verbs can.

127. *


‘(that the auction house) art sells and and antiques buys’

128. * Kunst wordt [[en antiek gekocht] en [verkocht]] door het veilinghuis

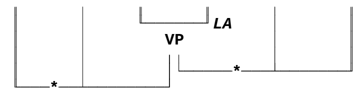
These examples show that coordination phenomena shouldn't be accounted for by assigning the category (X\X)/X to conjunctions.

Coordination Rule (125) is used in Houtman (1987a) and Houtman (1987b) and is also used in this study. The rule makes the right predictions, but it differs from the usual treatment of lexical items in categorial grammar. Instead of defining coordination syncategorematically, we could assign the conjunction **en** the category X\X/X which calls for simultaneous reducing of the two arguments, according to rule (129).

129. **Stereo Application (SA)**
X X\X/X X ⇒ X

Stereo Application, a notion due to Hoeksema,[23] avoids the drawbacks of the first treatment of conjunctions, assigning conjunctions the category (X\X)/X, because now we are not able to base derivations on the results of an intermediate stage (X\X), as is shown in (130) and (131). Furthermore, by assigning the category X\X/X to conjunctions, the account of coordinations now completely lies within the usual categorial grammar pattern.

```
130.     (dat het veilinghuis)
         kunst  en   antiek koopt   en    verkoopt
          NP   X\X/X   NP   NP\VP  X\X/X   NP\VP
```



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23 Hoeksema (1983) compares coordination to mathematical operations, and he says:
"Het zou echter onnatuurlijk zijn om te veronderstellen dat deze operatoren zich eerst met een element ter rechterzijde, en vervolgens met dat ter linkerzijde, of vice versa, verbinden. Beter dan dergelijke ongemotiveerde veronderstellingen te maken, is het om beide elementen tegelijkertijd, in één sprong, tot een nieuwe getalsnaam aaneen te smeden."
Hoeksema (1983: 9)
In translation:
It would, however, be unnatural to suppose, that these operators first combine with the element to the right, and next with the element to the left, or vice versa. Better than to make such unmotivated assumptions, is to join both elements at one time to a new number.

```
131.    (dat het veilinghuis)
        kunst  en   antiek koopt   en    verkoopt
         NP   X\X/X   NP   NP\VP  X\X/X   NP\VP
         |______|______| SA    |______|_______| SA
               NP                    NP\VP
                |____________________| LA
                          VP
```

Although Stereo Application avoids derivations with the results of intermediate stages, we are still able to allow ungrammatical results on the basis of the polymorphic category for **en**. I show this in example (132).

```
132. *  kunst  en            en               maar   geen antiek
          N   N\N/N   (N\N/N)\(N\N/N)/(N\N/N)  N\N/N  N/N    N
          |     |________________|________________| SA  |_____| RA
          |                    N\N/N                       N
          |______________________|_______________________| SA
                                 N
```

‘art and and but no antiques’

Because of the descriptive inadequacy of the categorematic approaches to conjunction categorial grammar has to make the choice in favour of the syncategorematic approach.

1.3.8 Starting points for a grammar of coordination

In section 1.2, we discussed the advantages of accounting for coordination in a categorial grammar, instead of in a transformational grammar. In section 1.3, we explored the categorial machinery, and some of the consequences of the categorial rules for the descriptive power of the grammar. In the next chapter, we will discuss the arguments for and against a flexible approach to coordination phenomena. We will illuminate the advantages and disadvantages of flexibility-increasing rules, like Functional Composition and Type Lifting. We will come to the conclusion that there must be a prominent role for product rules in a categorial grammar for coordination.

We will pursue this line of research in chapter 3. In this chapter, I will present a product-based applicative categorial grammar for coordination, that will make use of the least flexibility possible. Application rules and product rules will do most of the work. Rules for Harmonic Functional Composition and rules for Type

Lifting will be shown to be superfluous. The only composition rule we cannot dispense with is the rule for Disharmonic Composition. In this chapter we have shown that to a large extent, this Disharmonic Composition might be considered to operate in the lexicon. But on the other hand, the possibility of positioning adverbials inside verb clusters forces us to introduce a syntactic rule of Disharmonic Composition.

First of all, we will discuss two recent accounts of coordination in categorial grammar.

1.4 Early accounts of coordination in categorial grammar

In this section I will discuss two contributions to a categorial grammar account of coordination. The first is Dowty's account of non-constituent coordinations.[24] Dowty strongly appeals to Functional Composition and Type Lifting. One of the effects of Functional Composition is the unorthodox constituent structure he assumes is necessary to describe coordination phenomena. The second is Steedman's account of coordination.[25]

1.4.1 Dowty's non-constituent conjunction

According to Dowty, Functional Composition has two important effects, the first of which renders the 'slash category' mechanism of GPSG for describing long distance dependencies unnecessary. The second, and for the purposes of this thesis more relevant, effect is "the production of certain highly unorthodox left-branching structures (...)." (Dowty (1988: 154)). This new constituent structure is, again according to Dowty, parasitic on the 'normal' constituent structure. The odd constituents he calls *phantom constituents*. He refers to Nerbonne, who introduced

[24] Cf. Dowty (1988).

[25] Cf. Steedman (1985) and Steedman (1990).

the notion *Poltergeist constituent*.[26] A syntactic motivation for phantom constituents is non-constituent conjunction. This is the type of coordination we refer to as Forward Conjunction Reduction in this study. We present two examples in (134) and (135), and Dowty's Coordination Rule in (133). As we have discussed in section 1.3.7, there are objections to treating the conjunctions as having the category Conj. I will not repeat this discussion here.

133. **Coordination Rule**
X^+ Conj X ⇒ X

```
134.    John  saw      Mary     yesterday and      Bill      today
         NP  VP/NP  (VP/NP)\VP    VP\VP   Conj  (VP/NP)\VP  VP\VP
         |     |              └────────┘LC  |          └───────┘LC
         |     |          (VP/NP)\VP        |         (VP/NP)\VP
         |     |                 └──────────┴─────────────────┘CR
         |     |                    (VP/NP)\VP
         |     └────────────────────────────┘LA
         |                 VP
         └────────────────────┘LA
               S
```

```
135.    John    gave          Mary              a book     and         Susan          a record
         NP  (VP/NP)/NP ((VP/NP)/NP)\(VP/NP) (VP/NP)\VP  Conj ((VP/NP)/NP)\(VP/NP) (VP/NP)\VP
         |      |                  └──────────────────┘LC  |            └──────────────────┘LC
         |      |                   ((VP/NP)/NP)\VP        |             ((VP/NP)/NP)\VP
         |      |                          └───────────────┴──────────────────────────┘CR
         |      |                                ((VP/NP)/NP)\VP
         |      └─────────────────────────────────────────────┘LA
         |                          VP
         └────────────────────────────────┘LA
                      S
```

In these examples, I use a slightly different notation than Dowty does. For NP he uses the semantically motivated category **e**. The category for the transitive verb VP/NP, he abbreviates to **tv**, and the ditransitive (VP/NP)/NP, he abbreviates to **ttv**. The analysis (134) shows that the categories for *Mary* and *Bill* have been lifted from NP to (VP/NP)\VP. In (135), both object NP's are lifted; *Mary* and *Susan* from NP to ((VP/NP)/NP)\(VP/NP), and *a book* and *a record* from NP to (VP/NP)\VP. Furthermore VP is supposed to be short for the leftward looking functor NP\S, so that NP and VP are combined via Leftward Application.

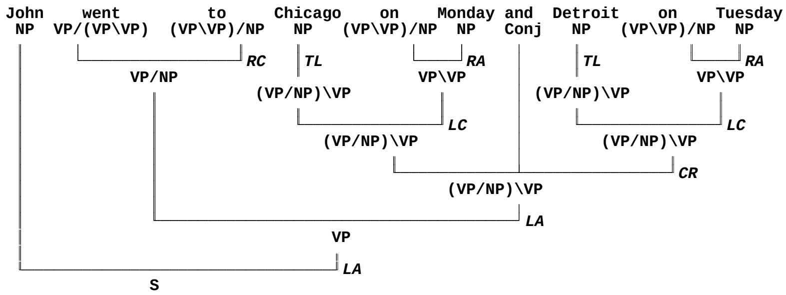
---

[26] Cf. Nerbonne (1986). He introduces the notion *Poltergeist constituent* to refer to the genuine use of constituents normally used only as auxiliary stages in derivations. He uses the notion in the context of the fronting of partial verb phrases, exemplified in (i).

i. [Ein Märchen erzählen] kann er ihr
Nerbonne (1986: 859)

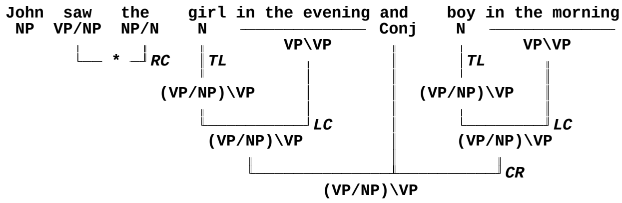
Dowty notices that non-constituent conjunction is also possible with partial sub-constituents. The classical example is the one in (136). Again, Functional Composition and Type Lifting do the job.

136.



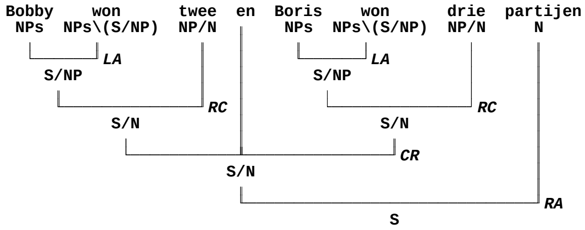
Similar examples with determiners instead of prepositions are apparently ungrammatical (see (137)). They seem to violate extraction island constraints. Dowty argues that these island constraints could be formulated as a condition on the composition rule, like the one in (138).

137.



138. **Functional Composition**
X/Y Y/Z $\Rightarrow$ X/Z, where Y $\neq$ NP

At least in Dutch, and probably also in English, this constraint seems very implausible, witness the Right Node Raising example in (139), and the English translation.

139. 

Bobby won two and Boris won three games

Furthermore, as we will argue in chapter 2, it is extremely difficult to formulate conditions on categorial rules in a flexible categorial grammar. The rules for Functional Composition and Type Lifting can provide an alternative derivation, even if the original one is blocked by the conditions.

In chapter 2, we will claim that not Functional Composition must be blocked in any way, but that coordinations like *girl in the evening and boy in the morning* have to be blocked in some way. There, we will further argue that Functional Composition and Type Lifting tend to cause overgeneration in disharmonic structured languages, like Dutch. Therefore, another solution to the problem is presented in chapter 3, using an applicative categorial grammar, exploiting product categories.

1.4.2 Steedman's coordination proposal

Steedman's proposals on coordination in categorial grammar[27] are to a large extent equivalent to Dowty's approach. Steedman uses Dowty's Coordination rule (133). Many of the coordinations in English and Dutch are accounted for by the application rules and by the (generalized) composition rules. Steedman also refers to the unorthodox constituent types, generated by categorial grammar, and he notices that they all can coordinate.

---

[27] Steedman (1985), Steedman (1990).

> "All the unorthodox constituent types that are introduced by the Forward Partial Combination Rule [i.e. Right Composition, JH] can conjoin."
> Steedman (1985: 542)

This is exemplified in (140), where *Harry cooked* and *Mary ate* are not constituents in the traditional sense, but they are in this categorial grammar interpretation.

```
140.    Harry  cooked  and   Mary    ate    the beans that I bought from Alice
        S/FVP  FVP/NP  Conj  S/FVP  FVP/NP  ________________________________
        |_________|RC   |     |_________|RC              NP
           S/NP         |        S/NP                     |
            |___________|__________|CR                    |
                       S/NP                               |
                        |_________________________________|RA
                                       S
```

Steedman claims that if preposing is impossible, then RNR is also impossible. He illustrates this with the example (141).[28]

141. a. * This picture [I know the woman who painted]
     b. * [I know the woman who painted, and you met the man who stole], the picture that Harry was so fond of

Although in Dutch it might be true that some conditions on preposing are also valid for Right Node Raising cases, we encounter in (142) a pretty grammatical example with parallel structures as example (141).

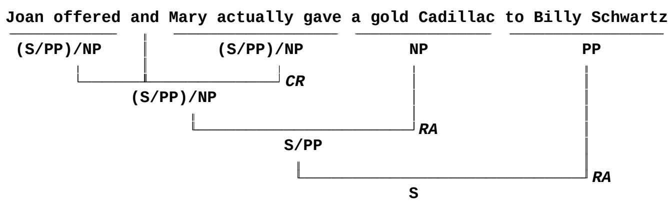
142. a. * [Partijen] won Nimzowitsch honderd
     'Games won Nimzowitsch hundred'
     Nimzowitsch won hundred games
     b. [Nimzowitsch won honderd en Donner verloor tweehonderd] partijen
     Nimzowitsch won one hundred and Donner lost two hundred games

---

[28] But as Oehrle (1990) notes:
> '..., RNR allows extraction from relative clauses (Wexler and Culicover (1980); Levine (1985))'
> Oehrle (1990: 411)

and he illustrates his point with the example
> I know a woman who admires and a clone who detests the paintings of Reynard
> Oehrle (1990: 412).

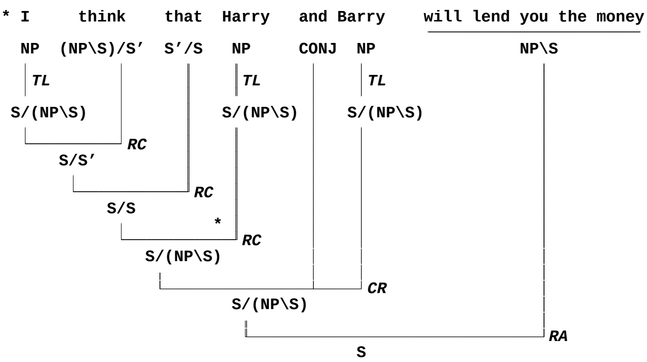
Steedman argues that Right Node Raising is subjected to fewer constraints than Preposing, because for Right Node Raising no Type Lifting has to be assumed. Thus, the category of the Right Node Raised part in example (143) doesn't have to be computed by Functional Composition and Type Lifting, because the conjunction category is one that takes two arguments anyway. Note that in this example Generalized Composition is used to compose *Joan offered* and *Mary actually gave*.

143.


In his paper 'Gapping as constituent coordination',[29] Steedman is of the opinion that all non-standard constituents can undergo coordination in syntax. For the English examples he presents, this means that restrictions must be formulated on the rule for Functional Composition (see (144)), because otherwise the sequences from sentence (145) *I think that Harry* and *Barry*, which have identical categorial status, could be coordinated.

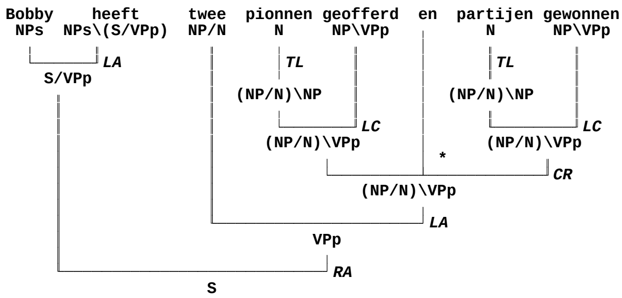
144. **Steedman's Restrictions on Functional Composition**

X/Y Y/Z $\Rightarrow$ X/Z, where Z$\in$ {NP,PP,AP,V',S'}

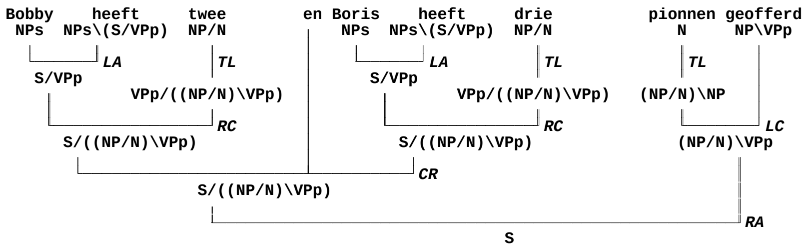
145. *


[29] Steedman (1990).

There are, however, cases of coordination that must be excluded for syntactical reasons. If we want to prevent example (146) from being derived by restricting the rule for Functional Composition, then it appears that the derivation of example (147) is also blocked. For the derivation of (147) we need Type Lifting from the category N to (NP/N)\NP, after which this category is composed with the category for transitive verbs NP\$VP_p$ to the function (NP/N)\$VP_p$ by means of Functional Composition. This is the category of the sequences *pionnen geofferd* (pawns sacrificed) and *partijen gewonnen* (games won). That is why the ungrammaticality of (146) shouldn't be accounted for by restrictions on the rule for Functional Composition, but rather by restrictions on the Coordination Rule.

146. *


'Bobby has two pawns sacrificed and games won'
Bobby has sacrificed two pawns and won (two) games

147.


'Bobby has two and Boris has three pawns sacrificed'
Bobby has sacrificed two pawns and Boris has sacrificed three (pawns)

Naturally, sentence (146) is only ungrammatical with the reading where Bobby has won two games. In the interpretation where Bobby has sacrificed two pawns but won an arbitrary number of games, the sentence is completely acceptable, as is predicted by the rules of the grammar. In this case, the derivation shows an ordinary VP-coordination, for which no restrictions are formulated (see (148)).

```
148.   Bobby    heeft       twee pionnen geofferd  en  partijen gewonnen
        NPs  NPs\(S/VPp)   NP/N    N     NP\VPp    |     NP     NP\VPp
        |________| LA       |______| RA     |      |     |         |
         S/VPp                 NP           |      |     |_________| LA
          |                    |____________| LA   |        VPp
          |                        VPp             |         |
          |                         |______________|_________| CR
          |                                       VPp
          |________________________________________| RA
                               S
```

'Bobby has two pawns sacrificed and games won'
Bobby has sacrificed two pawns and won (some) games

Even for English coordination phenomena, Steedman's restriction Z∈{NP,PP,AP,VP',S'} seems to be too strong, witness the examples (149) and (150) below.

```
149.   Bobby wants to win  three and   Boris should have won two games
       __________________              ____________________
             S/NP           NP/N  |            S/NP        NP/N  N
              |______________| RC |             |____________| RC |
                    S/N           |                  S/N          |
                     |____________|___________________| CR        |
                                 S/N                              |
                                  |_______________________________| RA
                                                 S
```

```
150.   I think that Harry   but  I doubt whether Barry   will lend you the money
       ___________               ______________          ______________________
           S/S       NP      |       S/S         NP               NP\S
            |        | TL    |        |          | TL              |
            |     S/(NP\S)   |        |       S/(NP\S)             |
            |________| RC    |        |__________| RC              |
           S/(NP\S)          |          S/(NP\S)                   |
              |______________|_____________| CR                    |
                          S/(NP\S)                                 |
                             |_____________________________________| RA
                                            S
```

Steedman's condition on Functional Composition satisfies neither the Dutch cases nor the English cases. In the grammars of both languages, we therefore seem to need restrictions on coordination.

1.5 Concluding remarks

In this chapter, we first introduced the coordination phenomena to be described in this study, and the phenomena that are left out (section 1.1). Next, we discussed the transformational efforts in accounting for the coordination phenomena Forward Conjunction Reduction and Right Node Raising. We concluded that the transformational framework is not suitable to account for these coordinations, but that we should employ a different view on syntax and constituent structure (section 1.2).

In section 1.3, we introduced categorial grammar in various aspects. We discussed the components of a categorial grammar, different word orders in Dutch main and subordinate clauses, the hierarchical structure of categorial grammars, the disharmonic structuring of Dutch, the Coordination Rule and the Product Rules. All this functions as the basis of the discussion, started in 1.4, and pursued in the chapters 2 and 3, on the ways coordinations has been accounted for in categorial grammar, and the way this dissertation proposes to account for it.

In section 1.4, we discussed Dowty's and Steedman's proposals on coordination. They both rely heavily on the rules for Functional Composition and Type Lifting. The first of these rules is independently motivated by extraction phenomena, especially unbounded dependencies. The second plays a crucial role in coordination. The two rules generate constituent structures that differ importantly from the traditional view of constituent structure. This is mostly regarded as one of the virtues of the categorial enterprise, because it allows us to provide a straightforward analysis of non-constituent conjunction. Nevertheless, as we will encounter in the next chapter, this flexible view on constituent structure has some clear disadvantages.

In chapter 2, we will discuss the advantages and the disadvantages of a flexible categorial grammar for Dutch coordination phenomena.