**Chapter 2**

**A three-dimensional theory of the syntax of coordination and its semantics**

In this chapter, I will present a three-dimensional syntactic theory of coordination together with a particular way of compositionally interpreting three-dimensional syntactic structures. The overall aim of the approach is to give justice both to the independent behavior of coordinates and to the equivalence, to an extent, between phrasal and clausal coordination. The compositional semantics will be based on a division of three-dimensional syntactic structures into smaller units, so-called m-plane assignments, and it will be articulated in terms of indirect semantics, that is, a translation of natural language expressions into the language of the relevant logic, which is plural logic. The syntactic theory largely matches that proposed in Moltmann (1992), which is itself in part inspired by the three-dimensional syntactic theories of coordination of Goodall (1985) and Muadz (1991). I will not discuss those predecessors, though, and will not engage in a comparison. For that the reader is referred to Moltmann (1992), where Goodall’s and Muadz’ theories are discussed in detail. While the three-dimensional theory of Moltmann (1992) was cast within generative syntax, it is itself independent of particular stages of the development of generative grammar. This is due to the nature of coordination itself. Coordination is a phenomenon that is largely orthogonal to the rest of syntax, displaying particularities of its own to which ordinary syntactic rules and conditions are largely inapplicable. The theory need not even be understood as part of generative syntactic theory, but may be adopted quite independently of any theoretical developments regarding the syntax of non-coordinate sentences.

* 1. **General requirements on a theory of coordination**
		1. **Parallelism and independence in coordinate structures**

There are two kinds of phenomena that are characteristic of coordination:

(1) Phenomena in which coordinated phrases or parallel parts of coordinated phrases behave as units - either in syntactic or in semantic respects or in both.

(2) Phenomena in which coordinated phrases exhibit a certain degree of syntactic or semantic independence from each other.

 Syntactic phenomena of the sort (1) are the conjuncts of a coordination that act as unit with respect to agreement or binding as in (1) or across-the-board (ATB) extraction as in (2):

1. a. John and Mary are dancing.

b. John and Mary like themselves.

1. Whom did John meet t and Mary invite t?

Semantically coordinated DPs may act as units in providing a plural referent for a collective predicate as in (3):

(3) John and Bill met.

Furthermore, parallel singular DPs (or other constituents denoting single entities) in distinct conjuncts may form plural antecedents, in what I will call **split-antecedent constructions**:

(4) a. Which pictures of *themselves* did John like and Mary hate?

 b. How many pictures *each* did John like and Mary hate?

 An example of the second sort of coordination phenomena is the possibility of DP-movement in one conjunct independently of the other one, as in (5):

(5) John drove his car to his house and seemed t to be exhausted.

An example of semantic independence is sentences with phrasal coordinations that receive a 'respectively' interpretation or **wide distributivity interpretation**:

(6) John and Bill read books by Mary and Sue (respectively).

Binding may display both phenomena in that it may take into consideration either only individual conjuncts or conjoined phrases. An example of the latter case was (1b), an example of the former ‘conjunction-specific anaphora, as below:

(7) *John* and *Mary* admire pictures of *himself* and stories about *herself* respectively.

 In what follows, I will outline three-dimensional syntactic theory of coordination that gives justice to both sorts of phenomena. The theory consists in various conditions on three-dimensional phrase markers. It is in particularly targeted to capturing phenomena in terms of implicit coordination, which include ATB-extraction, gapping and split antecedent constructions, as discussed in detail in Chapter 3.[[1]](#footnote-1)

* 1. **Three-dimensional theories of phrase markers**
		1. **The basic idea and motivation for three-dimensional phrase markers**

Coordinate structures with clausal coordination behave in many ways equivalent to coordinate structures with phrasal coordination. For instance, 'respectively'-sentences seem semantically equivalent to clausal coordinations. Yet the same phrasal conjunctions in respectively sentences can at the same time provides an antecedent for elements taking a plural antecedent:

(8) a. One after the other, John and Mary saw Sue and Bill respectively.

 b. One after the other, John saw Sue and Mary saw Bill.

The equivalence between clausal and phrasal coordinations is one of the motivations for three-dimensional syntactic structures, in the following way.

First, each plane in such a phrase marker should represent the 'semantic conjuncts' of a coordination. This allows wide scope interpretation of phrasal coordinations and an adequate representation of 'respectively'-sentences. Second, three-dimensional phrase markers are in some way 'composed' of two­dimensional phrase markers in such a way that grammatical principles apply to those two-dimensional phrase markers in the standard way. That is, coordination does not require any special grammatical rules apart from general conditions on three-dimensional syntactic trees. The grammar of coordinate sentences in that sense is meant to be reducible to the grammar of noncoordinate sentences.

 The main semantic motivations for exploring three-dimensional syntax is the phenomena of split antecedents. The phenomenon of split antecedents in coordinate sentences as described in its full generality in Chapter 3 can hardly be accounted for without making use of a construction of implicit coordination, coordination without the appearance of a coordinator. Implicit coordination is straightforwardly available within three-dimensional syntax, as multidominance. By contrast, implicit coordination can hardly be made sense of within ordinary two-dimensional syntax, which thus does not provide a syntactic basis for the compositional semantics of split antecedent sentences.

**1.3. A three-dimensional theory of coordination**

**1.3.1. Formal conditions on three-dimensional syntactic phrase markers**

In what follows I will state a range of formal conditions on three-dimensional syntactic trees or phrase markers.[[2]](#footnote-2)

 Phrase markers are conceived of as structures (N, D, P), where N is a set of nodes, D the dominance relation (x D y 'x dominates y') and P the relation of precedence (x P y 'x precedes y') and certain axioms about Dand P are satisfied.

 I will first introduce a notion more general than a phrase marker, as a precedence/dominance tree. The dominance relation in a precedence/dominance tree should be a reflexive and transitive relation which does not allow for 'loops', i.e., for two distinct nodes each dominating the other. Furthermore, a precedence/dominance tree should have a root node, i.e., a node dominating all the other nodes in the tree. The precedence relation in a precedence/dominance tree is an asymmetric, transitive relation.

 A number of conditions govern the relation between dominance and precedence. In particular, if elements stand in the relation of dominance to each other, they cannot stand in the relation of precedence to each other. Furthermore, a node x that precedes a node y should precede all nodes that are dominated by y. Finally, if two distinct nodes dominate the same node, then these nodes should not stand in the relation of precedence to each other. (This basically has the effect that the only cases of multidominance admitted in precedence/dominance trees are joining nodes that are dominated by nodes that belong to distinct planes.). Formally we thus have:

(9) A **precedence/dominance tree (PD tree)** is a triple (N, D, P), where N is a set of

 nodes and D and P binary relations on N x N satisfying the following conditions:

 a. (i) xDx.

 (ii) xDy, yDz, then xDz.

 (iii) xDy, yDx, then x = y.

 (iv) There is an x ∈ N such that for all y ∈ N, xDy.

 b. (i) xPy, then not yPx.

 (ii) xPy, yPz, then xPz.

 c. (i) If xDy, then neither xPy nor yPx.

 (ii) If xPy and yDz, then xPz.

 (iii) If xDz and yDz, then neither xPy nor yPx.

The following auxiliary notions will also be of use:

(10) Let (N, D, P) be a precedence/dominance tree.

a. x **immediately dominates** y **(x Di y)** in (N, D, P) iff xDy and for no z in N, z x,

 z/y, xDz and zDy.

 b. x **immediately precedes** y **(x Pi y)** in (N, D, P) iff xPy and for no z in N, xPz

 and zPy.

 c. x is a **terminal node** in (N, D, P) iff there is no y in N, y/x, such that xDy.

 d. x is the **root node** of (N, D, P) iff for all y in N', xDy.

 e. x is rightmost in (N, D, P) iff there is no y in N such that xPy.

 f. (N, D, P) is **binary** branching iff for any subset X of N such that for any y and z

 in X, x Di y, xDiz and yPz or zPy, X has at most two members.

 g. x is a **splitting node** in (N, D, P) iff there are y and z in N, y, z, xDiy and xDiz

 such that neither yPz nor zPy and neither y nor z is a coordinator.

 h. x is **ajoining node** in (N, D, P) iff there are nodes y and z in N, y/z, such that

 y Di x and zDix and neither yPz nor zPy.

 i. x is a **branching node** in (N, D, P) iff there are nodes y and z in N, xy, such that

 x Di y and xDiz and yPz.

 j. A set of nodes X is an **expansion** of a node x in (N, D, P) iff (i) - (iv):

 (i) x is in N

 (ii) for every y in X, x Di y

 (iii) for any y and y' in X, y ≠y', either y P y' or y' P y

 (iv) for every x in X and for every y in N, if yPx or xPy, then y is in X.

Further formal conditions are then to be imposed on three-dimensional phrase markers involving coordinators, that is, a lexical class of expression which includes *and, but* and *or.* I will henceforth use the varia les 'j, j"as a variable standing for coordinators.

 One of conditions on coordinators is that coordinators do not stand in the relation of precedence to any other element immediately dominated by the same node. Another condition is that for any splitting node x, either x has to immediately dominate a coordinator or the lowest IP node dominating x has to immediately dominate a coordinator. The two cases represent explicit phrasal coordination and gapping or bare argument ellipsis respectively. These two conditions on coordinators are formulated in the following axioms.

(11) Conditions on coordinators

 Let (N, D, P) be a PD tree.

 (i) For any j in N, for no x in N such that there is a y in N, yDix, yDij, xPj or jPx.

 (ii) For any splitting node x in (N, D, P), there is a j in N such that either xDij or for

 the lowest w in (N, D, P) that dominates x and has the label IP, wDij.

Furthermore, joining nodes are subject to a rightmost condition (for Right Node Raising):

(12) Condition on joining nodes

 Let (N, D, P) be a PD tree.

 If y is a joining node in (N, D, P), then y is rightmost in {N, D, P).

A three-dimensional phrase marker can now be defined as in (37):

(13) A **dimensional phrase marker** is a PD tree (N, D, P) satisfying (11) and (12).

A notion of a subphrase marker is given below:

(14) A triple (N', D', P') is a **(three-dimensional) subphrase marker** of a three­dimensional phrase marker (N, D, P) iff N' ⊆ N, D' ⊆ D, P' ⊆ P, and (N', D', P') is a three-dimensional phrase marker.

Let us now tum to how grammatical principles apply to three-dimensional phrase markers. One guiding idea of three-dimensional syntax is that the well-formedness of a three-dimensional phrase marker should be based on the well-formedness of the planes of the three-dimensional phrase marker. This first requires a definition of the notion of a plane. A plane is a maximal two-dimensional subtree of a three-dimensional phrase marker rooted in the same node and not containing any coordinators. That is, if a plane contains a node x, then this plane should contain any nodes dominated by x as long as those nodes stand in the precedence relation to each other. (More simply, a plane should 'go down' to the terminal nodes.)

(15) A **plane** of a three-dimensional phrase marker (N. D, P) is a maximal

 PD tree (N', D', P') such that the following holds:

(i) (N', D', P') has a root node x such that x is the root node of (N, D, P)

(ii) N’ ⊆ N.

 (iii) D'⊆ D.

 (iv) P’ ⊆ P.

 (v) For any x and y in N', either xDy, yDx, xPy or yPx

 (iv) N' does not contain any coordinator.

A plane assignment to a three-dimensional phrase marker will be the set of all f-planes of the phrase marker:

(16) Let (N, D, P) be a three-dimensional phrase marker.

 An f-**plane assignment** to (N, D, P) **(**PA(N**,** D, P)) is the set of all triples (N', D', P')

 such that (N', D', P') is a plane of (N, D, P).

 One might then propose that a three-dimensional phrase marker is well-formed iff each of its planes is well-formed (Muadz 1991) (such as Case-theory and Binding theory). However, this would be inadequate. First, it would not account for asymmetries between conjuncts. The asymmetry of conjuncts can be accounted within three-dimensionality of coordinate structures by treating coordinators syntactically as adjuncts of one of the conjuncts. This also means thatcoordinators will not have any special syntactic status in a phrase marker and do not require particular conditions.

 Second, the notion of a plane cannot both provide a syntactic basis for applying syntactic principle in the standard way as well as the requirement of providing a representation of scope of coordinators. A purely formal notion of plane has to be distinguished from the notion of a meaningful plane or m-plane, representing the scope of a coordinator. An m-plane is a three-dimensional subphrasemarker that serves as a basis for semantic interpretation. For the sake of convenience, I will still call such three-dimensional syntactic objects 'm­ planes', even though they are not literally planes. The interpretation of a (coordinate) sentence then has to be relativized not only to a phrase marker, but also to an assignment of m-planes, an m-plane assignment. Both formal planes (f-planes) and meaningful planes (m-planes) are needed. F-planes are required for the satisfaction of at least certain types of syntactic conditions, such as the Coordinate Structure Constraint, a part of Binding Theory, and presumably the biuniqueness condition of Case Theory. M-planes do not only play a role in semantic interpretation; they also influence the linearization of a sentence at PF, as we will see.

* + 1. **The distinction between formal and meaningful planes**

Let me now elaborate the notion of a meaningful plane or m-planes, by presenting its various motivations, defining the notion of an m-plane assignment, and proposing a compositional semantics of three-dimensional phrase marker based on an m-plane assignment.

 The first argument for the separation between the two notions of plane comes from sentences with narrow scope of coordinators and with nested coordinations. Consider a simple example:

(17) John and Mary met.

The two m-planes that should be associated with *and* and provide the basis for semantic interpretation correspond to John and Mary, not to John met and Mary met. Planes corresponding to John met and Mary met will be only f-planes. As such they will be disregarded for the purpose of semantic interpretation But f-planes are needed for the purpose of syntactic well-formedness. If syntactic conditions are satisfied in the individual m-planes, it does not follow that the entire sentence is therefore well-formed. It would not rule out a sentence such as (38), which could be assigned the same m-planes as (36).

(18) \* John and Mary happy.

(18) fails to be grammatical because the f-planes corresponding to *John met* and *Mary met* are not grammatical*,* though those planes cannot serve as the basis for semantic interpretation.

 Another reason for distinguishing f-planes and m-planes comes from nested coordinate structures:

(19) John or Mary compared Sue and Bill.

On one reasonable interpretation of (39), the planes associated with *or* would correspond to *John compared Sue and Bill* and to *Mary compared Sue and Bill.* But these two planes are not two-dimensional f-planes, but three-dimensional m-planes. (39) should also be assigned two-dimensional subphrase markers as f-planes, which correspond to *John compared Sue, John compared Bill, Mary compared Sue* and *Mary compared Bill.* But these serve only the purpose of ensuring grammaticality and semantic interpretation.

**1.4.4. The necessity of m-planes**

M-planes not only represent the scope of coordinators, which could also represented, for instance, by scope-indexing. M-planes are required as the syntactic basis for semantic interpretation, because they determine the syntactic units of interpretation of a three­ dimensional tree by resolving an ambiguity in the possible direction of compositional interpretation of a three-dimensional tree. Unlike two-dimensional syntactic trees, three-dimensional syntactic trees are ambiguous with respect to which direction the compositional interpretation of the sentence should take. Consider the three-dimensional tree in (20) and assume for the sake of the argument that the terminal nodes E, F and D are lexical items with particular meanings:

(20) C

A D

E F

There are two ways in which the set of terminal nodes of (42) could be evaluated. First, E and F could be evaluated as a unit. Then the evaluation of E and F would be subject to a semantic operation together with the evaluation of D. Second, E and D could first be evaluated as a unit as well as F and D. Then the evaluation of E and D and of F and D would be subject to a semantic operation.

 These two ways of evaluating (20) correspond attributed to two different assignments of m­planes. The first m-plane assignment contains two **'small' planes** terminating in E and F. The second m-plane assignment would contain two **'big' planes** terminating in ED and in FDD. M-planes are essential for providing the basis for an unambiguous compositional semantic interpretation of a coordinate sentence within a three-dimensional phrase marker approach. They also reflect the scope of a coordinator: the first m-plane assignment to (42) implements a narrow scope of the coordinator *and,* whereas the second m-plane assignment to (42) implements a wide scope of *and.*

 M-planes provide a new way of representing the scope of a coordinator and make different predictions than traditional syntactic theories of coordination. In the planar account of scope, there are no reason based on the format of the theory why a coordinator should be associated with smaller or bigger planes. Both kinds of planes are equally 'natural' given the syntactic structure. In contrast, traditional theories in which conjuncts constitute constituents with internal linear order in the same way as the surrounding elements, only narrow scope would be the natural choice. Wide scope would require special rules or devices such as movement of the coordinator.

**1.4.6. Syntactic conditions to be satisfied in f-planes: Coordinate Structure Constraint and others**

A number of syntactic conditions can be satisfied in three-dimensional phrase markers directly, without any reference to planes. for example, syntactic selection. To see whether a three-dimensional phrase marker satisfies syntactic selectional requirements, it is sufficient to check each expression and its arguments (in whatever plane they may be) to see whether the arguments are of the relevant syntactic categories. But there are syntactic conditions can neither be established directly in a three-dimensional tree, nor can they be established in m-planes only. The most important among those syntactic conditions is the one underlying the Coordinate Structure Constraint (CSC), namely the prohibition against vacuous quantification, which needs to be satisfied in each individual f-plane. The crucial observation in the present context is that the condition against vacuous quantification applies to quantifiers outside the 'scope' of coordinators with conjuncts containing bound variables, that is, outside of small m-planes. Thus, the planes for *and* in (21a) and (21b) do not extend beyond the object NPs. But still the wh-operator outside these planes requires variables to bind in each of the planes.

(21) a. Who did John compare a picture oft and a photograph oft.

 b. \* Who did John compare a picture of t and a photograph.

Does the prohibition against vacuous quantification have to be satisfied in the same way with quantifiers such as *every man?* Here it seems that the prohibition against vacuous quantification need not be satisfied in each f-plane if Quantifier Raising is assumed. That is, a quantifier originating in one conjunct at D-structure does not require a variable in every other conjunct:

(22) a. John met every student and Mary.

 b. John met all students and a lot of professors.

Without Quantifier Raising, there would not be any obvious need for the quantifier to bind a variable in the conjunct. Making use of scope-indexing in the sense of Williams (1986), rather than Quantifier Raising, the prohibition against vacuous quantification being satisfied in the individual f-planes will not arise.

 Other syntactic conditions that require f-planes are biuniqueness conditions, such as the biuniqueness condition for Case assignment. A Case assigner can assign Case only exactly once. This condition cannot be satisfied in a three-dimensional tree directly, because then it may in fact be violated in many cases. For instance, it would be violated in (23) because *compared* assigns accusative case twice, namely to *the picture* and to *the photograph.*

(23) John compared the picture and the photograph.

More generally, it appears that any syntactic condition involving a 1-1 relation between syntactic elements can be satisfied in three-dimensional trees only by being satisfied inf­ planes, for instance also the Bijection Principle (Koopman/Sportiche 1983).

 Besides the prohibition against vacuous quantification, there are other meaningful relations that can be established only in f-planes. Generally, it holds that a syntactic element x that requires a relation to another element has to satisfy this relation in all f-planes to which x belongs. For example, reflexives and other elements requiring an antecedent require an antecedent in all f­planes. This is seen in (44a), where the reflexive is dominated by a joining node. The reflexive requires an antecedent in each f-plane to which it belongs and thus in each of the two conjuncts. But this condition is not satisfied in (24a) because the second conjunct does not provide an antecedent for *themselves.* The condition, however, is satisfied in (24b), a split antecedent construction discussed in Chapter 2. Similar examples are given for binominal *each* in (25a) and (25b):

(24) a. \* *The men* praised and the woman criticized pictures of *themselves.*

 b. *The men* praised and *the women* criticized pictures of *themselves.*

(25) a. \* On two days *each* [*the men* played piano and it rained].

 b. On two days *each* [*the men* played piano and *the women* played violin].

But the converse, of course, does not hold. The antecedent of a reflexive does not require a reflexive in all f-planes:

(26) *John* played and entertained *himself.*

The same condition also holds for NPIs. If an NPI is in a position in which it belongs to several f-planes, it requires a licenser in each of those f-planes. This condition is not satisfied in (27a) and (27b) because here only the second conjunct provides an NPI licenser:

(27) a. \*Mary claimed and John denied that they ever met.

b. • Mary saw, but John did not see anybody.

Thus, we have the following condition on how required syntactic relations must be established in three-dimensional phrase markers.

(28) The condition on establishing required syntactic relations in three-dimensional phrase

 markers (CSR)

 If an element x (because of its lexically specified function) must stand in a relation

 to another element, it must stand in such a relation to such an element in each f-plane

 to which it belongs.

The condition (28) now subsumes the Coordinate Structure Constraint, that is, the requirement that the prohibition against vacuous quantification be satisfied in each f-plane to which the relevant operator belongs.

 The CSR requires a certain modification. On the view that there *is* no Quantifier Raising, a quantifier in one conjunct may bind a variable in another conjunct, both as a pronominal or a reflexive, as in (29).[[3]](#footnote-3)

(29) a. *every man* and *his* dog

 b. *every man* and a picture of *himself*

This presents a problem for the CRS since according to the CRS, *his* as a variable in (48a) and *himself* as a reflexive and a variable in (48b) require an antecedent in each f­plane to which they belong. But the only f-planes to which they belong will not contain an antecedent, given that no Quantifier Raising takes place. The only antecedents they take belong to other f-planes. The CSR should thus be modified to the effect that an element x that enters a required syntactic relation R to an element y in one f-plane to which x belongs has to enter this relation to an element in each f-plane to which x belongs:

(30) Condition on establishing required syntactic relations in a phrase marker (CRS –

 modified version

If an element x (because of its lexically specified function) must stand in a syntactic relation to another element and it stands in this relation in some f-plane to which x belongs, then it must stand in this relation to an element in each f­ plane.

The possibility that an anaphor takes an antecedent in an f-plane to which the anaphor does not belong motivates the following condition on anaphoric relationships and variable binding in three-dimensional phrase markers:

(31) Anaphoric relations and variable binding may be established directly in

 three­dimensional phrase markers, subject only to CSR.

Binding of an element in one conjunct by a quantifier in another conjunct will require a modification of the notion of c-command in three-dimensional phrase markers, so that *every man* will c-command *his* in (48a) and *himself* in (48b) (see Section. ).

**1.4. Syntactic conditions that cannot be satisfied in f-planes**

One of the main motivations of three-dimensional syntax of coordination was that the syntax of coordinate sentences can be reduced to the syntax of non-coordinated sentence by applying grammatical principles to individual lanes. However, certain syntactic conditions are clearly not satisfied inf-planes in coordinate sentences. For instance, plural verb agreement below must take into account elements that belong to distinct planes:

(32) John and Mary are singing.

More generally, the assignment of features to a projection may have to take into account features assigned to expansions in different f-planes. This holds regardless of what kind of m-planes are assigned. It holds even for 'respectively'-sentences, as in (33), which involve 'big' m-planes, m-planes rooted in the IP node.

(33) John and Mary are seeing Sue and Bill respectively.

**1.4.7. The assignment of m-planes to sentences with gapping and bare argument ellipsis vs phrasal coordination**

Let me add a few remarks about the treatment of gapping and bare argument ellipsis. Gapping is considered a structure involving overt clausal coordination and implicit phrasal coordination, and thus multidominance without overt coordinator. This is due to the possibility freely generating multiply dominating nodes without overt coordinator. The presence of the higher overt coordinator is to be enforced as a matter of m-plane construal or interpretation. The interpretations of separate planes have to be combined, which would be possible only by semantically evaluating an overt coordinator.

 There is an important difference between phrasal coordination on the one hand and gapping and bare argument ellipsis on the other hand. Unlike with phrasal coordination, the remnant and the correlate in a gapped sentence may never form a plural term, providing an argument for a collective predicate:

(34) # John shared the coffee and Bill the cake.

The same holds for bare argument ellipsis: the remnant and the correlate cannot constitute a group term providing an argument of a collective predicate:

(35) # John met and Bill (too).

This can be traced to rules of m-plane construal: gapping and bare argument ellipsis obligatorily involve the construal of 'big m-planes'. Thus ( ) has to be associated with the planes with the terminal nodes *John shared the coffee* and *Bill shared the cake* and (. ) has to be assigned the planes with the terminal nodes *John met* and *Bill met.* The reason is that m-planes construed on the basis of splitting nodes without overt coordinator have to 'meet' in a node immediately dominating an overt coordinator. In (. ), this node is the IP node. Since these planes must be semantically evaluated, the unacceptability of ( ) follows.

*respectively*-sentences

**4.7. Representing asymmetries among coordinates**

A general problem for a three-dimensional approach to coordination (as well as for syntactic theories of coordination in general) is the syntactic status of the coordinator. I propose an account of the position of the coordinator which also provides a way of representing asymmetries among conjuncts, as in the examples below, where a quantifier in the first conjunct may bind a pronoun in the second conjunct, but not vice versa.

(36) a. *every man* and *his* wife

b. *every man* and two of *his* children

c. *every man* and a picture of *himself*

(37) a. \* *his* wife and *every man*

b. \* two of *his* children and *every man*

c. • a picture of *himself* and *every man*

Another binding asymmetry, mentioned by Munn (1991) is the possibility of an R­ expression in the first conjunct being coreferential with a pronoun in the second, but not vice versa:

(38) a. *John's* dog and *he/him* went for a walk.

 b. \* *He* and *John's* dog went for a walk.

Another case of a binding asymmetry noted by Munn involves reciprocals:

(39) a. Theyi liked stories about themi and each otheri.

b. • Theyi liked stories about each otheri and themi.

For a three-dimensional syntactic theory, such data require first of all that conditions of Binding Theory to apply across planes. In addition, the theory needs to implement the asymmetry among coordinates. I propose that coordinators are formal adjuncts of (at least) one of the coordinates. This is supported by evidence that indicate that the coordinator forms a constituent with the last conjunct, noted by Ross (1967)

(40) a. John left; and he didn't even say goodbye.

b. John left. And he didn't even say goodbye.

c. \* John left and. He didn't even say goodbye.

Thus, the VP of (41a) has the following structure:

(41) a. John met *every man* and *his* wife.

b. John met every man (and his wife)

The possibility for Binding Theory to apply across planes and thus a quantifier in one conjunct to be able to bind a variable in another conjunct requires a new notion 'c-command'. The c-command relation should be able to obtain among nodes contained in different planes:

(42) C-command for three-dimensional phrase markers

 Let (N, D, P) be a three-dimensional phrase marker.

 x **c-commands** y in (N, D, P) iff x does not dominate y in all f-planes (N', D', P') of

 (N, D, P) such that x belongs to N', and every branching node z that dominates x

 dominates y.

Given that dominance is reflexive, no node will c-command itself. According to (71), DP1 c-commands DP3 in (70b) because every branching node dominating DP1 also dominates DP3 and DP1 does not dominate DP3 in all f-planes to which DP1 belongs (DP3 not being contained in one of the two f-planes which contain DP1). But DP3 does not c-command DP1, since it is dominated by a branching node DP2 which does not dominate DP1.

 On this account, the asymmetry among the conjuncts crucially depends on the presence of the overt coordinator. Note that the asymmetries also show up among (non-initial) conjuncts without overt coordinator, as in the following a-sentences, which are just as good the b-sentences.

(43) a. *every man, his* car and *his* dog

b. *every man* and *his* car and *his* dog

(44) a. *John's* dog, *he* and Mary left for a walk.

b. *John's* dog and *he* and Mary left for a walk.

(45) a. *They* told stories about *each other, them* and *each other's* friends.

b. *They* told stories about *each other* and *them* and *each other's* friends.

 The asymmetries hold in fact among any two conjuncts where one precedes the other:

(46) a. John and *every professor,* and *his* assistant

 b. John, *every professor,* Mary, and *his* assistant

 c. \* John, *his* assistant, *every professor,* and Mary

 d. \* John, *his* assistant, Mary, and *every professor*

This means that that every conjunct should contains a coordinator, which, though, may stay silent or else will later be deleted. The hierarchical structure thus should be extended to all conjuncts.

Note that phenomena that have motivated specifically the three-dimensional account of coordination, such as ATB extraction, may cooccur with phenomena involving binding asymmetries in the same structure:

(47) a. A man t and his wife t entered the room from Germany

b. \* Who did John meet a daughter oft and her husband?

In (47a) *a man* in the first conjunct binds *his* in the second conjunct and extraction of *from Germany* has taken place from both conjuncts across-the-board.

 There is the question why coordinators are excluded in initial conjuncts:

(48) \* And John and Mary met

Coordinators preceding initial conjuncts actually are not generally prohibited. Many languages have constructions in which also the initial conjunct may be preceded by a coordinator. This is the case, for instance, in the construction *et-et* in Latin or *ou-ou* in French. Also *either* or *whether* in English can be considered coordinators adjoining to initial conjuncts. The only difference between coordinators adjoining to initial conjuncts and coordinators adjoining to noninitial conjuncts is that there are generally more conditions on which coordinators may or must occur as adjuncts to initial conjuncts.

**A new formalization**

I will now formally present a theory of three-dimensional phrase markers which differs from the theory presented in Section in the relevant respects. This theory is also based on the notion of a precedence/dominance tree. However, it differs with respect to the possibility of joining nodes, the relation between coordinators and splitting nodes, the status of coordinators and with respect to the role of planes.

* + 1. **The definition of phrase markers**

The modifications of the previous definition of phrase markers concern first the status of joining nodes and second the status of splitting nodes. Now no structural conditions will be imposed on joining nodes (such as the condition of being rightmost in the tree). Rather the relevant restrictions follow from rules of linearization. There will be just a single condition on coordinators. A three­ dimensional phrase marker should allow for tree configurations of explicit phrasal/clausal coordination (e.g., *John and Mary came*)

as well as gapping and bare argument ellipsis (e.g., *John saw Sue and Bill Mary*), that is, the following configurations:

(49) a.

 b.

The definition of a precedence/dominance tree itself is sufficiently liberal to allow for those configurations. Coordinators in the present theory do not have a special syntactic status, but are simply adjuncts to one of the conjuncts. This means that they always belong to one of the f­ planes of a three-dimensional phrase marker. There is only conditions on the occurrence of coordinators, namely that each splitting node either immediately dominate a coordinator or be dominated by a node immediately dominating a coordinator so that no other splitting node intervenes between the splitting and the node dominating the coordinator.

(50) Condition on coordinators

 Let (N. D, P) be a PD tree.

 If x is a splitting node in (N. D. P), then there is a j in N such that either x Di j

 or there is a y in N such that y D x and y Di j and for no splitting node z in N, z, x,

 z *≠* y, y D z and z D x, there is a coordinator j' in N such that z Di j'.

Note that (50) does not say anything about whether the node y has to itself be a splitting node or not. y is a splitting node in the configurations (50c) and (50d), but not in the case of gapping and bare argument ellipsis in (50b).

 A three-dimensional phrase marker then is simply as a DP tree satisfying the condition on coordinators:

(51) A **three-dimensional phrase marker** is a DP tree satisfying the condition (86).

This is a less restrictive account of three­ dimensional phrase markers than the one given earlier. A number of restrictions will now not follow from the definition of a phrase marker itself, but rather from other components of the theory, in particular, conditions on the satisfaction of syntactic principles in three-dimensional phrase markers, rules for the construal of m-planes, the general requirement that a three-dimensional phrase marker be interpretable and rules of the linearization of a coordinate sentence at PF.

 The satisfaction of the prohibition against vacuous quantification can be stated as in (51):

(52) A three-dimensional P marker (N, D, P) **satisfies the prohibition against vacuous**

 **quantification** iff every f-plane in PA(N,D, P) satisfies the prohibition against vacuous

 quantification.

More generally, the requirement that elements requiring a syntactic relation to another element have to enter that relation to such an element in each f-plane can be stated as in (53):

(53) A three-dimensiona1 phrase marker (N, D, **P) satisfies the CRS** iff for any x in N which

 requires a syntactic relation R to an another element the following holds: for each (N', D',

 P') in FPA(N, D, P) such that x is in N', there is an element y in N' such that R(x, y) in

 (N', D', P').

We can now turn now turn to how m-planes are construed and permit the interpretation of a sentence can be interpreted with respect to a three-dimensional phrase marker.

* + 1. **M-plane assignment**

M-planes determine the units of semantic interpretation of three-dimensional phrase markers. At the same time, m-planes represent the scope of coordinators. However, since I will discuss the conditions governing the scope of coordinators only in later sections, I will restrict the discussion of m-planes in this section to simple cases of NP and IP coordination and gapping, where the scope of the coordinator roughly corresponds to the set of the nodes dominated by the node on which the coordinator depends.

 I will first define an m-plane. M-planes are associated with a splitting node, or, for instance in the case of gapping, with two splitting nodes. In order to provide a general enough definition, I will define an m-plane associated with two splitting nodes x and x', whereby x may be identical to x'. Furthermore, I will assume that m-planes have to have a root node dominating a coordinator. Later, however, we will see that this condition has to be revised for certain cases. M-planes should then include exactly one expansion of x, all nodes dominated by x and all nodes dominating x and dominated by y. In this sense, m-planes have to be maximal. Thus m-planes can be defined as below:

(54) (Preliminary) Definition of m-plane

Let x and x' be a splitting node in a three-dimensional phrase marker (N, D, P).

 An **m-plane associated** with x and x' is a maximal subphrase marker (N', D', P') of

 (N, D, P) such that N' contains exactly one expansion of x and exactly one

 expansion of x' and the root node of (N', D', P') is the lowest node y such that y

 dominates x and a coordinator J.

We will see later that the definition in (54) is too narrow in three respects. First, it holds only for splitting nodes that are IPs or referential NPs. Second, it does not account for wide scope coordinators and in particular 'respectively'-sentences (see Section 1.6.).

Third, it only defines obligatory planes, which are the planes rooted in a node dominating a coordinator. We will see in Chapter 3, that a sentence may also be assigned nonobligatory planes, which can be rooted in a splitting node not dominating a coordinator.

 Let us now define an m-plane assignment, as a complete set of m-planes associated with splitting nodes x and x' is a set of m-planes which are all rooted in the same node:

(55) Let x be a splitting node in (N, D, P).

 **A complete set of m-planes C** associated with splitting nodes x and x' is a

 maximal set of m-planes associated with x and x' such that there is a y such that for

 every **(N',** D', P') in C, y is the root of **(N',** D', P') and for any distinct **(N',** D', P') in

 C and (N", D", P") in C, N' and N" contain distinct expansions of x and distinct

 expansions of x'.

This definition guarantees that the m-planes in a complete set of m-planes all share the same root node. Also, it requires that m-planes be distinguished from each other by containing different expansions of the same splitting node(s). Furthermore, it ensures that the m-planes be 'anchored in a coordinator', i.e., have a root node dominating a coordinator. This condition clearly does not allow for wide scope of coordinators and it will be modified in later sections.

 In the definition just given, in the case of ordinary coordination, x, x'and y coincide. In. the case of bare argument ellipsis, x and x' coincide but differ from y. Inthe case of gapping, x and x' are distinct. In this case, m-planes have to differ both with respect to the choice of an expansion of x and the choice of an expansion x'. This captures the observation that gapping allows for only two meaningful planes, unlike multiple ordinary phrasal coordination.

 The definitions are formulated in a way general enough to cover both ordinary coordination, bare argument ellipsis and gapping.

 In order to represent the coordinator associated with a complete set of m-planes explicitly, let us define a **complete m-plane pair** asa pair consisting of the (singleton) set containing relevant coordinator and the complete set of m-planes associated with that coordinator:

(56) <X, Y> is a **complete m-plane pair** iff X contains only coordinators and Y is a

 complete set of m-planes associated with the splitting nodes x and x' and j is

 dominated by the root of the m-planes.

The reason why the first argument of a complete m-plane pair is a set containing the coordinator, rather than a coordinator itself, is that complete m-plane pairs should be admitted that are not associated with a coordinator. In this case, the first element of the pair is the empty set. Complete m-plane pairs of this sort will play a role in the implicit coordination constructions discussed in Chapter 3.

 An m-plane assignment, for the present purposes, should consist of at least as many complete pairs of m-planes as there are coordinators in the sentence. Consider (95).

(57) John or Mary compared Sue and Bill.

(57) is associated with two complete m-plane pairs, one associated with the splitting node dominating *and* and one associated with the splitting node dominating *or.* The m-planes associated with *or* include each of the two m-planes associated with *and.* The set of the two *sets* of complete pairs of m-planes will be called an **m-plane assignment** for (57). The m-plane assignment for (57) can be represented by only mentioning the terminal nodes of the planes as in (58):

(58) {<{*or*}, {*John compared Sue and Bill, or Mary compared Sue and Bill*}*>,*

 *<*{*and*},{*Sue, and Bill*}>)}

An m-plane assignment can now be defined as a set of complete m-plane pairs which in a certain way 'exhaust' the splitting nodes in the three-dimensional phrase marker. The definition is given in (59):

(59) An **m-plane assignment** Mfor a three-dimensional phrase marker (N, D, P) is a set

 of complete m-plane pairs such that each splitting node in (N, D, P) is associated

 with exactly one element in M.

(59) only requires that each splitting node in a phrase marker be associated with exactly one complete set of m-planes; it does not require the converse, namely that each complete set of m-planes in the m-plane assignment be associated with exactly one splitting node. This is so in order to allow for gapping, where a complete set of m-planes is associated with two splitting nodes.

* + 1. **The interpretation of a sentence relative to an m-plane assignment**

In three-dimensional syntax, the semantic interpretation of a sentence is relativized both to a phrase marker (N, D, P) and an m-plane assignment M to (N, D, P). The m-plane assignment will determine which sequences of terminal elements will be assigned a meaning as a unit.

 The compositional interpretation of a coordinate sentence relative to an m­plane assignment will then proceed as follows. First, consider the set(s) of the smallest m-planes and evaluate the terminal nodes of the set with respect to those planes. Then evaluate the relevant coordinator relative to the semantic values of those planes. Then proceed to the set(s) of the next larger planes and so on.

 I will adopt the view that compositional interpretation is based on systematic correlations between syntactic relations or functions and semantic operations.[[4]](#footnote-4) associated semantic types. Here are the basic assumptions and notions of this view of compositionality. In every language, specific syntactic relations or functions are correlated with semantic operations or semantic conditions on meanings. Syntactic relations hold between constituents or more generally parts. of sentences relative to a phrase marker and an assignment of m-planes. Syntactic functions hold of individual constituents in a sentence relative to a phrase marker and m-plane assignment. Both syntactic relations and syntactic functions have to be syntactically identifiable for a sentence. They are associated with what I call **'identification conditions'.** Identification condition consist for instance in information about the syntactic position and about morphological properties of constituents.

 **Semantic operations** are functions from n-tuples of meanings to meanings. **Semantic conditions** impose certain requirements on meanings that can be assigned to a sentence. For instance. the syntactic relation of coindexing between anaphors and their antecedents is correlated with the semantic condition that the referents of the anaphors and the antecedents be identical. Semantic conditions can be conceived simply as relations between meanings of constituent. Formally the correlation between syntactic relations or functions and semantic operations or conditions will be a set **corr** of pairs consisting of a syntactic relation or syntactic function R and a semantic operation or condition O.

 Semantic composition then consists in the following. Let R be an n-place syntactic relation correlated with a semantic operation O (<R, 0> corr. Syntactic relations R are functions always are relativized to a phrase marker T and, in the case of a three-dimensional phrase markers to an m-plane assignment M (R(T, M)). If constituents x1, x2, …, xn stand in the relation R in a phrase marker T, i.e. if <x1, x2, .., xn> ∈ R(T, M), then the application of O to the meanings of x1, x2, …, xn gives the meaning of the syntactic unit consisting of x1, .., xn. In the case of a two-dimensional phrase marker, this syntactic unit is the sequence of x 1, ... , xn, i.e., xl^… ^xn. That is, given is the semantic interpretation function and T is a two-dimensional phrase marker, we have O([xl]T, [x2]T, ..., [xn]T) = [xi … xn]T. I will later come to how this principle applies to three-dimensional phrase markers.

If R is a syntactic function of a single constituent correlated with a semantic condition C, then we have C([xl]). More precisely, the following two principles hold for semantic composition, where [] is the semantic interpretation function relative to a sentence S, a phrase marker T of S and an m-plane assignment of P.

(60) a. Let R be an n-place syntactic relation and O an n-place semantic operation such

 that <R, O> ∈ corr.

If for a sentence S with a phrase marker P and an m-plane assignment M,

<xl, .... xn> ∈ R(T), then O([xl](T), ... [xn](T)) = [xl … xn](T)

 b. Let R be an n-place syntactic relation and O an n-place semantic condition such that

 <R, O> ∈ corr.

If for a sentence S with a phrase marker P and an m-plane assignment M,

<xl, .... xn> ∈ R(T), replace [xi] in such a way that O([xl](T), … [xn](T)).

The syntactic relations or functions R need not involve constituents; they may also be applicable to three-dimensional syntactic units, such as complete m-plane pairs.

 I will show to how this conception of compositional interpretation applies to three-dimensional phrase markers below. First, I will restrict myself to two-dimensional phrase markers and only later generalize the relevant notions and principles to three-dimensional phrase markers.

On the basis of the syntactic relations and functions holding of constituents of parts of a sentence, a precise formulation of the principle of Full Interpretation (Chomsky 1985) is now available. First of all, every sentence with a phrase marker P will be associated with a set of n-tuples which are arguments of meaningful syntactic relations. I will call such a set a 'functional assignment' to a sentence relative to a phrase marker:

(61) The **functional assignment** to S relative to a phrase marker T is a set F of pairs

 consisting of a syntactic relation R or function and an n-tuple <x1,…, xn> such

 that <xl, ..., xn> ∈R(S, T).

The principle of full interpretation then says that every terminal element must be a component of such an n-tuple:

(62) The Principle of Full Interpretation (FI)

 For every sentence S with a phrase marker T, there must be a functional assignment F

 to S relative to T such that every constituent C of S relative to T is a component of an

 n-tuple in a pair in F.

An m-plane assignment can now be conceived as a part of a functional assignment to a sentence. An m-plane assignment contains all the pairs that stand in the relation of being argument of a coordinator to each other. In fact, an m-plane assignment is enforced by FI because the coordinators have to stand in a meaningful syntactic relation to other elements. The condition on complete sets of m-planes then constitute the identification condition on such coordinator relations. Thus, we redefine the relevant notions in the following way.

(63) Identification condition for the coordinator-relation

 <Y, X> ∈ j-coord iff X is a complete m-plane pair and all elements in Y are

 coordinators of type j.

(64) Definition of an m-plane assignment

 Let S is a sentence with a three-dimensional phrase marker T and functional assignment

 F, satisfying FI.

 The **m-plane assignment** to S relative to T is the greatest subset M of F such that the

 first component of every element in M is coord.

In syntactic theories, syntactic relations generally are conceived not as relations between constituents, but rather as relations between category nodes in a tree, where the category nodes are the lowest nodes dominating all the elements the constituent consists of. But there is always a one-to-one correspondence between the relevant category nodes and strings of terminal elements:

(65) Let T be a (two-dimensional) phrase marker and X a string of terminal elements.

 The category node of X in T (cat(X, T)) is the lowest node y in T such that for any

 (66) element x of X, y D x.

This leads to the following condition on the identification of syntactic relations among strings of terminal elements, where R is a meaningful syntactic relation defined in traditional syntactic way and R' the corresponding syntactic relation among strings of terminal elements:

(66) Let T be a (two-dimensional) phrase marker, X1, ..., Xn strings of terminal elements such

 that cat(Xi, T) = xi, and R an n-place meaningful syntactic relation.

 If R(xl, .... xn), then R'(Xl, …, Xn).

In the following, I will use terms for syntactic relations ambiguously for either category nodes or strings of terminal elements. The definitions (64) and (65) later have to be modified to account for three-dimensional phrase markers.

 The distinction between syntactic relations holding among strings of terminal elements and category nodes is not only required conceptually. It will also play an empirically significant role in the behavior of elements with respect to ATB reconstruction, as discussed in Section .

 A number of remarks are in order about the nature of meanings that I will assume. In this dissertation, I will assume an indirect semantics. That is, natural language expressions are translated into a semantic representation language, rather than assigned model-theoretic meanings directly. Note that this assumption is independent of the particular conception of compositionality that I adopt. The semantic operations associated with syntactic relations or functions are then syntactic operations on expressions of the semantic representation language. The semantic representation language that is required for the present purposes is simply the language of first-order logic with the property abstractor and the description operator Fur the explicit semantic translation, I will disregard quantifiers such as *most* and *few* and many other expressions that are not in the focus of investigation (at least in the first four chapters of this dissertation).

 The semantic representation language contains the following special symbols. + is a two-place functional parameter, > (is a part of) a two-place predicate parameter. In part, expressions from the object language English will be used for individuals and predicate parameters, for instance 'John', 'Mary. 'meet', love'. Following the tradition of Davidson (1967). I will assume that every verb that takes n arguments is translated as an (n+1)-place relation, where the first argument position is occupied by (single or plural) events.

 The symbols of the semantic representation language are partly listed below:

Individual parameters

John, Mary, Bill, Sue,

Individual variables: x, y, z, …

Plural variables: xx, yy, zz, …

Relational parameters

one-place predicates: 'man', 'dog', ...

two-place relations: 'come', < (is part of),

three-place relations: 'meet', admire', praise', criticize', ...

four-place relations: 'show', 'give', ...

Logical constants

&, v, 🡪, -. =, λ (as a property formation operator), ι (the description operator), + (the complex plural term functor)

 Given the adoption of an indirect semantics, [] is to be understood as a function from occurrences of natural language expressions in a sentence S to expressions of plural logic relative to a phrase marker T of S and an m-plane assignment M to T. Proper names are translated simply into individual parameters. The coordinator *or* is always translated as the logical constant 'v'.

(67) If *or* occurs in a sentence S with a phrase marker T and a plane assignment M, then

 [*or*]S, T, M = v .

In contrast, *and* is translated a plural connective + (see Chapter 1).

 Every proper name is translated as the parameter represented by the same name. Furthermore, every verb and every noun is translated as the predicate parameter represented by the same verb or noun.

(68) If(x is a noun or verb in S relative to T and M, then [x] T, M = x.

Furthermore, I will assume that finite verbs are always interpreted in such a way that the event variable is bound by an event quantifier. However, I will completely disregard tense. Thus, for transitive verbs (and analogously for intransitive verbs), we have the following condition on []:

(69) If X is a finite transitive verb in S with respect to T and M, then

 [X]T, M = λxy[∃e([X]T, M(e, x, y))].

Let me illustrate how semantic composition works in this view with the syntactic relation of argumenthood. I will first consider the case of non-coordinate structures and later generalize the definitions to three-dimensional syntactic units. (11la) and (11lb) give the definition schemas for the syntactic relation of argumenthood and the associated semantic operation.

(70) a. The relation of argumenthood

 Let T be a phrase marker. For strings of terminal elements x1 and x2 in T,

 <x1, x2**>** ∈ ARGi, k(T) iff x2 is k-place and x1 is the ith argument of x2.

 b. The operation of argument satisfaction

 For a k-place relation symbol and an individual symbol x,

 argi, k(R, x) = λy1,...,yi-1, yi+l, .. yk[R(yl, y2, ... , yi-1, x, yi+l, .., yk)]

 c. <ARGi, k, argi,k> ∈ corr.

The syntactic relations of argumenthood are associated with certain identification conditions. For instance, we have (71a) and (71b) for the relation 'is the internal argument or and the relation of 'is the subject of’.

(71) Let T be a phrase marker and x1, x2 strings of terminal elements of T.

 a. <x1, x2> ∈ ARG2,2(T) ('x1 is object of x2') iff the lowest maximal projection

 dominating x1 is immediately dominated by the smallest maximal projection

 dominating x2.

 b. <x1, x2> ∈ ARG1, l(T) ('x1 is subject of x2') iff the lowest maximal projection

 dominating x1 is sister of the lowest maximal projection dominating x2.

We can now apply the syntactic relations and semantic operations to an example:

(72) John met Mary.

According to (70) and (71), we get the following translation for the primitive constituents in (72) (relative to a phrase marker T and an m-plane assignment M):

(71) [*John*]S*,* P, M = John

 [*Mary*]S, P, M = Mary

 [*met*]S, P, M = λxy[∃e meet(e, x, y)]

Given the syntactic positions of the NPs relative to the verb in (113), we have the following syntactic relations in (115).

(72) a. *<Mary,* met> ∈ ARG2, 2(T)

 b. *<John, met Mary>* ∈ ARG1, 1(T)

Given the correlation of these syntactic relations with semantic operations, we can apply semantic operations as in (116).

(73) a. arg2, 2([*Mary*], [*met*]) = λx[∃e(meet(e, x, Mary)]

 b. argl, 1([*John*], [*met Mary*])= ∃e(meet(e, John, Mary))

Now let us tum to the more difficult task of translating quantificational sentences. For reasons given later (Chapter 4), I will assume a syntactic representation of quantifier scope in the way proposed by Williams (1986), rather than by Quantifier Raising in the tradition of May (1977). On Williams' proposal, a quantifier is coindexed with die category dominating its scope. Thus for (74a), we have the representation of quantifier scope in (74b):

(74) a. Every man came.

 b. [IP [Every man]i came]i

More precisely, a quantifier such as *every* in (74a) enter a syntactic relation to their restriction (i.e., *man*) and their scope, i.e., *every man came.* For universal quantifiers, there will thus be a relation UNIVQUANT that applies to the phrase marker T of (74a) as below:

(75) *<every, man, every man came>* ∈ UNIVQUANT(T).

From this relation we want to get to the following(77) semantic representation:

(76) ∀x(man(x) 🡪 ∃e come(e, x))

This requires first an adequate translation for the scope of the quantifier, i.e., the third argument of UNIVQUANT. For that purpose, we can assume that quantifiers by themselves are always translated as just variable:

(77)n If X is a quantified DP in T and M, then [X]T, M = x.

Given the translation of the finite verb form *came* according to ( ), we get the property in (78) as the translation as the third component of the triple in (. ).

(78) [*every man came*]T, M = λx[∃e come(e, x)]

Only the quadruple consisting of the quantifier, its restriction and its scope is translated into a quantificational structure:

(79) a. *<every, man, every man came>* ∈ UNIVQUANT(T)

 b. univquant(<[*every*], [*man*]. [*every man came*]>) = ∀x(man(x) 🡪 ∃e(come(e,

 x))

More generally, we have the following syntactic relation and correlated semantic operation:

(80) a. The scope relation for universally quantified DPs

 Let X1, X2 and X3 be constituents of S with a phrase marker T and an m-plane

 assignment M.

 <Xl, X2, X3> ∈ UNIVQUANT(S, T, M) iff xl is of the form *every*

or *all,* X1^X2 is a DP in S relative to T, X3 is the smallest IP in T containing

 Xl^X2.

 b. univquant(<X1, X2, X3>) = ∀x(([X2](x) 🡪 [X3](x)).

 c. <UNIVQUANT, univquant> ∈ corr.

Similarly, for existentially quantified NP we have:

(81) a. The scope relation for existentially quantified DP

 Let X1, X2 and X3 be constituents of S with a phrase marker T and an m-plane M.

 <Xl, X2, X3> ∈ EXISTQUANT(S, T, M) in T iff Xl is of the form *some a* or 0,

 Xl^X2 is a DP in S relative to T, X3 is the smallest IP containing Xl^X2.

 b. The semantic operation for existentially quantified DPs

 univquant(<Xl, X2, X3>) = ∃x([X2](x) & [X3](x)).

 c. <EXISTQUANT, existquant> ∈corr.

Later, in Chapter 4, we will see that the condition on the syntactic relations UNIVQUANT and EXISTQUANT have to be revised in certain ways.

 Pronouns are translated either as parameters or as variables. How they are translated depends on whether they are coindexed or contra-indexed with another DP. Assuming standard identification conditions for coindexing and contra-indexing, we have the following principles:

(81) a. <Xl, X2> ∈ COIND(S, T, M), then [Xl] = [X2].

 b.. <ANAPH, => ∈ corr.

(82) a. <Xl, X2> ∈CONTRAIND(S, T, M), then [Xl] ≠ [X2].

 b. <CONTRAIND, ≠> ∈ corr.

(83) If X is a pronoun in S with respect to T and M, then choose a variable or

 parameter c, [X]T, M = c, so that (81a) and (81b) are satisfied.

I will now tum to the task of generalizing this conception of compositional semantic interpretation to three-dimensional phrase markers. This requires both dealing with multidominance and with the role of f-planes and m-planes in establishing meaningful syntactic relations.

 First, I will have to generalize the notions for meaningful syntactic relations to three­ dimensional phrase markers. In the semantic interpretation of coordinate sentences, meaningful syntactic relation have to be established that involve not just constituents, but also the terminal nodes of complete sets of m-planes, that is, 'three-dimensional syntactic units'. Consider (. ) with the m-plane assignment given in (. a) and the f-plane assignment g. In order to evaluate ( ) semantically, the following meaningful syntactic relation has to established among a set of terminal nodes and a terminal node of the phrase marker T of (. ).

(84) {*John, and* Bill} is second argument of *met.* in T.

How is this relation established? There are two possibilities for establishing the relation in (84). The first possibility involves f-planes. The second one involves m-planes and is based on the correlation between syntactic relations among terminal elements and syntactic relations between category nodes.

 The first alternative of establishing the relation in (84) goes as follows. (84) holds because the relation of argumenthood holds in a corresponding way between terminal elements; Given that we have the notion of an f-plane available for independent reasons, we can say that (85) holds because (85) holds:

(85) *John* is second argument of *met* in the first f-plane;

 *Bill* is second argument of *met* in the second f-plane.

Thus, a generalized relation of argumenthood ARG as in (86), based on the notion of 'correspondent' in (87).

(86) Definition of ‘correspondent’

 Let X be a constituent or a set of constituents. A constituent x is a **correspondent** of X

 if x = X or x is an element of X.

(87) Definition of argumenthood for three-dimensional syntactic units

 Let T a phrase marker and X1 and X2 constituents or sets of constituents.

 <Xl, X2> ∈ ARGi, k(T)iff for every f-plane T' ∈FPA(T), there is a correspondent x1

 of X1 and a correspondent x2 of X2 such that <x1, x2> ∈ ARGi, k(T)

More generally, we can posit the following principle for establishing meaningful syntactic relations among three-dimensional syntactic units.

(88) Definition of Meaningful Syntactic Relations among Three-Dimensional Syntactic

 Units

 Let T be a three-dimensional phrase marker, M an m-plane assignment of T,

 X1, ..., Xn sets of strings of terminal elements of complete sets of m-planes in M or

 strings of terminal elements, and R an n-place meaningful syntactic relation.

 <X, Y> ∈ **R'(T)** iff for every T in FPA(T) there is a correspondent x of X and a

 correspondent y of Y such that <x, y> ∈R(T).

 Let us now tum to the second alternative of defining the relation in ( ). For that purpose, the notion of a category node has to be generalized to three­dimensional syntactic units, that is, sets of strings of terminal elements that are not ordered with respect to each other with respect to precedence:

(89) Let X be set of elements, T a three-dimensional phrase marker and R a meaningful

 syntactic relation.

 The **3D-category node** of X (3D-cat(X, P)) is the lowest node y in T such that for

 every X' in X, y = cat(X', T) and for every Y such that y = cat(Y, T), Y X.

Clearly, X in (89) may also be a complete set of m-planes. In fact, meaningful syntactic relations among three-dimensional syntactic units generally involve complete sets of m­ planes. But what is the relation between sets of sets of strings of terminal elements and the category nodes among which syntactic relations are first established? The following definition generalizes over the two-dimensional and the three-dimensional case.

(90) Let T be a three-dimensional phrase marker, x1, **...,** xn category nodes in T, M an

 m-plane assignment to T, R a meaningful n-place syntactic relation, and Xi either a

 complete set of m-planes in M or a string of terminal elements such that xi∈ cat(Xi, T)

 for O < i < n.

 If R(xl, ..., xn), then R'(Xl, ..., Xn).

We can now apply the definition (90) to the three­dimensional phrase marker of (. ). {*John, and Bill*}is a complete set of m-planes with DP1 as its category node. Given the identification condition in (89b), DP1 is first argument of the VP node. Therefore, given (90), {*John, and Bill*} will be the first argument of *met* in (. ).

 It is easy to see that the two alternatives of defining syntactic relations between three­ dimensional syntactic units are equivalent.

 Both definitions do not exclude the possibility that an element of a complete m-plane by itself stands in a relation to an element outside this set of m-planes. This is the case, for instance, in (91).

(91) John compared himself and Mary.

In (91), the complete set of m-planes associated with *and* is the set {*himself, and Mary*}*.* However, only *himself* stands in the relation of anaphorhood to *John.*

 In either way of establishing the relation in (129), we also get the case in which the verbs or verb phrases are coordinated and the case in which both the argument and the verbs or verb phrases are coordinated as in (92).

(92) a. John came and left.

 b. John and Mary met and sat down.

In the case of (92a), we have the relation in (93a), in the case of (92b) the relation in (93b) (for a relevant phrase marker T and an m-plane assignment M).

(93) a. *<.John,* {*came, and left*}> ∈ ARG1,1(T, M)

 b. < *John, and Mary*}*,* (*met, and sat down*}*>* ∈ARG1,1(T, M).

When complete sets of m-planes stand in meaningful syntactic relations to other syntactic units, they of course must themselves receive a semantic evaluation. The strings of terminal nodes in complete m-plane pairs are assigned a semantic value, based on the meaning of the coordinators in the first argument and the meaning of the terminal nodes of the m-planes. For the moment, I define the semantic interpretation of three­ dimensional syntactic units as follows, where [] on the right-hand side is the standard semantic interpretation function (implicitly relativized to a phrase marker and an m-plane assignment).

(94) The semantic interpretation of complete m-plane pairs

 Let T a three-dimensional phrase marker and M an m-plane assignment M to T.

 If for a complete m-plane pair <{j}, **{**X1**, ...,** Xn}> M, xi is the string of terminal

 nodes of Xi (i ∈ { l, ..., n}).

 [<xl, .., xn>]T, M = [j]T, M({[xt]T, M, [x2']T, M, ... , [xn']T, M}), where xi' is obtained from

 xi by leaving out an initial coordinator.

Let me illustrate how the semantic interpretation works in detail for the simple example *John and Bill met*. For the sake of illustration, I will assume that and translates as +, functor forming from two terms a plurally referring term:

(95) [*and*]T, M = +

Then we have:

(96) [<{*and*}, {*John, and* Bill}>]T, M = [*and*]T, M({[*John*]T, M, [*Bill*]T, M}) = [John + Bill]T, M

[*met*]T. M in *John and Bill met* will then apply to the plurality of John and Bill*.* Thus, based on the syntactic relation in ( ), which is evaluated roughly as (96):

(96) meet(John + Bill).

However, the schema of interpretation is general enough to be carried over to the semantics of more complex coordinate sentences, also with other coordinators. In Chapter 3, the semantic interpretation of coordinate sentence relative to an m-plane assignment will be elaborated in more detail for a number of other cases.

**1.5.7. The linearization of coordinate sentences at PF**

The remaining task of the theory of coordination is to provide rules of linearization of coordinate sentences at PF. I will presuppose that there is a linearization procedure for non-coordinate sentences. The linearization rules for coordinate sentences can be stated on the basis of precedence relation established on the basis of this procedure.

 Two things play a role for the linearization of coordinate sentences: first, the position of the coordinator in the tree and second the assignment of m-planes. The latter shows that the linearization is in a particular way related to semantic interpretation.

 A general principle for the linearization of coordinate sentences is: preserve the linearization of the terminal elements of the f-planes as much as possible. The ordering relation to be established among the terminal nodes of a three-dimensional syntactic tree is based upon the ordering relation P. In particular, an ordering relation Pi, 'immediate precedence', is established among the terminal elements of each f-plane of a dominance tree. A derivative ordering relation P’ holds among sequences of terminal nodes of the f-planes of a dominance tree. The relations Pi and Pi involve sequence of terminal nodes is defined in (98):

(98) <x1, ..., xn> is a sequence of terminal elements iff xi Pi xi+l for 0 < i <n.

(99) Let X, Y, Z,... be variables ranging over terminal nodes or sequences of terminal nodes.

 a. X P' Yiff for every x in X' and y in Y', x P y.

 b. X Pi' Y iff for the final element x in X' and the initial element yin Y, xPi y.

The task now is to define an ordering relation among the terminal nodes of a dominance tree. I will call this relation of immediate precedence 'L'. Given that the terminal elements or strings of terminal elements of a three-dimensional tree are partially ordered by Pi, we can state the conditions on L. Again, L holds either among terminal nodes or sequences of terminal nodes.

 The linearization of a coordinate sentence requires a recursive definition. I will first define the linearization of non-nested coordinate sentence and then consider the nested case.

(100) L is a linearization of the termjnal nodes or strings of terminal nodes of the three­

 dimensional phrase marker (N, D, P) representing a non-nested coordinate structure

 with an m-plane assignment M iff the following conditions are satisfied:

(i) If X Pi Y Pi Z and for no Y', Y/Y, X Pi Y' Pi Z, then X L Y L Z.

 (ii) If for a maximal set {Y1, ..., Yn} such that X Pi Yk Pi Z (k ∈ {1, ..., n}) and

 Yi = j Y' for some Y' and i ∈{2, ..., n}, then X L Yt L ... L Yn L Z, where X

 (iii) d Y'/j Y", and for V and V' , X L V L Z, X L V' L Z and Y and V belong to the

 same m-plane M' in M and Y' and V' belong to the same m-plane in M, and Y P V,

 then Z Ln j Y V, where j is the coordinator associated with M.

 (iv) After (i) has applied: if for V and V', V/V', V Pi Z and V' Pi Z and for no X

 consisting of elements in N, Y Pi X, then V L Z if for some W Z L W, V' L Z

 otherwise.

(100)(i) ensures that if terminal elements involve no coordination and thus are completely ordered by P, they are ordered in the same way by L. Condition (100)(ii) establishes the ordering relation L among the conjuncts of an ordinary phrasal coordination. Notice that (100)(ii) is intended only for coordinations such as *John and Bill and Mary,* not *John, Bill and Mary.* I will assume that a coordinator *and* between *John* and *Bill* in *John, Bill and Mary* has been deleted at PF, after linearizalion.

 Condition (100)(iii) accounts for gapping and bare argument ellipsis. (100)(iii) states that all but one of the elements dominated by a splitting node without coordinator follow everything else in the sentence. This ensures that all but one of the phrasal conjuncts in gapping and bare argument ellipsis are at the end of the sentence. Furthermore, (100)(iii) states the following for a case in which there are more than one such splitting node (i.e. gapping). The relative order in one f-plane (P) among the elements that are expansions of different splitting nodes must be preserved when these elements are put at the end of the linearized structure. This guarantees that (101a) is linearized for instance as (101b), not as (101c):

(101) a. John met Mary and Bill Sue

 b. John met Mary and Sue Bill.

(l00)(iii) makes reference tom-planes. The intended effect is that the remnants in a gapped sentence belong to the same m-plane and so for the correlates. This accounts for why a sentence with them-plane assignment in (102a) is linearized as in (102b), rather than as, for instance, (102c):

(102) a. {<{*and*}, {*John met Mary, Bill met Sue*}*>*

 b. John met Mary and Bill met Sue.

 c. John met Sue and Bill Mary

(102b) disallows an interpretation in which John met Mary and Bill met Sue. For this reason, (100)(iii) requires that *John* and *Sue* belong to the same m-plane and so for *Bill* and *Mary. As* a further condition that influences the relation between interpretation and of gapping sentences, recall that a complete set of m-planes for gapping may contain only two m-planes.

 Condition (100)(iv) accounts for the linearization of Right Node Raising structures. It says that after a precedence relation among the clausal conjuncts in a RNR sentence has been established, an element that immediately follows (in the sense of Pi) the material in the first conjunct in one plane and the material in the second conjunct in another plane should follow (in the sense of Pi) only the material of the rightmost conjunct (which has been so ordered by the prior application of (100)(ii) to the clausal coordination). This account for the fact that (103a) is linearized as in (103b), rather than as in (103c).

(103) a.

 b. John saw and Sue met this man.

 c. \* John saw this man and Sue met.

1. Within generative syntax, there are two types of proposals for coordinate structures. roughly, one of the approaches captures only the first characteristic of coordinated sentence, the behavior of conjuncts as units, whereas the second one captures only the second characteristic, the independence of conjuncts. The first approach is Williams' (1978) theory of simultaneous factorization. The second approach are theories based on three-dimensional phrase markers, in particular the theories of Goodall (1987) and Muadz (1991). See Moltmann (1992) for a discussion of the motivations and the shortcomings of the two approaches. [↑](#footnote-ref-1)
2. This is essentially reconstruction of Muadz's theory in terms of. formal conditions on phrase markers . Formal conditions on phrase markers or node admissibility conditionswere proposed by Mccawley (1968, 1982) for discontinuous constituents (see also Higginbotham 1983). [↑](#footnote-ref-2)
3. Interestingly not all quantifiers allow for variable binding from one conjunct to another. For instance, *no* does not:

(i) a.\* *No man* and *his* dog entered the room.

 b. \* John saw *no movie* and praised *it.*

Perhaps, *no* obligatory takes narrow scope, a scope which cannot extend over a single conjunct. Then the phenomenon on (1) would be a matter of scope and possibly independent of variable binding. Alternatively, (1) might be ruled out because *his dog* and *no man* do not have the monotonicity properties, a general condition on coordinate NPs (cf. Barwise/Cooper 1982). (la) then would be ruled out for the same reason as (2a), which also contrast with (2b) *with every:*

(i) a.\* No man and Mary/ Mary and no man entered the room.

 b. Every man and Mary / Mary and every man entered the room. [↑](#footnote-ref-3)
4. This conception goes back to ideas of Lieb (l983). It constitutes a very general of conceiving of semantic composition, not tying semantic composition directly to syntactic categories, but syntactic functions or reations that can in. principle be identified on the basis of various syntactic properties, including syntactic categories. This avoids associating semantic types with syntactic categories directly, which is wellknown to be inadequate in general. The conception has again particular motivations from three-dimensional syntax, which does not permit semantic composition to proceed on the basis of syntactic categories alone. [↑](#footnote-ref-4)