In the discussion of natural reasoning in Chapter 4, we have noticed that natural language quantifiers do not realize the full set of combinatorial possibilities for scope dependencies predicted by their semantic type assignment as sets of properties. As a result, certain monotonicity inference substitutions that would be logically valid are not available in natural reasoning. Furthermore, we have seen that the syntactic distribution of certain expressions depends on the semantic properties of other expressions in their syntactic environment, which act as licensors. In this part of the thesis, we investigate these phenomena in more detail switching the focus from natural reasoning inferences to the study of grammatical composition relations.

Linguistic composition is affected by several aspects of the constituents involved. In Chapter 6, we investigate logico-semantic properties of quantifier phrases, and how they influence their different scope behavior. In Chapter 7, we focus attention on the composition relations based on the sensitivity of an item with respect to a certain semantic property shared by other expressions called ‘triggers’. Following [Gia97], we consider the relation between a sensitive item and the trigger to be either a licensing or an antilicensing relation. From this it follows that a structure can be ungrammatical either because the sensitive item is not provided with the required property, or because it occurs in a context supplying the property the item is allergic to. Categorial Type Logic (CTL) helps us clarify these differences among composition relations and the ways scope elements interact.

The behavior both of quantifier phrases and sensitive items provides the information required to reach a classification of such expressions. These classifications can be thought of as reflecting distinctions within the domains of interpretation of the linguistic signs. By means of CTL we spell out the link between the subset relations holding at the semantic level and the way the interpreted items behave syntactically. Using our extended vocabulary of type-forming operators, the subset relations within semantic domains are captured by syntactic derivability relations between types. As a result, we gain a proof theoretical understanding of the syntactic licensing/antilicensing relations.
Chapter 5. Composition Relations

5.1 Two Sorts of Deviations

In her discussion of scopal possibilities [Sza97], Szabolcsi makes an important distinction between coherent and incoherent deviations, illustrated by the two examples below.

(1) a. Three referees read few abstracts. [Three > Few, *Few > Three].
    b. Few referees read three abstracts. [Three > Few, Few > Three].
(2) a. *How didn’t Fido behave?
    b. Who didn’t Fido see?

The difference between (1-a) and (1-b) shows that no incoherence results when few_n takes scope over three_N. This reading, though blocked in (1-a), is available in (1-b). The reason for this contrast is to be found on the syntax-semantic interface and has been described by saying that ‘counting’ quantifier phrases take scope locally [BS97], or in other words that they cannot have scope wider than where they occur overtly.

The sentences in (2) form a different case of deviation. The inability of the wh-phrase how to take scope over didn’t (2-a) is traditionally thought of as the effect of a syntactic constraint: the so-called weak island constraint of Ross [Ros67]. Recently, weak islands have been explained in terms of algebraic semantic characterizations of scope interaction [SZ97], which would explain the incoherence of the interpretation needed in (2-a) and the availability of it in (2-b).

Szabolcsi and Zwarts [SZ97] consider wh-phrases as items sensitive to weak islands, or more specifically, sensitive to the property of the scope elements which form the island. For instance, how is said to be sensitive to the weak island formed by didn’t and the extraction from it is blocked (2-a). Moreover, Szabolcsi and Zwarts show that different wh-phrases are sensitive to weak-islands of different strength.

In the Szabolcsi and Zwarts’ account, for a wh-phrase to take wide scope over some scope element (SE) the definition/verification of the answer involves specific operations associated with the SE. For instance, not corresponds to taking the complement of a set (¬), universal quantifiers are associated with intersection (∩), and existential quantifiers with union (∪). If the wh-phrase ranges over a semantic domain corresponding to an algebraic structure which is not closed under such an operator, it is unable to have scope over the SE. One could say that a wh-phrase is allergic to a property particular to the SE or more generally that it is sensitive to the weak-island formed by the SE. Briefly, the different distributional behavior of wh-phrases receives a semantic explanation: A classification of weak-islands and hence of the extractees can be given based on the properties of their domains of interpretation.

Let us illustrate this theory by looking at an example. From the fact that how ranges over manner adverbial which denote on an algebraic structure closed under ∪, namely semilattices (SL), it follows that how is sensitive to weak islands created by SEs involving ∩ and ¬ (e.g. it cannot have scope over universal quantifier and negation). Similarly, since how many ranges over numbers —lattices (LA) which are closed under ∪ and ∩— and who over individuals —boolean structures (BO) which are closed under ∪, ∩ and ¬ — it follows that how many is sensitive to SEs associated with ¬ (2-a), and who can extract from all weak islands (2-b). Note that since a set inclusion relation
holds among these three algebraic structures, \( SL \subseteq LA \subseteq BO \), a wh-phrase sensitive to a weak island corresponding to a certain structure will be sensitive to a richer one as well, where ‘richness’ is defined in terms of the operations which are defined in the structure. For instance, \( how \) is sensitive to the weak island built by the universal quantifier (which denotes over \( LA \)) and also fails to extract from a weak island built by negation (which denotes over \( BO \)).

(3)  
  a. *How did no kid behave?  

The behavior of wh-phrases with respect to weak-islands can be described in more general terms by considering licensing and antilicensing relations.

5.2 Licensing and Antilicensing Relations

In the discussion of negative polarity distribution in Section 4.1, we have seen that they are items in a licensing relation with downward monotone functions. One could say that they are attracted by the monotonicity property of their licensor and incompatible with functions which do not share this feature. On the other hand, assuming Szabolcsi and Zwarts’ analysis of wh-phrases, \( how \) could be said to be repelled by the property of ‘having the complement operation’, shared by the scope elements interpreted over boolean structures. In other words, the wh-phrase can be said to be in an antilicensing relation with such property. The linguistic classification of Dutch positive polarity items given in [Wou94] could be interpreted in a similar way. We clarify these two composition relations by reviewing the analysis of Dutch negative and positive polarity items.

Recall from Section 4.1 that the polarity of a context is closely connected to the monotonicity of its constituents. The concept of monotonicity is linked to the concept of negation identified by the De Morgan’s laws. The connection between negation and monotonicity has been deeply studied [KF85, Zwa83] and it turns out that the set of antimorphic functions (\( AM \)) —negation-like expressions— is a subset of the set of downward monotone functions (\( DM \)). Moreover, it is possible to identify in the set \( DM \) the subset of antiadditive functions (\( AA \)), satisfying the first De Morgan law and half of the second one. This classification of downward monotone expressions is summarized in Table 5.1 together with the part of the De Morgan’s laws they satisfy. Clearly, an inclusion relation holds among the sets of functions of different negative strength: \( AM \subseteq AA \subseteq DM \).

<table>
<thead>
<tr>
<th>antimorphic</th>
<th>antiadditive</th>
<th>downward monotone</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(X \cap Y) = f(X) \cup f(Y) )</td>
<td>( f(X) \cup f(Y) \leq f(X \cap Y) )</td>
<td>( f(X \cup Y) \subseteq f(X \cap f(Y)) )</td>
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<tr>
<td>( f(X \cup Y) = f(X) \cap f(Y) )</td>
<td>( f(X \cup Y) = f(X) \cap f(Y) )</td>
<td>( f(X \cap Y) \subseteq f(X) \cap f(Y) )</td>
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</tbody>
</table>

| not | nobody, never, nothing | few, seldom, hardly |

Table 5.1: Monotone functions classification.

\(^1\)Notice that the table could include also a fourth subset, namely the one characterized by the second De Morgan law and half of the first one (antimultiplicative). However, these functions seem to have no relevant role in the distribution of polarity items in Dutch [Wou94].
In [Wou94], it is shown that a classification of both Dutch positive and negative polarity items can be given in terms of their sensitivity to (downward) monotonicity properties. The following examples illustrate their different relations with such functions. The monotone functions are emphasized, whereas the polarity items are underlined. We take weinig (tr. few), niemand (tr. nobody) and niet (tr. not) as representative of the sets DM, AA and AM, respectively; the determiner ook maar (tr. any) and the idiomatic mals (tr. tender) are examples of negative polarity items (NPIs) whereas allerminst (tr. not-at-all) and een beetje (tr. a bit) exemplify their positive counterparts. We indicate with % mildly ungrammatical sentences.

(4) a. \%Weinig monniken zullen ook maar iets bereiken. [%DM > ook maar].
   Few monks will anything achieve.
   tr. Few monks will achieve something.
b. Niemand zal ook maar iets bereiken. [AA > ook maar].
   Noboy will anything achieve.
   tr. Nobody will achieve anything.
c. Ik denk niet dat er ook maar iemand zal komen. [AM > ook maar].
   I think not that anybody will come.
   tr. I don’t think that anybody will come
d. *Van weinig monniken was de kritiek mals. [*DM > mals].
   Of few monks was the criticism tender.
   tr. The criticism of few monks was tender.
e. *De kritiek van vader abt was nooit mals. [*AA > mals].
   The criticism of father abbot was never tender.
   tr. The criticism of father abbot was never tender.
f. De kritiek zal niet mals zijn. [AM > mals].
   The criticism will not tender be.
   tr. The criticism will be harsh.

(5) a. *Weinig monniken zijn allerminst gelukkig. [*DM > allerminst].
   Few monks are not-all happy.
   tr. Few monks are not-all happy.
b. Weinig monniken zijn een beetje gelukkig. [DM > een beetje].
   Few monks are a bit happy.
   tr. Few monks are a bit happy.
c. %Niemand is een beetje gelukkig. [%AA > een beetje].
   Nobdy is a bit happy.
   tr. Nobody is a bit happy.
d. Niemand wil nog Donne lezen. [AA > nog].
   Nobody wants still Donne read.
   tr. Nobody wants to read Donne anymore.
e. *Jan wil niet nog Donne lezen. [*AM > nog].
   Jan wants not still Donne read.
5.3 Calibrating Grammatical Composition Relations

Our aim in the next chapters is to obtain a deductive account of the linguistic classifications discussed above. In particular, we account for the scope deviations among quantifier phrases, and the licensing/antilicensing relations using modalities as ‘logical features’ controlling composition relations.

We claim that a type logical approach sheds light on the distinction between (a) an element sensitive to the function which can taken it as argument, and (b) a functional expression sensitive to its argument, e.g. NPIs. Thus, in a function-argument structure the function can be either (a) the trigger or (b) the sensitive item. Moreover, in each case the sensitive item and the trigger can be either in a licensing or in an antilicensing relation. These distinctions call for a general definition of the ways in which linguistic expressions containing sensitive items are composed.

Recall from Section 1.3 that linguistic signs are structured objects and their composition is driven by the way their components interact. In particular, we can think of an expression as a pair consisting of a form component $\alpha$, and a meaning component $\alpha'$, represented as $[\alpha_A : \alpha'_a]$, where $A$ and $a$ are the syntactic and semantic types, respectively. Expressions with the same semantic type take their denotation in the same
domain, though their forms and therefore their syntactic types may be different. In particular, a sensitive item can be interpreted in the same domain of a non-sensitive item of the same type, but the two expressions show different distributional behavior. We illustrate this difference in the example below.

**Example 5.1.** Let us consider to sentences with the same structure, which differ only on the signs they are composed of.

(6)  
   a. John didn’t read anything.
   b. Didn’t(Anything(λy.(read y)x)))

(7)  
   a. John didn’t read something.
   b. *Didn’t(Something(λy.(read y)x)))

The sign *anything* has the same semantic type as *something*. However, the latter is ungrammatical in (7) with the meaning in (b) and similarly *anything* would be ungrammatical if we replace (6) *didn’t* with *did*. The difference is due to the way *something* and *anything* are effected by the semantic property of *didn’t*: *anything* is licensed by this property, whereas *something* is incompatible with it.

The example shows the importance of distinguishing the form and meaning components of an expression and hence their syntactic and semantic type. Moreover, by looking at the way the sensitive item *anything* is in construction with the trigger *didn’t*, we can reach a general representation of the relation of *be in construction with*. Let us give a global definition of grammatical composition which abstract away from irrelevant details.

\[ C([γ : γ'], [α : α'], [β : β']) \]  
\[ R(γ, α, β) \land M(γ', α', β') \]

where \( R(γ, α, β) \) stands for the syntactic composition of a structure \( γ \) out of \( α \) and \( β \) and possibly other constituents—it is intended to be a reminiscent of the grammatical composition relation \( R_\bullet \) of the Kripke models (Definition 2.8)—and \( M(γ', α', β') \) stands for the semantic composition of a term \( γ' \) out of \( α' \) and \( β' \) and possibly of other terms—it is meant to generalize the meaning assembly carried out by the operation of the semantic algebra (Definition 1.16). We say that \([α : α']\) is in construction with \([β : β']\) in \([γ : γ']\). Based on this assembly of forms and meanings, we can define the licensing and antiligating relations holding between a sensitive item and the semantic property of its triggers.

**Definition 5.2.** [Composition Relations] The following composition relations can hold between two signs.

1. A sign \([α : α']\) is in a ***compatibility*** relation with a sign \([β : β']\), if the relation below holds. Notation: \([β'] \in P \] stands for \([β']\) has the property \( P \).

   \[ \text{If } [β'] \in P, \text{ then } \exists [γ : γ'] \text{ s.t. } C([γ : γ'], [α : α'], [β : β']). \]

2. A sign \([α : α']\) is in a ***licensing*** relation with a sign \([β : β']\), if

   \[ [β'] \in P \text{ iff } \exists [γ : γ'] \text{ s.t. } C([γ : γ'], [α : α'], [β : β']). \]
iii. A sign $[\alpha : \alpha']$ is in an incompatibility relation with a sign $[\beta : \beta']$, if the relation below holds:

$$\text{If } [\beta'] \in P \text{, then } \exists \exists [\gamma : \gamma'] \text{ s.t. } C([\gamma : \gamma'], [\alpha : \alpha'], [\beta : \beta']).$$

iv. A sign $[\alpha : \alpha']$ is in an antilicensing relation with a sign $[\beta : \beta']$, if

$$[\beta'] \in P \text{ iff } \exists [\gamma : \gamma'] \text{ s.t. } C([\gamma : \gamma'], [\alpha : \alpha'], [\beta : \beta']).$$

We will alternatively say that a sign is licensed by the property which is licensor must have. Finally, as commented above in a function-argument structure, we can distinguish two cases:

(a) $[\alpha : \alpha']$ is an element sensitive to the property of a function, then in the points above $M$ is such that $\beta'$ has immediate scope over $\alpha'$ in $\gamma'$;

(b) $[\alpha : \alpha']$ is a function sensitive to the property of its argument, then in the points above $M$ is such that $\alpha'$ has immediate scope over $\beta'$ in $\gamma'^2$.

**Remark 5.3.** Some logical consequences derive from the definition above. In particular, if a sign $[\alpha : \alpha']$ is licensed by a sign $[\beta : \beta']$ that has a property $P$, it will be compatible (resp. incompatible) with any sign $[\beta_1 : \beta'_1]$ that has a property equal to or stronger (resp. weaker) than $P$. Similarly, if a sign $[\alpha : \alpha']$ is antilicensed by a sign $[\beta : \beta']$ that has a property $P$, it will be incompatible (compatible) with any sign $[\beta_1 : \beta'_1]$ that has a property equal to or stronger (resp. weaker) than $P$.

Intuitively, one could think of the composition of a sensitive item with a trigger as a relation which ‘must’ or ‘must not’ hold, and the grammatical and ungrammatical construction which follows as relations which ‘can’ or ‘cannot’ hold. Based on this definition we can identify the sensitive items and their triggers as below.

**Definition 5.4. [Sensitive Items and their Triggers]**

i. An expression $A := [\alpha : \alpha']$ is a sensitive item if it is in a licensing or antilicensing relation.

ii. A sign $B := [\beta : \beta']$ is a direct trigger of $A$ sensitive to $P$, if $[\beta'] \in P$ and for any other stronger property $P' [\beta'] \notin P'$.

iii. A sign $B_1 := [\beta_1 : \beta'_1]$ is an indirect trigger of $A$ if $[\beta_1] \in P$ and also $[\beta'_1] \in P'$ for $P' \subseteq P$.

Let us now check how these definitions apply to the linguistic phenomena we have introduced in the previous section. In the case of Dutch negative polarity items, the relevant sets of licensors are identified by the properties of ‘antimorphic’, ‘antiadditive’

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Note that the definition of antilicensing relation we propose differs from the definition given in [Gia97] where it is seen as the negation of a licensing relation. Her definition of antilicensing relation corresponds to what we refer to as incompatibility relation: it is a negative information from which no positive relation can be derived.
and ‘downward monotone’, which we have represented as the sets $AM$, $AA$, and $DM$. A negative polarity item, licensed by a certain property, will have as direct triggers the expressions displayed in Table 5.1 as representative of the corresponding set.

Consider the weak negative polarity item *ook maar* (tr. any) which is licensed by ‘antiadditivity’. Let *ook maar* be represented by $A := [\alpha : \alpha']$. For any function $B := [\beta : \beta']$ which belongs to a set stronger than or equal to $AA \exists C := [\gamma : \gamma'] \subset (C, A, B)$; whereas for any function $B_1$ which does not belong to $AA$ such $C$ does not exist. For instance, *niemand* (tr. nobody) and *niet* (tr. not) are in $AA$ and *ook maar* is grammatical when in construction with them, whereas *weinig_n* (tr. few_n) does not belong to $AA$ and *ook maar* is not grammatical in its (immediate) scope. Moreover, *niemand* is a direct trigger whereas *niet* is an indirect one.

The definition of antilicensing relation can be illustrated by looking at (a) Dutch positive polarity items and their relation with respect to monotone functions, and (b) the behavior of wh-phrases with respect to the scope elements forming weak-islands. The first case exemplifies Definition 5.2-(iva), whereas the second instantiates Definition 5.2-(ivb). A weak positive polarity item like *nog* (tr. still) is antilicensed by ‘antimorphicity’: it is incompatible with the characteristic function identifying the set $AM$, and incompatible with all the other functions building bigger sets. In other words, it is ungrammatical in construction with its triggers, but it is grammatical with the functions belonging to bigger sets and which are not in $AM$.

Similarly, in English the wh-phrase *how many* is antilicensed by the property of ‘having the complement operation’. Consequently, its application to scope elements which take their denotation over domains of elements having this property is undefined. Again, *how many* is compatible with the characteristic function identifying bigger sets, i.e. it can be in construction with elements belonging to bigger sets$^3$.

Finally, an example of an expression in a compatibility relation with a semantic property is given by the adverb *almost* which can modify universal quantifiers (8-a), but not the existential ones (8-b).

(8) a. Almost every student came.
b. *Almost some student came.
c. He almost missed the train.

*Almost* is compatible with the property ‘being universal’ and it is incompatible with the one of ‘being existential’. Note that the compatibility relation is weaker than the licensing one, since it does not require the item to be incompatible with all the expressions which do not have the property it is compatible with (8-c). Similarly, the incompatibility relation differs from the antilicensing one, since it does not say anything about how the item behaves with respect to other weaker properties$^4$.

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$^3$Note that, the subset relation holding among the algebraic structures is reversed when considering the sets of the expressions which denote over them. For example, the set of the expressions with the property of ‘having the complement’ (which denote over $BO$) is smaller than the set of the expressions with the property of ‘having the intersection’ (which denote over $LA$).

$^4$In [Gia99] the English negative polarity item *any* is claimed to be incompatible (accordingly to our terminology) with veridicality. Therefore, it may be grammatical with nonveridical functions, but not necessarily with all of them.
5.4 Key Concepts

In this chapter we have prepared the ground for this part of the thesis. We have seen that,

1. Linguistic theories offer classifications of items based on semantic differences or on the different interactions of syntactic and semantic properties. In particular,

2. Items can deviate in their ways of scope taking, e.g. quantifier phrases.

3. Composition of linguistic signs may be driven by licensing or antilicensing conditions, e.g. negative and positive polarity items with respect to downward monotone functions.

4. We have calibrated the definition of composition relations distinguishing the ways a sensitive item relates with a certain semantic property.