Classifying modal interaction in discourse

C.F.M. Vermeulen
UiL OTS
Utrecht University

Abstract

This paper reports on ongoing research into modal interaction in discourse. In particular, a classification is presented method that was developed for this phenomenon during recent corpus investigations. For a proper understanding a short introduction to the topic has been included, as well as several examples from the corpus investigations and a brief discussion of the relation with other phenomena of interaction in discourse: modal subordination, quantificational subordination, E-type anaphora, tense operators and discourse operators.

1 Modal interaction in discourse

The topic of this paper is modal interaction in discourse. Therefore we start with a short introduction to this phenomenon. In the literature most examples of modal interaction are cases of modal subordination, as in:

(1a) A lion might come in.
(1b) It would eat you first.
(1c) It might eat me later.

(2a) A lion might come in.
(2b) It might eat you first.
(2c) It might choose me instead.

A superficial glance at these discourses suggests a representation as in:

(1) $\Diamond p \wedge \Box q \wedge \Diamond r$
(2) $\Diamond p \wedge \Diamond q \wedge \Diamond r$

But some further consideration already suffices to see that this cannot be right. The appropriate interpretations of the examples require *interaction* of the modalities: what the lion will do in the (b)-parts is to be considered only in situations where the lion actually has come in, as indicated in the (a)-parts. As an attempt to get this interaction right, we could try to get away with a simple nesting of modalities:

(1) $\Diamond(p \wedge \Box(q \wedge \Diamond r))$
(2) $\Diamond(p \wedge \Diamond(q \wedge \Diamond r))$

But again it is easy to see that this won't do. For one, the claim in (1b) clearly is *not* that it might be the case that a lion comes in and would eat you first: so, we do not want anything like $\Diamond(p \wedge \Box q)$. (1b) claims that *whenever* a lion comes in, it would eat you first. And similarly for (2b). Therefore, nesting the modalities is not a good idea.
Furthermore, there is a notable distinction in the (c)-parts of the examples which is not accounted for in either of the representation-attempts: the information in (1c) is about situations where a lion has come in *and* eats you first. In example (2c), however, we are just considering situations in which a lion has come in.[1] This means that, in the general case, there is not just *one* extra situation that we have to keep in mind. Apart from the real world, there are *several* other options available as a context for the interpretation of modal expressions. This fact is easily overlooked.
The best approximations of the meanings of the examples in ordinary propositional modal logic are as follows:

(1) $\Diamond p$
$\wedge\ (p \rightarrow \Box q)$

[1] Arguably it is even assumed that it has *not* eaten you. But this seems to be a subtlety of the meaning of *instead*, that we do not claim to represent here. See for example (Asher, 1996) on the implications of such indicators of contrast.

$\wedge\ (p \wedge q \rightarrow \Diamond r)$

(2) $\Diamond p$
$\wedge\ (p \rightarrow \Diamond q)$
$\wedge\ (p \rightarrow \Diamond r)$

Crucial facts about these approximations are: (i) some form of conditionalisation is required; (ii) the antecedents of the conditionals do not contain modalities. (i) is a good reason for describing the phenomenon as *subordination*. (ii) is a confirmation of the observation above that there is no nesting of modalities involved. Both (i) and (ii) provide a serious obstacle for any attempt at a compositional translation of modal subordination into an ordinary modal language. Although we do not come close to providing such a translation in this paper, this is one good motivation for developing other languages for a more careful analysis of the phenomenon.
We consider yet another example of modal interaction. This example is of a more complex kind than the ones usually considered in the literature.[2] It shows that we are not just dealing with modal subordination (=conditionalisation), but that there is something more general going on.

(3) Morgen kan ze zwanger zijn.
Het kan ook nog vandaag.
Het kan van de behanger zijn,
Of van een Franse zanger zijn,
Of iemand uit Den Haag.

In English:

(3') Tomorrow she might be pregnant.
Maybe already today.
It could be from the handy man,
Or from the candy man,
Or someone from Torquay.

The modal approximation of this example follows the pattern:

($\Diamond$ tomorrow
$\wedge\ \Diamond$ today)
$\wedge$ (tomorrow $\vee$ today $\rightarrow \Diamond$ handy-man)
$\wedge$ (tomorrow $\vee$ today $\rightarrow \Diamond$ candy-man)
$\wedge$ (tomorrow $\vee$ today $\rightarrow \Diamond$ torquay)

[2]This example is from the famous Dutch song *Op een mooie Pinksterdag*, lyrics: A. Schmidt, music: H. Bannink. The English 'translation' is literary rather than literal.

The example shows that apart from the familiar subordination effects also more involved patterns of interaction are available. In (3) the 'antecedent' of the modal interaction is formed as the *union* of two options mentioned in the discourse sofar: tomorrow or today. The options mentioned then form a list of alternatives that could be the case in this 'antecedent'-situation. The important point about this example is that is not a simple adding up of modal subordinations as in (1) or (2). Hence in a general account of modal interaction different operations on modal 'antecedents' will have to be present.

This analysis of the linguistic data is quite compatible with the analysis of modal subordination from, for example, (Roberts, 1989), (Frank and Kamp, 1997), (Kibble, 1994). However, our account diverges from these predecessors in important respects. First of all, we regard the phenomena as examples of interaction between the *modalities*. We submit that the modalities 'communicate' with one another and that it is this communication that controls all the interdependencies noted in the examples. By putting the blame so clearly on the dynamics of the modalities, we get rid of the smell of mystery about cases of modal subordination that remains in other accounts. Secondly, we regard modal subordination not as an isolated rarity, that sometimes occurs, but rather as an example of a general phenomenon of interaction between modal expressions. There *always* is such interaction and sometimes this turns into a case of modal subordination. Thirdly, we will regard the interaction patterns between the modalities as an instance of an even more general phenomenon of semantic interaction in discourse: also quantifiers, temporal expressions, E-type anaphors and discourse operators display interaction patterns in ways similar to the interaction of modalities. And the interaction patterns of these distinct kinds of operators can also be mixed: for example, a tense operator can interact with a modality, etc. We postpone the discussion of such examples to section 3, but it is clear that this makes the phenomena even less *ad hoc* and the results and techniques of the pilot study even more relevant for the analysis of discourse.

2 Classification of modal interaction

The example above shows that a logic just covering modal subordination is not good enough for a general account of modal interaction in discourse. We see, in the Schmidt example (3), that other interaction types are also available and that it is only natural to regard them as *of the same kind* as modal subordination. So, the aim should be a logic that covers them all. But this requires that we obtain some kind of overview over the diversity of interaction patterns that is involved. How complex can things get? For this purpose we have collected a corpus of real life examples that we have investigated for patterns of modal interaction.[3] During these investigations we have confirmed our suspicion that modal interaction in discourse is quite common. We have also seen that the patterns that occur are rather well behaved. They can all be described with a relatively small repertoire of diagram-schemes. Below we discuss several of the real life examples. This will give us a chance to see in what kind of text we can expect modal interaction. During the discussion of the examples we will also be in a position to see the method of classification-by-diagrams at work. It seems to be a convenient way to introduce the classification-diagrams.

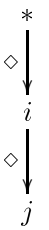
All the examples are from Times newspaper and the dates are as indicated below the fragments. The examples have been collected from the *Bank of English*, at http://titania.cobuild.collins.co.uk, using the free demo option. We will represent the texts as we found them in the corpus, including funny symbols, such as (/b), (h), (p). These symbols are instructions from the editor of Times to the printer: we imagine that b, h, p, stand for *bold*, *header* and *paragraph*, respectively.

Politics

Quite a few examples of modal interaction occur in speculations about what will happen in politics. We give an example in which a reader of the Times responds to a letter that has appeared in a previous issue of the newspaper.

Fragment 1

> on single currency; Letter (/h) (b) (/b) (p) From Mr D.J. Hallet (p) Sir, Matthew Parris (March 13) indicates that we may be approaching the time when the difference in Parliament will not be Left or Right but for Europe and anti-Europe. (p) Apart from anything else it might be a little more honest. (p) Yours faithfully (p) D.J.Hallet (p) ...



(Times, 20 mar 96)

In this fragment the writer considers the possibility of a situation i where the traditional distinction between Left and Right in politics is no longer dominant.[4] Then he mentions the possibility that this will increase the honesty of the political debate. We will denote this (truly) hypothetical situation with j. All these options are considered from the current situation, indicated by $*$.

In this example $*$ probably co-incides with the present situation—i.e. March 20, 1996—in the real world. In other fragments $*$ is the situation at stake at that point in the discourse. This situation may not be the current, real world situation at all. Also, the current situation either may be indicated explicitly in the discourse, or can be left implicit. In what follows we will use $*$ and generalise over such differences in the precise status of the current situation.[5]

In the diagram that follows the fragment we have indicated the relative positions of $*$, i and j: i has to be consider as one option that is accessible from the current situation $*$; j is then considered as an option *given* i. The transitions between the positions are labelled to indicate the modality that links them. This way we obtain a diagram in which distinct options are connected by a pattern of labelled arrows. This gives the first example of how we use dia-

[3] Consult http://www.phil.uu.nl/~keesv.

[4] This situation will lie in the *future*, as indicated,. But we do not look at the tense operators here. A bit more on tense is in section 3.

[5] It may help to compare the current situation to Reichenbach's *reference time*.

grams to classify the modal interaction patterns in discourse.

There might be some discussion about the match of the diagram and the text of the example. In particular, one may wonder: is i really distinct from j? My guess is that the writer intends them to be situated at the same point in *time* in the future. But that is not the dimension we are investigating here. We are thinking about the *modal* status of i and j. It seems that the writer (ironically) considers the increase in honesty as just one of the possibilities of the disappearance of the traditional Left-Right distinction. Hence, given i, j is but one of the possibilities.

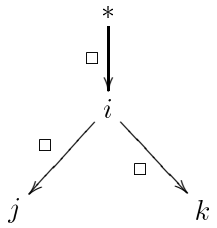
We see that this first example is a real-life case of modal subordination. Modal subordination corresponds to *chaining* of arrows in the diagrams. This is one basic pattern we have to keep in mind.

Gossip

Of course, also the society pages contain a lot of speculation, which gives rise to a lot of modal interaction in discourse. Here we quote an example about the possible outcome of negotiations about a divorce settlement for Charles and Diana.

Fragment 2

> not have the capital to raise 15m pound 20m pound. The palace team is certain, too, to point to the trust funds set up for Diana by her father, who left an 89m pound will in 1992, although little of his wealth went to the princess. (p) It is also likely that any settlement would include a confidentiality clause. 'The Duchess of York only got her way because she threatened to go public,' said Nash. 'The palace know what could happen if Diana published anything and will be anxious to prevent that eventuality. (p) Princess Diana does not have the



(Times, 24 nov 95)

As $*$ we take the situation we found ourselves in at the time the paper was published: there is no settlement yet. Then the fragment introduces the situation at which a settlement will be conjured up and considers two points that could come up in that situation: the inheritance of Diana's father and the need of a confidentiality clause.

So, starting from $*$, we are lead to a settlement-discussion situation, i. It is then claimed that, given i, the inheritance business, j, will certainly be brought up. Also given i, but independently from j, it seems, the likelihood of a confidentiality clause, k, is claimed. This gives us the four situations in the diagram and the modal links as indicated. Note that we do not distinguish notationally between the modalities *certain* and *likely*: both have been indicated by $\Box$.

The two options j and k are not presented as extensions of one another: they are both considered in the light of the settlement situation i. Therefore the arrows to j and k both start from i. This splitting of options is traditionally called *co-ordination* in the literature on discourse structure. We will also use the term *branching*.

It may be confusing that two distinct situations arising from i both can be considered likely-if-not-certain from the point of view of i. Yet, this seems to be exactly what the interaction of the modalities tells us. The fact that, if both j and k are necessary extensions, they will undoubtedly be related-if-not-identical situations, is not due to the interaction patterns involved, but to independent facts about the semantics of modalities.

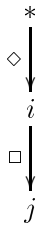
Sports

Perhaps surprisingly, also the sports section of the Times produces quite a few nice examples of modal interaction. We discovered that the sports section is not just a section where the

main sporting events of the previous day are discussed on the basis of facts and (match) statistics. It turns out that sports writers often indulge in looking ahead and speculating about what is to come. Here they do not restrict themselves to the sporting events themselves, but eagerly include speculations of a more 'social' nature.

Fragment 3

> was about to be proudly presented to the media, there was a tense delay as the story spread that Fergus McCann, the chief executive, was finding the terms of the contract unacceptable. For the disillusioned multitude of supporters, who had grown accustomed to settling for anything but the best, that would have been the final blow. (p) Cast in the uncomfortable role of saviour, Thom initially responded in a highly positive manner, scoring twice in each leg of the Cup Winners' Cup tie against Dinamo Batumi of Georgia. However, only two goals have come his way so far in the



(Times, 18 nov 95)

At the beginning of this fragment, we find ourselves in situation $*$: a situation in which Fergus McCann is about to be presented to the media. Then there is a rumour: perhaps, he will not sign. If this rumour would turn out to be true, that would be the final blow for the fans. Hence we have another case where three situations are described: $*$, i, and j and the modalities indicate their interrelation, as depicted in the diagram.

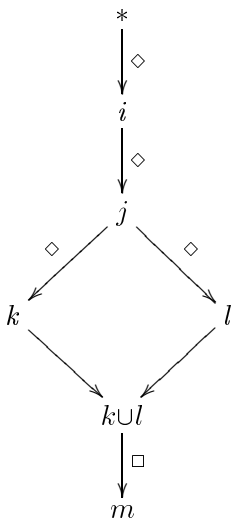
Finance

Yet another source of examples is the financial section. Here we find a fair deal of speculation about share prizes, take-over bids, etc. Consider, for example:

Fragment 4

> Thames shares are selling at less than seven times prospective earnings, little more than the 6.7 per cent dividend yield. Meanwhile, scarcity value is pushing London Electricity out of sight. It may come down to earth as potential foreign bidders fight shy of political exposure. Even then, the merger might only make financial sense if London was the bidder. Co-operation on services may well show that North West's expectations of savings are fancy, but should help to squeeze operating costs. In any case, Thames needs to deal with its own problems first. Its diversifications have been among

(Times, 1 nov 95)



Here we start from $*$ and first consider the option that it will 'come down to earth'—situation i. The next situation considered in the discourse is that the merger makes financial sense. This situation, j say, is considered only in the event that i has in fact arisen. Hence, we see a case of *chaining* in the diagram. Now two options are considered in the light of j: one that North West's expectations turn out to be fancy, situation k, the other that the merger helps squeeze the costs, situation l. A fair amount of world knowledge is missing here, I have to confess, but it seems safe to say that the two situations are to be considered in parallel: it is the merger (called co-operation here) that would account for the reduction in operating costs, regardless

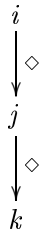
of the fancifulness of the expectations of savings. In the next step we find a summation over options: whatever turns out to be the case, Thames needs to deal with its problems. We estimate that the summation here is over k and l, but we have to be careful here: perhaps an even more drastic summation is intended.

Overview

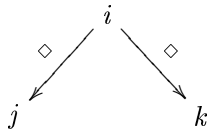
In these examples we see that there is a lot of modal interaction in discourse. And we see that all kinds of topics can serve as a trigger for rather complex forms of speculation: politics, gossip, sports, finance, ... This show that the phenomenon we are considering definitely is not a rarity, only of interest to the arm chair semanticists, but is an important topic worthy of thorough investigation.

We have been able to describe the interaction patterns using diagrams. Although these diagrams can become quite complex—as in fragment 4—, in all cases considered they can be built up using only a small number of basic interaction schemes:[6]

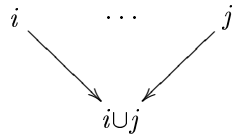
- chaining



- branching

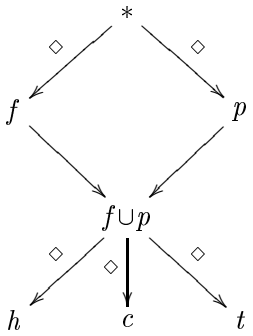


- summation



[6] In the schemes we have indicating all modalities by ◇, but of course occurrences of □ occur as well, as is clear from the examples.

In fact combinations of these three basic types suffice, not only in the four examples we mention here, but in all the (127) fragments we have collected. And they also cover the interaction of the Schmidt example, (3), above. There the appropriate diagram is:



In the corpus investigations that we have carried out, there was only one fragment that suggested just one extra scheme for modal interaction: negation. Consider the fragment below:

Fragment 5

> British Gas, Tim Eggar, the Industry Minister, said. (p) Calling for producers to open talks with British Gas about price cuts in response to a gas glut, he signaled Government willingness to assist possibly by cuts in the pound 170 million-a-year levy on gas production where specific fields might otherwise be uneconomic. He said that some US producers had been too inclined to consult lawyers rather than talk. He suggested that they should take their share of the responsibilities that went with participation in the 'flexible regime' that prevailed on the United Kingdom continental shelf.

(Times, 23 nov 95)

Here it seems that some option j, that things turn out to be uneconomic, has to be considered in the context of the *negation* of situation i, the situation that there are cuts: if we do *not* make cuts, things might go wrong. This could be seen as evidence that yet another scheme of interaction has to be added: negation of contexts. But, alternatively we could say that it

is not the interaction of modalities that acts as a trigger for the negation in the example. Instead we can put the blame on the semantics of *otherwise*. Under this second view, *otherwise* becomes an entry in the list of other linguistic triggers of interaction, of which we will say a bit more in section 3 below. This second view is rather tempting, in particular as there was only one example in which a negation seemed to operate on the contexts.[7]

So, it seems that there are natural bounds on the abundance of interaction in discourse: they can all be described using the three types of diagram mentioned above. Of these three types, chaining and branching are quite common. Phenomena of summation are quite rare. This suggests that we could also try to 'explain summation away.' But it seems that the few examples of summation that we did find are very natural, indeed. This makes it undesirable to try and explain those cases in another way. Furthermore, there is another potential explanation for the lack of summation examples in our corpus: the fragments we are considering could be just too short to allow for decent cases of summation.

Some fact and figures

In our investigations we have looked for examples of modal interaction in Times newspaper. We have done this by searching the *Bank of English* (http://titania.cobuild.collins.co.uk), using key words: *might*, *would*, *probable*, *likely* and *may*. For each key word the *Bank* provides discourse fragments in which the key word occurs. We have consistently taken the first examples that came up, limiting ourselves to approximately 25 fragments per key word. This 'random' selection of discourse fragments resulted in an example of modal interaction in more than one out of three cases, clearly confirming that modal interaction is a common phenomenon.[8] In the investigation of the fragments we have restricted ourselves to interaction between *modal* expressions. Other kinds of interaction (cf. section 3) have not yet been considered. Also more involved questions have not yet been considered, e.g. comparing the numbers of combinations of $\Box$-$\Box$ chains with the number of $\Diamond$-$\Box$ chains, interaction with discourse structure etc. We have not been very ambitious in this stage about the precise correspondence between the modalities in the diagrams and their lexical realisation in the texts: we just made a rough, intuitive distinction between $\Box$-like and $\Diamond$-like modalities.

The table below sums up some of the numbers involved. We suggest a look at http://www.phil.uu.nl/~keesv for more details about the corpus.

key	total	interaction
might	25	10
probable	25	13
would	25	12
likely	26	8
may	26	6
	127	49

3 Other types of interaction

In this section we point briefly at the relation with other important phenomena in the semantics of discourse. First we look at quantificational subordination. It seems that quantifiers in discourse interact in very much the same way as modal expressions. This is not a new observation. And it also is not surprising, given the well-established semantic correspondence between quantifiers and modalities (cf. (van Benthem, 1985)). But it confirms that the interaction of modalities is not an isolated atrocity: it is an instance of general patterns of interaction in discourse.

We give some examples parallel to (1) and (2) above.

(4) (It started to rain.)
Some people came in.
Most (of them) had
no umbrella.
Some did not even have a
rain coat.

(5) (It started to rain.)
Some people came in.
Some of them had
no umbrella.
Some (others) were afraid
to catch a cold.

[7] There were many more examples with negations, of course. The crucial thing is that here the *context* i seems to be negated.

[8] Although all examples of modal interaction were found using these search keys, in some of the examples the key itself was not involved in the interaction that we noticed in the fragment.

We see that (4) is just like (1) and that (5) is very similar to (2). Good approximations in a standard approach to (generalised) quantification would be as follows.[9]

(4) $\mathsf{Some}(p, c)$
$\wedge\, \mathsf{Most}(p \wedge c, u)$
$\wedge\, \mathsf{Some}(p \wedge c \wedge u, r)$

(5) $\mathsf{Some}(p, c)$
$\wedge\, \mathsf{Some}(p \wedge c, u)$
$\wedge\, \mathsf{Some}(p \wedge c, a)$

This shows how the accumulation of material in the restrictor of the quantifiers works along the same lines as the accumulation of material in the conditions of the implications above. It also shows that there is no nesting of quantifiers involved. We have discussed such examples in (Vermeulen, 1997).[10] The similarities with the patterns of interaction of quantifiers are so strong that an account of modal interaction can be converted immediately into an account of the quantificational dependencies.
E-type anaphora seems to be yet another related phenomenon.[11] In fact, E-types are very much like the examples of quantificational interaction that we saw above. The difference is that in the E-type examples the quantifier tends to remain implicit. Consider the following case.

(6) (It started to rain.)
Some people came in.
They had no umbrella.
They did not even have a rain coat.
$\mathsf{Some}(p, c) \wedge \mathsf{All}(p \wedge c, u) \wedge \mathsf{All}(p \wedge c \wedge u, r)$

This example looks just like a cases of quantificational subordination, except for the fact that the All-quantifiers are *implicit*. Even more examples of interaction are provided by tense operators in discourse. And as even further examples of the phenomenon we could look at operators such as *otherwise*, mentioned above. In all it seems clear that, not only is modal interaction an appropriate generalisation of modal subordination: we also should make a generalisation from modal operators to other discourse operators.

Finally we note that there are also mixed examples, where different types of operators interact. It is not difficult to find lots of examples in our corpus, but let's stick to an artificial example in line with (4) and (5) above.

(7) It could be a rainy day.
Then most people would come inside.
They may not have an umbrella.
Some will not even have a raincoat.
Or they are simply afraid
that they will catch a cold.

4 Conclusion

In this paper we have reported on a corpus study into modal interaction, a notoriously complex phenomenon in discourse semantics. We have submitted that patterns of interaction exist between all kinds of expressions. Among the examples we find: modals, quantifiers, E-type anaphors. Hence the situation is so complex that we could really benefit from serious corpus investigations to get a proper estimate of the complexities involved. Here we have only made a first step in this direction: investigation the *modal* interaction in a *small* corpus.
Based on the interaction patterns we actually find in the corpus investigations, we can then come up with serious proposals for a logic to analyse and represent the phenomena. Such a description logic will have to have the right kind of expressive power.[12] Sofar our investigations lead to the provisional conclusion that the interactions follow a rather limited number of schemes. And hence we may hope for a reasonable bound on the complexity of the logical descriptions required. This makes the search for a good description logic look like a worthwhile task for future research.

References

N. Asher. 1996. *Reference to abstract objects in discourse*. Kluwer, Dordrecht.

[9] As we are interested in the general patterns the names involved do not really matter. Still, it might be helpful to read: p as *people*; c as *comers-in*; u as *umbrellaless*; r as *rain-coat-less*; a as *afraid*.

[10] The effects are also mentioned earlier, for example, in (Gawron et al., 1992) and (Roberts, 1989).

[11] See (Evans, 1980) for discussion.

[12] In (Vermeulen, 1999) we have already proposed a description logic for modal subordination. The paper also shows that this logic is decidable. But the logic does not cover the summation operation that is required for the generalisations we suggest here.

G. Evans. 1980. Pronouns. *Linguistic inquiry*, 11:337–362.

A. Frank and H. Kamp. 1997. On the context dependence in modal constructions. In *Proceedings of SALT-97*.

J. Gawron, J. Nerbonne, and S. Peters. 1992. The absorption principle and e-type anaphora. In *Situation Theory and its applications, volume II*. CSLI Lecture Notes 26, Stanford.

R. Kibble. 1994. Dynamics of epistemic modality and anaphora. In H. Bunt et al, editor, *Proceedings of IWCS94*. Tilburg University, the Netherlands.

C. Roberts. 1989. Modal subordination and pronominal anaphora in discourse. *Linguistics and Philosophy*, 12:683–721.

J. van Benthem. 1984. Correspondence theory. In D. Gabbay and F. Günther, editors, *Handbook of Philosophical Logic*, pages 167–247. Elsevier.

J. van Benthem. 1985. *Modal Logic and Classical Logic*. Bibliopolis, Naples.

C. Vermeulen and A. Visser. 1996. Dynamic bracketing and discourse representation. *Notre Dame Journal of Formal Logic*, 37(2):321–365.

C. Vermeulen. 1997. (some) dynamics of quantification. Workshop on quantification, ESSLLI97, manuscript available from author.

C. Vermeulen. 1999. Type declaration for modal subordination. In H. Bunt et al, editor, *Proceedings of IWCS99*. Tilburg University, the Netherlands.