

Domain Restriction , Mental Models and Discourse Context

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The main objective of this paper is to compare two different approaches to the study of the semantics of some operators in natural language: dynamic semantics and mental models.

To do that, we start by discussing the nature of their domain restriction, noting that in some constructions the restriction is linguistically explicit, whereas in others it is only partially or even not at all. In these cases the context of utterance is of great importance.

It is argued then that the domain restriction is presuppositional (Roberts 89) and it is dependent not only on the structure of the utterance, but also on the *common ground* of the interlocutors.

Based on a dynamic conception of semantics, where the information about the discourse is constantly updated, the restriction is related to the notion of *accommodation* (Lewis 79 and Heim 82 and 83). It is then shown that, in some ways, the domain restriction can be viewed as a complex of different kinds of information, parallel to a mental model (Johnson-Laird 83 and 86)

So as presuppositions often arise non-linguistically (also in the case of domain restriction), they cannot be determined in a purely structure driven way. This is to say that domain restriction for all sorts of operators involve besides accommodation, also inferences made on the basis of the common ground and the (partial) meaning of the utterance.

1. The Domain Restriction

It is recognised for a long time, but forgotten quite often, that quantifiers and other operators have two arguments, the first is the *restriction* that restricts the domain over which the second, the *nuclear scope* (or matrix), is evaluated.

Several types of operators can be analysed in a tripartite structure. It is the case of some quantificational determiners, adverbs of quantifica-

tion, modals, conditionals, tense/reference time, generic sentences, and others. The following examples illustrate them:

- (1) Todos os alunos que fizeram os exercícios passaram no exame.
'Every student who made the exercises passed the exam.'
- (2) Se está bom tempo, a Maria geralmente sai com os filhos.
'If the whether is fine, Maria generally goes out with the children'
- (3) Se estiver bom tempo, podíamos passar o fim de semana fora.
'If the whether is fine, we could go out for the weekend.'
- (4) Quando a Maria chegou a casa, o Pedro foi preparar o jantar.
'When Maria arrived home, Pedro prepared the diner (afterwards).'

The more recent way of treating these operators as binary is due to Lewis (75) in his article about adverbs of quantification. He proposes a tripartite structure consisting of the adverb, the restriction (having the form of a conditional) and the modified sentence. According to this proposal, a binary operator can be seen as an adverbial operator that relates a set of conditions, having one or more variables, and another set, which can share some of the variables with the first set. One of Lewis's examples is the following:

- (5) Sometimes, if x is a man, if y is a donkey, and if x owns y, x beats y now and then.

Which corresponds roughly to:

- (5') Sometimes (x is a man, y is a donkey, and x owns y ; x beats y now and then)

The way the restriction and the nuclear scope are related is shown also in (6), using a classical example, but which can be extended to any of the previous ones.

- (6) Todo o homem que tem um burro bate-lhe com um pau.

‘Every man who owns a donkey beats it with a stick.’

Todo [homem que tem um burro] [bate-lhe com um pau]

$\forall_{x,y}$ [homem(x) & burro(y) & ter(x,y)] \exists_z [pau(z) & bater com (x,y,z)]¹

In the examples (1)-(4) above, the domain of the operator is explicitly restricted by different means (CN with relative clause, if-clause and when clause). But this is not always the case as it is seen in the following examples where the restriction is at least partly available in the context.²

(1') Os alunos da turma A fizeram os exercícios. Todos passaram no exame.

‘The students of class A made the exercises. Everyone passed the exam.’

(2') Em dias de bom tempo o Manuel anda de bicicleta. A Maria geralmente sai com os filhos.

‘In a fine whether Manuel rides the bicycle. Maria generally goes out with the children.’

(3') Espero que esteja bom tempo nos próximos dias. Se assim for, podíamos passar o fim de semana fora.

1 The example (6) shows a tripartite structure, that is, the quantifier, the restrictor (the material inside the first parentheses) and the nuclear scope. So, besides the universal quantifier which bounds the variables in the restrictor and also the ones in the scope because the quantifier is non selective, there is also an existential quantification in order to bind the free variable in the scope (um pau/ a stick). As it is an indefinite, the existential force is assigned by default, through *existential closure*.

2 There are cases where, at the surface phrase structure, the operator is implicit or where there isn't any explicit marking to indicate a division into restrictor and nuclear scope. This can be the case of some generic sentences and also of some *if/when* clauses when there is no overt adverb of quantification or quantificational operator. There are also cases where the division into restrictor and nuclear scope is sort of explicit, but the operator is implicit, like in the following example: “*Do you have a problem with your computer? Jorge can solve it.*” Here the question acts like a restrictor and it is possible to consider a suppressed *if*-clause constructed from the question. Note that what follows the question is not an answer.

'I hope it will be a fine whether during the next few days. If so, we could go out next weekend.'

(4') A Maria chegou a casa cansada. O Pedro foi preparar o jantar.

'Maria arrived home tired. Pedro prepared the diner (afterwards).'

In (1'), provided one knows what "turma A" is, the interpretation of the second sentence depends on restricting the quantifier to "alunos da turma A fizeram os exercícios", which corresponds to the first sentence. The following two examples are interpreted in the same way, taking into account the restriction in the context, that is, in this case, the previous sentence. The last example can also be viewed as having a reference time, established by the first sentence and given by the probable nature of the discourse, which serves as a further restriction on the evaluation of the second sentence.

One way of considering the context in a semantic interpretation is by using the Stalnaker's notion (79) of *common ground*. It can be defined as a set of propositions taken as the assumptions the speaker and the hearer have in common (or believe to have in common) about the world, or the way it is. This notion is then seen as a set of presuppositions the participants share in some way or another. Some theories of meaning like DRT (Kamp 81) and File Change Semantics (Heim 82), among others, use this notion and elaborate on it so to include also some information about the discourse, which allow to solve some problems of anaphora. In these theories, the information about the discourse and the propositions expressed are continually updated and this is why the meaning is not viewed as static, but dynamic. So, in a way, these theories reconcile a static vision of the meaning and a dynamic (or procedural) one in that the meaning of an expression is an instruction to the hearer to "built" (part of) the representation.

In some linguistic contexts, called modal subordination (Roberts 89), it is sometimes difficult to keep track of the antecedents of anaphors just because they are under some type of modal context. This is the case of (7)

(7) *Espero ter dinheiro para comprar uma casa no campo. Se tiver, vou plantar roseiras no jardim. Podia também plantar amarilis, embora ainda não imagine em que local os havia de plantar.*

‘I hope that I will have money to buy a cottage. If I have it, I will plant roses in the garden. I might plant also amaryllis, although I’m still not imagining in which place I would plant them.’

This discourse can be understood like this.

- (7') If I have money, I buy a cottage (the cottage has a garden). If I have money I plant roses in the garden. If I plant roses, I might plant also amaryllis. However, I am not sure in which place (in the garden) I would plant them.

We have several modal contexts and the domain restriction is not explicit in some cases. So, according to Roberts, we can say that, in order to understand the discourse, the hearer has to accommodate the domain restriction. The notion of *accommodation* is due to David Lewis who formulates it in the following way: “If at time *t* something is said that requires presupposition *P* to be acceptable, and if *P* is not presupposed just before *t*, then – *ceteris paribus* and within certain limits – presupposition *P* comes into existence at *t*” (Lewis 79:172). This can be extended in the sense that, if the speaker presupposes something not explicit in the discourse, the cooperative hearer accommodates it as if it was already in the common ground.

To make sense of the discourse in (7)/(7'), which involves satisfying the familiarity presuppositions (Heim 82) of any definite NP, such as definite descriptions, requires keeping track of all the nonfactual propositions in the discourse, storing discourse markers for hypothetical or fictional referents. This calls up for a *hypothetical common ground* (see Roberts 89:699) seen as a set of propositions familiar to both speaker and hearer taken as compatible but not necessarily true in the actual world. This means that the cooperative hearer accommodates non-factual propositions in order to evaluate the proposition under the scope of the modal. This accommodation is *local* (Heim 83) as the presuppositions involved are only accommodated under the scope of an operator (modal or an adverb of quantification) and do not become part of the common ground for the discourse as a whole.

In the example (7) the proposition that the speaker will have money to buy a cottage is only local because it serves as a restrictor to the modal.

If discourse has returned to a factual mode we can no longer refer anaphorically to a NP within the preceding non-factual context. See the examples (8)-(9) and the corresponding ones, (10)-(11), in Portuguese, language in which the 'Imparfait' can substitute the Conditional.

- (8) I had enough money, I would buy a cottage. It would have a garden and I would plant some roses.
- (9) If I had enough money, I would buy a cottage. *It had a garden and I planted some roses.
- (10) Se eu tivesse dinheiro suficiente compraria(Con)/comprava (Imp) uma casa de campo. Teria(Con) um jardim e eu plantaria(Con)/ plantava(Imp) algumas rosas.
- (11) Se eu tivesse dinheiro suficiente compraria(Con)/comprava (Imp) uma casa de campo. (Ela) *Tinha(Imp) um jardim e eu plantaria(Con)/plantava(Imp) algumas rosas.

In (8) local accommodation of *I buy a cottage* restricts the domain of *would* and provides an antecedent for *it*, but in (9) the pronoun does not have access to the non factual proposition and cannot use it (*a cottage*) as a discourse marker. The same can be said about the examples in Portuguese where 'Imparfait' can be used instead of Conditional. In the second sentence of (11) *uma casa de campo (cottage)* cannot be a discourse marker because of the non-factual proposition starting by a subjunctive tense (*se eu tivesse /if I had*). It is also interesting to note that in this context the 'Imparfait' is not acceptable.

This accommodation is relatively free in that only requires that the proposition in question should be consistent with any other locally accommodated propositions. That is, the speaker may invite the hearer to entertain the consequences of any consistent set of propositions, whether or not actually true.

The *global accommodation* (Heim 83) is different in the way the presuppositions are permanently added to the factual common ground. So, once we have established the truth of a proposition in discourse (because it has been asserted or has been globally accommodated) the interlocutors may assume its truth, including the existence of any individuals referred afterwards. This also allows anaphoric reference to individuals

and to the proposition. This is the case in a situation where one is on the phone and suddenly one of the persons says something like (12).

(12) Wait a minute. Someone is knocking on the door.

The door is now part of the common ground and we can go on referring to it as it was introduced in the discourse. The interesting thing about it is that it was introduced by a definite description.

Nevertheless, global accommodation is more demanding than the local one. The latter only requires consistency. The former requires, besides that, that the hearer assents to the truth of the proposition in question. That is, the proposition is only added to the common ground in case there is a consensus, even if it is only pretended. In some cases it is trivial, as it is part of what is general knowledge in a certain society (or community). But it is not always so obvious, as one can see from the example (13):

(13) A Maria teve um sonho fabuloso: o Rui deu-lhe um anel de brilhantes. No dia seguinte encontrou-o em cima da mesa.

‘Maria had a fabulous dream: Rui gave her a diamond ring. The following day she found it on the table.’

What happens in (13) is that we have a pronoun (*o/it*) whose antecedent is an indefinite (*um anel de brilhantes /a diamond ring*) under the scope of a modal. As a consequence, the pronoun cannot refer to an existing entity introduced in the context explicitly as such. Accepting the third sentence would presuppose that the speaker believes it is true and that Maria actually received a ring. So the hearer has to accommodate such proposition. This means that a salient non-factual proposition is available in discourse and it has been added to the common ground (at least the hypothetical one). But unlike anaphora to accessible antecedents, this example requires assent in order to make it felicitous.

Let’s see now examples where the antecedent of an anaphor is a proposition.

(14) Uma tempestade pode(podia) abater-se sobre a ilha. Isso assustaria a população.

‘A storm may (might) strike the island. That would frighten the people.’

(15) Uma tempestade abateu-se sobre a ilha. Isso assustou a população.

‘A storm struck the island. That frightened the people.’

(16) Uma tempestade pode(podia) abater-se sobre a ilha. Isso assusta a população.

‘A storm may (might) strike the island. That frightens the people.’

The difference between the sentences is very interesting. There are only some slightly changes, but the semantic difference is quite considerable. In (14), the first sentence is non-factual because of the modal (*pode*). The subject of the second sentence, under the scope of *assustaria* seems to refer to a kind of nominalization of the proposition denoted by the nuclear scope (*abater-se sobre a ilha*) of the modal *pode*. In (15) the first sentence is factual and the second sentence refers to it as a fact corresponding to the event. In (16), after the same non-factual sentence as in (14), the meaning of the second sentence (factual) is different from the example (15). That is, what *assusta a população* (*frightens the people*) is the possibility and not the possible event (as it was the case in (14)).

This seems quite difficult to solve in some (more or less) standard semantic theories, but if we consider that the accommodation is triggered by presuppositions, then, may be it is possible to cope with the difference between (14) and (16) and also the example (13).

In modal subordination the hearer accommodates the speaker’s presupposition of an appropriate domain restriction for a modal operator and going back in the discourse to find appropriate material. Also, the propositions accommodated must satisfy any other presuppositions already in the context and others like the familiarity presuppositions for definite descriptions.

So, in (13) the only plausible antecedent for *o* (*it*) is *anel de brilhantes* (*diamond ring*) and one has to assume that the speaker believes that Maria’s dream became true. In (16) the modal (in the Present, or even ‘Imparfait’) indicates that we are talking about a future possibility and, as a consequence, that the speaker doesn’t know (or presuppose) the truth of the nuclear scope of the modal. Because of that one cannot interpret *isso* (*that*) as referring to a presupposed proposition in the nuclear scope.

An approach where the analysis of anaphora only takes into account the previous sentence is not enough in some cases as that it depends too much on grammatical aspects of the preceding sentences. The same can be said about some operators which do not have (at least in some cases) conventionally given restrictive terms, like adverbs of quantification or generics.

But purely semantic information is also inadequate to deal with all the possibilities in domain restriction. So, what we need, in determining possible values for the restrictive term of an operator in discourse, is, apart from syntactic and semantic information about the utterance and about previous utterances, a variety of kinds of information usually described as “pragmatic” (see the notion of *common ground*) which includes inferences and implicatures.

Since contextual information seems to play such an important role in domain restriction one has to consider it in a dynamic way. The treatment of the restriction of certain operators as a variable whose value is fixed by context calls up to consider that it is, in a great sense, presuppositional (see Karttunen 73, Gazdar 79, Heim 83). If domain restriction is presuppositional, then one would expect that there is some filter (Karttunen and Peters 79) which does not always project presuppositions to the entire preceding context (see Barbosa 97).

This is why (17) is difficult to understand without any other information. But if we consider (18), the domain restriction of a modal operator occurs in the consequent of a conditional construction and as such the presupposition is satisfied by the antecedent. This is not to say that it is the sole proposition relevant, but it suggests the set of propositions which determines a set of situations in which Maria buy a car.

(17) Maria could buy a car.

(18) If Maria had enough money, she could buy a car.

Presuppositions, both in general and in the case of the domain restriction, often arise non-linguistically. Domain restriction for all sorts of operators essentially involves accommodation of pragmatic presuppositions, based on the knowledge of the common ground, inferences on the common ground and the partial meaning of the utterance.

This is not to say that one is looking for the speaker’s meaning in

Grice's sense, but that one needs this to solve some problems like the ones in (13) and (16).

2. Domain Restriction and Mental Models

If we agree that at least some operators in natural language do have a tripartite structure, and especially a restriction (sometimes on the form of a conditional' antecedent) this means that it also can be viewed as the construction of mental models based on the superficial linguistic representation.

This reminds us of some examples by Johnson-Laird (86). Assuming that the semantic interpretation of conditionals can be compositional, he says about an example like (19) that "If both speaker and listener are conscious of the content of an antecedent (of a conditional) i.e. of the imminence of the corresponding state of affairs, then it can be omitted"(86:64). As a corollary of the previous assumption Johnson-Laird considers that "the function of an antecedent of a conditional is to establish a context, i.e. a state of affairs that should be taken for granted in considering the consequent".

This is a different way of saying that the antecedent of a conditional is a kind of restriction and that it helps to establish the context in which the consequent is evaluated.

That is why he says that, in a conversation between mother and child, the mother would not say to the child (20) in the context the child has already taken the cake. He adds that in this case it would only be appropriate to use an antecedent that designates a generic state of affairs that subsumes what has happened, like (21):

(19) I'll smack you...

(20) If you take the cake...

(21) If you take cakes...

So, in this framework, to analyse a conditional implies, although in an oversimplified way, a scheme like the following(see Johnson-Laird 86:65):

(22) Step 1: Construct a mental model based on the superficial linguistic representation of the antecedent and on those beliefs triggered during this process.

Step 2: Interpret the consequent in the context of the model and general knowledge.

After arguing about what seems to be obvious for a speaker - that there is a relation between the antecedent and the consequent of a conditional – Johnson-Laird considers that there are at least three possible degrees of relation. The antecedent could determine the state of affairs in which the consequent is to be evaluated completely, partially or not at all. The third case is illustrated by (23), where the antecedent expresses a desire, a need, a predilection or a state of mind that cannot be related to the truth of the consequent. The conditional is true if the consequent is true. The general schema for such conditionals would be (24).

(23) Se tens sede, há cerveja no frigorífico.

‘If you are thirsty, there is some beer in the fridge.’

(24) If ‘p’ (where p implies x (needs/wants...) y) then (x will be interested to know that) ‘q’ is the case.

The first case is illustrated by (25), which is a case of entailment. This type of conditional (*if p, then q*) is true if ‘q’ is true in any mental model of ‘p’.

(25) Se alguém está na sala, então há uma sala que não está vazia.

‘If someone is in the room, there is a room that is not empty.’

This is a different way of saying that the domain restriction is empty and that the ‘modal’ ranges over all possible situations.

The second case is the most common: the antecedent only provides part but only part of the specification of the situation in which the consequent is to be evaluated. Let’s see his example about a murder in a cinema:

(26) If the accused was on a train when the murder occurred, then he must be innocent.

According to Johnson-Laird, to assert (26) is to base the claim on a number of implicit assumptions:

- (27) A person cannot be in 2 places at the same time;
There are no cinemas on the train;
Trains do not pass through cinemas.
And so on.

These assumptions are obviously used in constructing the mental model based on the evidence given at the trial, but they could have the form of (conjoined) antecedents. So, the consequent is evaluated with respect to a mental model of the situation described by the antecedent and general knowledge.

What are then the relations between these two approaches? In fact, all these assumptions mentioned above seem to be what was said before to be presuppositions and moreover, what is said about the antecedent of a conditional is very similar to what is an explicit restrictor. In this type of construction, when we have general knowledge to take into account, we would say that it would tend to be globally accommodated in case the hearer assents to the truth of the propositions. In a simplified way, the antecedent provides part of the domain restriction and the general knowledge is in some sense a set of presuppositions one has to accommodate.

So, in examples like (25), which is a maximal domain, one still needs some context because there is no such thing as a completely null context, that is, the maximal domain should always be available.

In the case of the example (26) (and in many others) it is possible that the antecedent situation is nevertheless underdetermined, as it is possible to consider many other scenarios that would make the conditional true or false. But, as Johnson-Laird puts it, "the mental model theory copes with the indeterminacy of discourse in the following way: an initial model is constructed (perhaps even based on arbitrary choices) which can be revised recursively in the light of subsequent information"(86:72). Interestingly enough, this can be obtained even by the consequent, as Quine's (60) well-known pair of examples shows:

- (28) If Caesar had been in command in Korea, he would have used catapults.
(29) If Caesar had been in command in Korea, he would have used the atom bomb.

This “revision of the model in the light of subsequent information” is one of the core assumptions of the dynamic theories of meaning.

So, it seems, in both theories, dynamic semantics and mental models, there is a search for how meaning is processed, but in the dynamic theories the potential of meaning, that can be updated, of an expression is also viewed on the light of the hearer. That is, the idea is that when we speak, we, in some way, give some instructions to the hearer for him to process the utterance.

3. Conclusion

To sum up, the idea that, in order to understand some utterances, one needs a restrictor and that this one is quite often presuppositional in that it also needs accommodation, seems to be very near to the conception of mental models and implicit inferences proposed by Johnson-Laird.³

As we could see from the analysis of some of the examples, the restrictive term of certain operators seems to work like a variable whose value is fixed by context. In these cases, the presuppositions are not necessarily explicit, as a hearer can recover them from the context and if he is cooperative, then he accommodates them. This allows us to say that the restriction of some operators is given, at least partly, by the context of utterance and also some general information.

To conclude: a fairly completely stable semantics for a natural language is impossible, even for a single speaker. We can only work with fragments and we cannot guarantee our own consistency the same way we can't be sure we understand each other. We cannot change our limitations of finiteness, but fortunately we are aware of our ignorance and we have the ability to decrease it. The two approaches, dynamic theories of meaning and mental models, seem to be a promising way.

So, simplifying assumptions may be expedient or even essential for real life communication situations or for studying parts of language in detail, but we cannot idealise away the factors that make a completely specified semantics impossible.

3 Johnson-Laird develops his notion of implicit inferences in chapter VI of *Mental Models*. At the same time it is interesting to note that, for him, a propositional representation is a mental representation of a verbally expressible proposition (83:155)..

I agree with B. Partee (82:103) in saying that “there is no incompatibility in the enterprises of formal semantics and psychological semantics; the apparent conflicts may well have resulted from the false assumption in both sides that a human language must have a finitely representable semantics. Abandoning that assumption opens up interesting new possibilities for trying to understand more about how our minds work by studying how our language works, and suggests a new dimension for the concept of language creativity”.

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