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Topic Structure in Route Explanation Dialogues.

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ABSTRACT. This paper deals with the representation of dialogue, including the semantic aspects. We have been working on a real speech corpus of route explanation dialogues. The paper follows the tradition of dynamic semantics (Kamp and Reyle 1993), and we will use the SDRT of (Asher 1993) which proposes a treatment of the semantic-pragmatic interface. Dynamic semantic theories have traditionally focused on discourse issues, but a few studies have begun to look at dialogue within that framework in the past few years. (Asher and Lascarides 1998). To the rhetorical and intentional structure proposed by SDRT we add a "topic structure" closely related to the informational structure.

1 Introduction

We address here the problem of representing human dialogue¹. We are interested in a specific kind of dialogue : *route explanation dialogue*². We place ourselves in the tradition of dynamic semantics (Gronendjik and Stokhof 1991) (Kamp and Reyle 1993) (Asher 1993). These approaches, which have mainly focused on the problem of monologue, are now addressing the domain of dialogue (Ginzburg 1994) (Asher and Lascarides 1998). From another perspective, works also exist which enrich dialogue-act theories with semantic content, rhetorical structure and dialogue games (Poesio and Traum 1997).

Here, the chosen framework is SDRT (Segmented Discourse Representation Theory) (Asher 1993). Several works based on this theory have studied the interaction between semantic content and *Discourse Structure* (Asher, Aurnague, Bras, Sablayrolles, and Vieu 1995) (Asher, Busquets, and Vieu pear).

The notion of "topic" is used in this framework but it is not precisely defined. Recently we have proposed a treatment of dialogue global topic in route explanation dialogues (Prévot 2000). After the collection of a real corpus, our analysis has

¹Dialogue is seen here as a discourse with two speakers.

²See section 2 for a more complete definition of this kind of dialogue.

shown the necessity of taking *Information Structure* into account, as was predicted by (Asher and Txurruka 1995) (Engdahl, Larsson, and Ericsson 2000) (Engdahl 2000).

Now, in a prospective work, we want to study the interaction between *Information Structure* and *Discourse Structure* and between *Information Structure* and *Topic Global Structure*.

First, we briefly present the corpus that we have recorded and that we are studying (section 2). Then our analysis of some pieces of those dialogues will be presented in three points : first from the SDRT point of view, strictly speaking (section 3.1) ; then in the light of Txurruka's account of *Information Structure* and *Discourse Structure* (section 3.2); thirdly, taking global topic into account (section 3.3). Lastly, we propose a construction of a topic structure (section 4).

2 The Corpus

We introduce in this section the corpus we have recorded. At this stage, it is composed of 15 dialogues for a total time of 30 minutes. To ensure a large coverage of the kind of phenomena we plan to collect more dialogues. As we have said, it is a corpus of route explanation dialogues. This kind of dialogues involves two participants : a giver and a receiver. The giver explains to the receiver how to go from one location to an other one. We have chosen the domain of route description because a lot of work has already been done on it, especially in lexical semantics (motion verbs, spatio-temporal prepositions, ...) (Asher and Sablayrolles 1995) (Muller 1998). It give us a basis for the representation of the semantic content of utterances.

Many features are important in the complete definition of this dialogues (characteristics of places used, of the participants, ...)³. Here, for reasons we will explain below, we focus on two of these features : dialogue situation and participants' knowledge.

As far as the dialogue situation is concerned, we will focus on the following two questions :

- Are the speakers located in the “explanation place”?
- Are the speakers together, in a same place?

In our work, we want to focus on purely verbal linguistic phenomena. Therefore, we have to minimize the utterance context dependency (deictic uses, gestures, face expressions). Thus we have not placed the participants together in a same location

³See (Denis 1997) for a classification of route explanation.

and have recorded telephone conversations.

During a previous corpus collection we had noticed that if the receiver didn't know anything about the global location including the route (for example in a town) there was no exchange between participants. As we wanted precisely to study interactions between the participants mental states, we chose subjects who had some knowledge about the location.

The analysis of our corpus is directed along three lines :

1. Study the Discourse Structure / Information Structure interaction.
2. Within each structure, study the interaction of sentential and discursive level.
3. Study the Task Structure / Linguistic Structure interaction.

Below is a transcript of a representative example from our corpus.

- A 1 A: Allons-y! donc tu pars d'où?
Let's go ! so where are you going to come from ?
- 2 B: Je pars donc de chez Laurent, c'est dans la grande rue St-Michel euh à peu près 200 mètres avant la place St-Michel.
I will come from Laurent's place, it is in St-Michel Street er... about 200m before St-Michel Plaza
- 3 A: 200 mètres avant la place St-Michel. Donc cté plutt vers le boulevard des Recollets, en partant....
200m before St-Michel Plaza. Therefore, rather on the side of Recollets Boulevard, leaving from....
- 4 B: Ouais.
yeah.
- 5 A: D'accord. Donc pour venir chez Philippe c'est assez simple. Tu descends la grande rue St-Michel. Tu traverses le carrefour.
Ok. So to come to Philippe's, it's rather simple. You go down St-Michel street. You cross the junction.
- 6 B: Ouais.
yeah.
- 7 A: Tu... euh... Tu prends la rue Pharaon.
you ... er... you take Pharaon Street
- A 8 B: La rue Pharaon?
Pharaon Street ?
- 9 A: Oui.
Yes.
- 10 B: Je ne connais pas cette rue.
I don't know that street

- 11 A: Tu ne connais pas la rue Pharaon.
You don't know that street.
- 12 B: C'est après le carrefour, euh?
It's after the junction, ..?
- 13 A: Dans le prolongement euh oui c'est après le carrefour.
continuing ... er yes it's after the junction.
- 14 B: Ouais.
yeah.
- 15 A: Dans le prolongement de la grande rue St-Michel Tu as la rue qui s'appelle je sais plus rue du Languedoc ou la rue Ozenne.
Continuing St-Michel street, you've got that street called i don't know , Languedoc Street or Ozenne Street
- 16 B: Ouais d'accord.
yeah, okay
- 17 A: Bon euh 100 mètres après le carrefour, le grand carrefour de St-Michel...euh... il y a une fourche, la rue du languedoc ou la rue Ozenne je sais plus comment elle s'appelle oblique vers la droite.
well er 100m after the junction, after the big junction at St-Michel er... there's a fork, Languedoc St or Ozenne St, i don't remember its name, it turns right.
- 18 B: Ouais.
yeah.
- 19 A: et tu as devant toi une petite rue à sens unique... qui s'appelle la rue Pharaon.
and you've got a small one-way street in front of you... called Pharaon Street
- 20 B: Ah ouais d'accord. OK. Je situe.
Oh, yeah, okay. I see.
- 21 A: Donc, tu parcours toute cette rue... euh... Tu vas arriver à la place des Carmes.
So, you take this street and go all the way, er... you will arrive at Carmes Place
- 22 B: muhm... muhm...
...
- A 23 A: Arrivé à la place des Carmes euh... tu tournes à gauche dans la rue des Polinaires, c'est une rue qui débouche sur la place des Carmes... Arrivé au 27 de la rue des Polinaires... sur ta droite tu trouveras...euh le 27 où habite Philippe Muller.
When you are a the Carmes Place,... you turn left in Polinaires Street, it's a street that goes on Carmes Place. when you are at the 27 of Polinaires street, on your right you will see er... the 27 where PM lives.
- 24 B: OK. Donc, rue des Pharaons jusqu'à la rue des Carmes et après...
Ok. So, Pharaon Street up to Carmes Street and then...

- 25 A: jusqu'à la place des Carmes.
up to Carmes Place
- 26 B: Oui place des Carmes... et à gauche.
yes, Carmes Place,... and to the left
- 27 A: Alors la première à gauche, c'est pas la bonne quand tu débouches sur la place des Carmes.
then the first on the left is not the right one when you arrive at Carmes Place
- 28 B: Ouais.
Yeah.
- 29 A: la seconde à gauche c'est la bonne. C'est au bout de la place des carmes en fait. Est-ce que tu vois la rue des Filatiers?
The second one on the left is the right one. It's at the end of Carmes Place actually. Do you see Filatiers Street ?
- 30 B: Ouais.
yeah.
- 31 A: Eh bien tu vas jusqu'à la rue des Filatiers, tu t'engages pas dedans. Tu regardes à ta gauche et tu verras la rue des Polinaires.
well, you go to Filatiers Street, you don't take it. You look on your left and you will see Polinaires Street
- 32 B: D'accord.
Okay.
- 33 A: C'est bon?
All right ?
- 34 B: Ouais c'est bon.
yeah, all right.

3 Elements of dialogue analysis

3.1 Dialogue structures as Discourse Structures

We will now give an SDRT-oriented analysis of a piece of this dialogue, but first we will give a very rough outline of this theory. Asher's theory assumes that a dialogue is a kind of discourse involving two participants. SDRT also assumes, as RST (Mann and Thompson 1987), that a discourse can be seen as a set of segments linked with (rhetorical or intentional) relations. These relations can be hierarchical or not. Hierarchical relations between segments induce a tree structure which imposes constraints on the interpretation of current utterances (e.g. anaphora resolution can be limited to certain segments of the current interpretation). More generally, constraints based on the structure induced by the segmentation determine what is a coherent dialogue. New utterances will be attached to some segment incrementally within an already existing dialogue structure as they come, by taking

into account lexical semantics, world knowledge and semantic-pragmatic rules selecting an appropriate relation in context (see (Asher and Lascarides 1998)). These aspects are often taken for granted in theories taking as primitives propositions and speech acts related to these propositions. Our goal is to account for the construction of such structures within an incremental interpretation process of the dialogue seen as a public construction of a common ground between participants. We will make use of topics in that perspective, focusing here on questions and answers sequences. Our approach is thus rather “top-down” compared to (Kruijff-Korbyova and Kruijff 1997) who places her analysis in the same discursive perspective but closer to the sentence level. That being said, even though we use SDRT as our framework, we depart somewhat from some of its choices made in the context of dialogues e.g. in (Asher and Lascarides 1998). We will keep the following principles, while leaving aside the presently less stable aspects of the still in progress theory :

- the global representation of a dialogue is composed of a set of labelled speech acts (SA) and rhetorical relations between these occurrences of SA. A speech act will be of the form $\langle \textit{Speaker}, \textit{Mode}, \textit{Content} \rangle$, where the mode can be interrogative, declarative or imperative. Content can be any part of the representation of the dialogue or a sub-dialogue. A basic semantic content will be a DRS, that is a set of linguistic referents and of conditions (predicates) on those referents. Speech acts, seen in other frameworks as having an intentional content, take on an intentional dimension only when linked together by relations bearing an intentional content.
- In order to deal with dialogue, SDRT had to be enriched with new relations. The list of relations needed by a dialogue version of SDRT is still very unstable in the prospective work of (Asher and Lascarides 1998). We have divided them into the following categories :
 - **discursive relations**⁴: *narration, elaboration, explanation, continuation, background, parallel, contrast, comment, result, consequence* ;
 - **dialogic relations**: we depart from the work of Asher by considering the following relations, dividing question elaborations into *precision request*⁵ and *confirmation request*⁶. (At this time we don't make any differences between direct and indirect partial answer.⁷ *no-answer* (linking replies, such

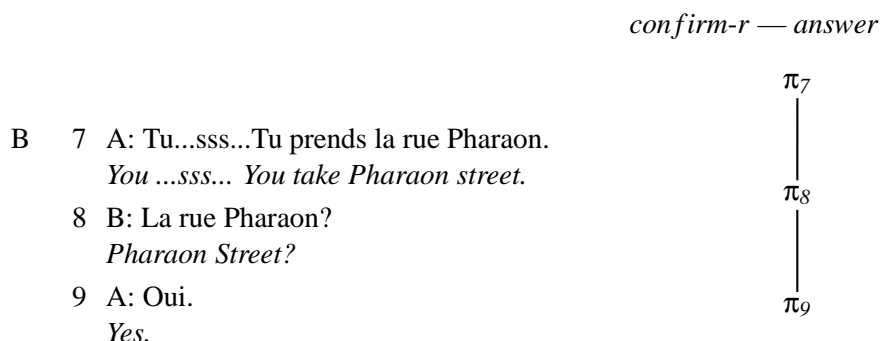
⁴The set presented in (Asher, Busquets, and Vieu pear).

⁵Divided between Yes/No questions and WH-questions.

⁶This kind of request doesn't introduce any information, it only ask a confirmation of already introduced informations. See B₈.

⁷Probably these distinctions are necessary for the evaluation of the “answeriness” of an utterance. But for the moment, within the application of our rules, we only consider that there are utterances which give an answer (direct, indirect or partial) and some which don't. In technical terms, the relation *answer* recovers *QAP* (Question Answer Pair), *IQAP* (Indirect Question Answer Pair), and *PQAP* (Partial Question Answer Pair) SDRT relations.

as, “I don’t know”), *acknowledge*, and *correction*. For instance $answer(\alpha, \beta)$ relates a turn β to its corresponding question α .



It should be noted that intonation is crucial in this example. The interrogative mode, that we use for the inference of the *confirmation-request* relation, is given by an interrogative intonation. This kind of questions is precisely identified by Reis (cited by (Engdahl 2000)) as “echo deciding question”. Here if we don’t have the rising intonation, (8) could be an acknowledgement of (7).

3.2 Information Structure, Asher and Txurruka analysis

In this section we are going to present the augmented SDRT of (Asher and Txurruka 1995).

As was said before, dialogue analysis has to take into account *informational structure*. The question is how to explain why a single propositional content may have different realizations in dialogue (Lambrecht 1994) (Vallduví and Engdahl 1996). The partitioning of the content of a sentence into two parts –sentence topic and sentence focus– structures the sentence in terms of informativeness. The partition criteria varies among authors : given/in discussion, presupposed/asserted, ...⁸ and these different definitions raise different denomination : *topic/comment*, *topic/focus*, *ground/focus*. In spite of these heterogeneity in the sentence topic definition, we will use the common notion of topic emphasis. This *Informational Structure* is assumed to be given by the syntactic and intonational analysis (Lambrecht 1994) (van Kuppevelt 1995).

Now we focus on Asher and Txurruka’s propositions. They study the interaction between Discourse Relations and Informational Structure⁹ of utterances. They assume, as their main hypothesis, a double interaction between *Discourse*

⁸For a complete taxonomy of topic/focus partition, see (van Kuppevelt 1998).

⁹They speak of informational *partition* with the aim to underline the two separate parts of the sentence.

Structure and Informational Structure. The informational structure will be influenced by the previous piece of discourse, but the discourse relation which links two segments helps to disambiguate the informational structure of the second one.

They claim for a systematic study of context impact on the determining of informational structure.

Very roughly, we can say that in their theory :

- Discourse relations force constraints on *Informational Structure*. (DS \rightarrow IS)
- The constraint satisfaction is an important clue for the establishment of the discourse relation. (IS \rightarrow DS)

Now we are going to consider our example from Asher and Txurruka's point of view. We now look more precisely at (25) turn of (A) (a correction). The corrected utterance will be called the target (here 24). Asher and Txurruka say that a correction introduces an inconsistent proposition with some previous discourse proposition. In the example, there is no inconsistency in a strict sense. (Asher 1998) extends this definition and proposes a semantic for the *correction* relation. Here we have only studied one kind of correction. In the future we will have to look at the other ones.

From Asher and Txurruka's point of view the interaction between the discourse relation of *correction* and the *Information Structure* of (25) is fundamental for dialogue coherence. In particular, the distinction between the linguistic material shared by correction (25) and target (24) (*until the Carmes*) and contradicting information (*place/square*) is given by *Information structure*. The inconsistent information (related to a shared situation) will be in focus whereas shared information will appear as sentence topic element.

In our example, it is the intonation which stresses the focus. The *Information Structure* is crucial here; indeed if the stressed element was not only the word "place", the discourse relation would be different.

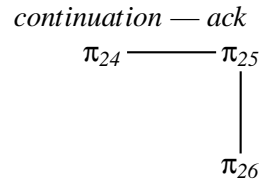
- C 24 B: OK. Donc, rue des Pharaons jusqu'à la rue des Carmes et après...
ok so Pharaon street up to Carmes street and after...
- 25 A:...jusqu'à la PLACE des Carmes.
...up to Carmes SQUARE¹⁰
- 26 B: Oui, place des Carmes.
Yes, Carmes square.

The (24-25) pair satisfies the correction constraint¹¹: The correction (25) and the target (24) differs in one point. The focus of the correction does not match

¹⁰We write in capitals the stressed part of utterances.

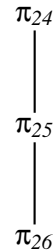
¹¹See (Asher and Txurruka 1995), (Asher 1998) for a more complete account on *correction* in SDRT.

with the corresponding element in the target. Here the stressed element “place” (square) does not match the “rue” (street). If we didn’t have this intonational stress on “place”, (25) would be a continuation of the explanation of the route (figure 1.) instead of a correction (figure 2.). We notice that here, we don’t have an inconsistency¹² between the correction (25) and the target (24). So, a strictly semantic analysis cannot provide us with the correction. Here *Information Structure* is not only a cue in the analysis but really the only way to obtain the right interpretation.



(Fig1.)

correction — ack



(Fig2.)

3.3 Global Topics

Dialogues of our corpus are all task-oriented. This kind of dialogue are studied by a lot of researchers, mainly in a human-machine interaction perspective. A widespread idea about these dialogues is that they obey a general purpose, which constrains the structure of the whole dialogue. (Grosz and Sidner 1986) speak about the *Discourse Purpose* distinguished from the *Discourse Segment Purpose*. (van Kuppevelt 1995) enriches this view with his definition of topic in term of *topic constituting questions*. He claims that in a Task Oriented Dialogue, as in a narrative discourse, “the utterances belonging to the main structure form together an answer to a single topic-constituting question”. We follow this idea that there is a topic which arches over the other topics (which become sub-topics). In this section we study the effect of global topic, not only the overarching one but also the subtopics corresponding to sub-dialogues. From a general point of view, the dialogue topic is given by the context of dialogue (linguistic or not; verbalised or not).

In our corpus, the overarching topic is a *route explanation*. We have to represent the route components related to the explanation : there is a starting point, and

¹²In fact, if there was a Carnes street leading to a Carnes square, there would be no contradiction between (24) and (25). It is the intonation that points out the correction nature of (25). So Asher and Txurruka’s proposition for the constraints on *correction* relation must be extended.

end point, and a prescription sequence (Denis 1997), introducing recursive sub-iterinary descriptions. The two participants are supposed to fill in an incomplete structure made of these elements. This presupposed structure gives us a canvas for the construction of the final, shared structure. We call these elements the **dialogue topics (DT)**. It will be used in a **top-down** manner. We give the following form :

a b c d
start(a)
end(b)
path(c)
direction(d)

Fig3.

We have to explain what is a “path” in this context. There are several ways of defining paths in theories of space¹³. But in the route context, a path is usually seen as an action sequence. Each action of the sequence is a move between two places. We are interested in the linguistic aspect of routes, so we focus on the prescriptions of these actions. Participants (A and B) are going to establish a sequence of prescription of the actions that B has to do in order to follow the path (c) in a direction (d) from (a) to (b).

At the beginning of the dialogue (turns 1 to 5), there is a first sub-dialog to establish the starting point. It is a subtopic elaborating the overarching one. It is related to the referent “a”. This sequence is a specification of “a” which fills out the canvas. We don’t give here the dialogue analysis of this establishment of the starting point, but we give the representation for this dialogue segment with an approximate translation in English (*Fig4.*)¹⁴¹⁵.

¹³See (Muller 1998) for a presentation of these definitions.

¹⁴The “d1” direction is presupposed by the “avant” use. It is not the same with “d” (from overarching global topic) which comes from the preliminary context.

¹⁵For a more precise account of the semantic representation of a route, see (Krause 2000).

e f d1 g h	e f d1 g h
Laurent(e)	Laurent(e)
chez(e,a)	a is Laurent's place
rue(f)	street(f)
nom(f,"St-michel")	name(f,"St-michel")
dans(a,f)	in/on(a,f)
place(g)	square(g)
nom(g,"St-michel")	name(g,"St-michel")
direction(d1)	direction(d1)
avant(a,g,d1,c)	before(a,g,d1,c)
distance(a,g,200m)	distance(a,g,200m)
rue(h)	street(h)
nom(h,"Recollets")	name(h,"Recollets")
du-cote-vers(a,g)	near(a,g)

Fig4.

All the informations exchanged in this sub-dialogue concerns the starting point. This fact is crucial information in the analysis of the dialogue.

The (8-20) sequence is the establishment of Pharaon street introduced by (7). We do not study here the construction of this establishment. At the end of the sequence, Pharaon street is grounded and the shared information is only the taking of the street by B (Fig5.) .

g e1
street(g)
name(g,"Pharaon")
take(B,g,e1)

Fig5.

We can see in the final route structure that some of the information introduced in the dialogue is preserved and some is left out. Typically the piece of information kept is what is shared (i.e. accepted) by both participants.

The building of this shared information is mainly guided by the rhetorical structure of the dialogue. However, trying to process it as a shared plan within the rhetorical representation of the dialogue, as in (Asher and Lascarides 1998), yields clumsy representations of the dynamics of the process itself (e.g. for correction, no-answers,...), and obscures the difference between the course of a dialogue and its underlying objectives. We therefore propose to create another structure, based on the notion of topic, for integrating this information.

As we have seen before, in task oriented dialogues (in which route explanations can be included) these "topics" comes from two sides : sentence level (see 3.2) and discourse level (see 3.3). We think that we must integrate these two sides of Information structure to contribute to the construction of a hierarchic topic structure.

4 Constructing topic and rhetorical structures in parallel

Our proposal is to enrich the rhetorical structure with a parallel structure keeping track of topic constructions. For this we consider topics as propositional contents linked by specific relations, called *topical relations*, either *topic sequence* or *topic elaboration*. In classical SDRT, these relations are somewhat related to the plan relations of SDRT (e.g. there is a plan-elaboration relation), but are not separated from rhetorical relations, while we think it is important to distinguish the course of a dialogue with the construction of a common-ground (which is often the sharing or communication of a plan in task-oriented dialogues). Besides, the topics of some parts of the dialogues are just these parts of the task to be achieved. In this sense we join the (Traum and Nakatani 1999) point of view on the multi-level approach of dialogue. Our global topic recovers the meso and macro levels of Traum and Nakatani. Nonetheless topic relations intend to go beyond plans in task-oriented dialogue, by introducing a more general information structure.

An important notion for defining the topic structure is the resolvedness of a topic. The content of a resolved topic is shared between the participants: this kind of topic is in the common ground of the conversation. By contrast, the content of an unresolved topic is still under discussion, it can be pulled out of the topic structure. We will mark an unresolved topic with “*” and we remove “*” when the topic become resolved.

We now give a set of construction rules for the topic structure. Topic structure construction is done in parallel with semantic interpretation and establishment of rhetorical relations. For every rhetoric relation we have to trigger off a topic update rule.

- **Confirmation request(α, β)** : unresolves the α associated topic.
- **Precision request(α, β)** : introduces a new unresolved topic, attached to the topic associated to α with a Topic-Elaboration relation. The actual content of this topic will depend on the nature of the question (Y/N, WH).
- **Answer(α, β)** :
 - to a confirmation request : resolves the topic associated to α .
 - to a precision request : Resolves the topic associated to α and destroys unresolved sub-topic elaborating it.¹⁶ Moreover we have to add new focused (information) from β in the DT.
- **No Answer** : This rhetoric relation has no effects on the topic structure.
- **Acknowledge(α, β)** : An acknowledgement resolves the topic associated to α .

¹⁶We destroy the unresolved topic because they are not established in the common ground and so they don't participate in the construction of the global topic structure

- **Continuation**(α, β) : A continuation resolves the topic associated to α and introduces an unresolved new topic attached to the topic associated to α by a topic sequence relation.
- **Correction**(α, β) : A correction replaces in the topic associated to α the corrected element by the focus of the correction (β)¹⁷.

Considering that we have the *correction* relation in the rhetorical structure (inferred with an IS account); considering the preceding rules; we give the following construction for the (24-26) turns. This structure recovers the meso and macro levels of (Traum and Nakatani 1999). In our structure, the meso-level is down and the macro-level is up.

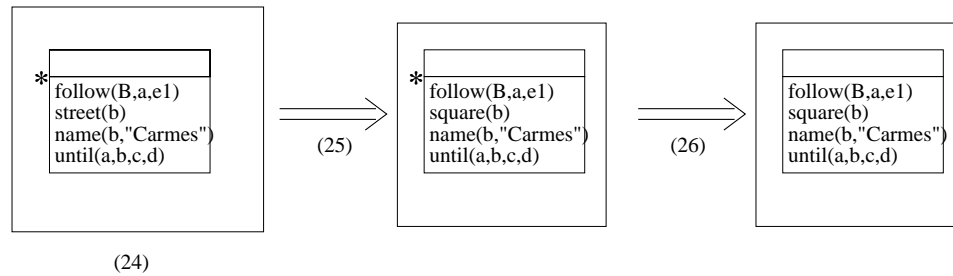


Fig6.

5 Conclusion

We have proposed here a way of structuring the analysis of a dialogue by taking into account works on topics in a semantic-pragmatic framework. We adopted a still-open theory, the Asher's SDRT, showing how to modify it to build in parallel a dialogue structure and a topic structure reflecting the construction of a common ground between two participants in a task-oriented dialogue. Our approach has remained global (ignoring the specific task of building a dialogue topic from a dialogue turn) and to a certain extent prospective. We claim that topics have to be considered in a systematic manner at any segment of a dialogue, and not only occasionally to solve specific local problems.

One of our preoccupations is to stay as close as possible to the real speech corpus. Indeed, if we want to take *Information Structure* into account we must be precise and integrate prosodic and intonational components. We don't want to avoid the problems related to the oral nature of the corpus and we think that on this subject, we have to do a lot of work. In the future we plan to modify our

¹⁷The *correction* rule that we give here concerns a specific use of correction. There are a lot of different types of corrections (*counterevidence*, *contradiction*) which are mentioned in (Asher 1998) (Prévoit 2000).

transcripts. Instead of using the “written” punctuation, we are going to use specific speech notations, developed in speech corpus domain (Blanche-Benveniste. 1997) (Valli and Véronis 1999) for the speech phenomenon (pauses, overlaps, truncated words).

Many open problems remain to be fully investigated in that perspective. First sentence topic and sentence focus have to be more precisely linked to the discourse topic, to see how they contribute to the whole structure. Then, we have to see in which contexts the computation of discourse topics interact with the determination and acceptability of rhetorical relations. We have so far only looked at the cases where selecting these relations precedes constructing the topics.

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