Uncovering the structure of discourse: Recent developments in monologic text generation

Julia LAVID
Universidad Complutense de Madrid

ABSTRACT

One of the most urgent research tasks for the discipline of discourse analysis in the 1990s is an interdisciplinary discussion about the types of structure that a unified theory of discourse should account for. To date, this scientific enterprise has only been partially undertaken by researchers in the various fields of Linguistics, Sociology, Psychology, and Artificial Intelligence, to name only a few, with the result that efforts in one area have often been ignored or insufficiently made use of by the other. An example of this is the rare adoption of computation as a medium for theoretical development by linguists. The aim of this paper is to partially bridge this gap by contributing to the development of the theory of discourse from a computational perspective. Based on recent research by the author and others, the paper describes the state-of-the-art in computational research on monologic text generation, concentrating on some of the issues which are relevant for a future unified theory of discourse structure.

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OUTLINE

1. INTRODUCTION

The study of discourse structure has been the object of concern of several scientific disciplines in the last two decades. Cognitive Psychology, Sociology, Linguistics, Artificial Intelligence and Computational Linguistics, to name only a few, all play a role in the dynamics of discourse organization, and have all devised their own models to account for the structure of discourse. In this sense, one can say that discourse analysis is not a unitary field of study in itself, but a cross-discipline constantly affected by developments in several areas. This fact, in my view, makes the study of discourse an exciting task, a scientific enterprise which is open to new and sometimes simultaneous advances in different fields, but also one which is less predictable and stable than other well-established disciplines.

Within the field of Natural Language Processing, the relevance and applicability of the study of discourse began to emerge as researchers faced up to the three central questions of Computational Linguistics. The generation question is *how can one generate coherent text*? and involves problems of selecting material to include and organizing it into a well-structured message. The parsing question is *how can one understand text, and how does knowing the structure help*? and involves problems of recognizing segments and their organization and using segments to help with reference resolution and other tasks. The dialogue question is *how can you manage the building of a single discourse structure by several people in conjunction*? and involves issues of negotiating turns, maintaining the initiative, and signalling acceptance or misunderstanding.

Whereas research on parsing has now been pursued for between three and four decades, research on language generation goes back about two decades. In this latter subarea, computational research on discourse has been pursued for not longer than a decade, and has been split into monologic and dialogic discourse, respectively [1]. With respect to dialogue,

research has tended to focus on "plan-based" dialogues -dialogues that occur around cooperative plan-based endeavours such as tutoring, interactive explanation, and collaborative action. The nature and role of the participants' beliefs and intentions is a current issue of research (Pollack, 1986; Cohen & Levesque, 1985; Grosz and Sidner, 1990) together with the type of plans that underlie this type of discourse (Lambert and Carberry, 1991; Ramshaw, 1991). Non-plan oriented varieties of dialogic discourse, such as everyday conversations, storytelling, etc. are not currently studied.

Work on monologic discourse, on the contrary, has concentrated more on language-related issues such as text planning , cohesion (Morris and Hirst, 1991), anaphor (Webber, 1991) and style (DiMarco, 1990). Within this camp, two major approaches can be identified: the formalist and the functionalist perspectives. Both approaches have been developing theories which are largely complementary and which, hopefully, seem to be converging toward a unified model of (single- and multi-speaker) discourse.

In the following sections we will concentrate only on recent trends in monologic text generation which are relevant for a future unified theory of discourse structure.

2. THE PAST: FIRST ATTEMPTS IN MONOLOGIC TEXT GENERATION

The work of B. Grosz and C. Sidner (Grosz & Sidner, 1986) has been considered one of the more influential theories of discourse structure within the computational arena. Combining the two major existing approaches to the study of discourse, the formalist and the functionalist perspectives, these authors designed a model that describes a three-way parallel analysis of discourse into the (structural) segmentation of the utterances, the (functional) structure of interlocutor intentions, and the attentional state. The formalist argument goes as follows: discourse exhibits internal structure, where structural segments are defined by semantically related material. Some of the more influential work is discourse representation theory (DRT; Kamp 1981), and that of Polanyi (1988), Reichman (1985), and Cohen (1983).

While the formalist approach concentrates on the development of formalisms that capture the properties of discourse segments and the discourse structure itself, the functionalist argument goes as follows: discourse exhibits internal structure, where the segments are defined by communicative purpose. Functional theories, therefore, have focussed on the goals of the speaker and the way those goals are reflected in the discourse structure, often as interrelationships between segments. Some of the more influential functionalist work is rhetorical structure theory (RST; Mann & Thompson, 1988), and that of Hobbs (1979), and Grimes (1975).[2]

FIGURE 1
The identification schema in TEXT, [Mckeown 85]

IDENTIFICATION

1. Identification (class & attribute / function)
2. {Analogy / Constituency / Attributive / Renaming} +
3. Particular -illustration / Evidence +
4. {Amplification / Analogy / Attributive}
5. {Particular-illustration / Evidence}

Example: Eltville (Germany) 1) An important wine village of the Rheingau region. 2) The vineyards make wines that are emphatically of the Rheingau style, 3) with a considerable weight for a white wine. 4) Taubenberg, Sonnenberg and Langenstuck are among vineyards of note.

Another relevant piece of research was McKeown's work. Her TEXT system (McKeown, 1985) was one of the first text generators which took discourse structure into account. It used *schemas* (predefined representations of stereotypical paragraph structures) to generate short texts which described various naval objects such as submarines. TEXT used four schemas: Identify, Describe, Compare & Contrast, and Attributive. An example schema is shown in Figure 1. Schemas were also used in ROMPER (McCoy, 1985), SEMTEX (Rösner, 1986), TAILOR (Paris, 1987) and (Rambow, 1990). Despite their popularity, the main shortcoming of schemas is, obviously, their inflexibility, which makes computational systems unable to replan any portion of the text generated and reason about it.

In order to address this shortcoming, a method of dynamically assembling coherent texts from basic building blocks had to be developed. After a study involving hundreds of paragraphs, Mann & Thompson (Mann & Thompson, 1988), proposed that a set of about 25 relations suffices to represent the relations that hold within the texts that normally occur in English. This theory, called Rhetorical Structure Theory (RST), based itself on the implicit assumption that a paragraph is only coherent if all its parts can eventually be made to fit into one overarching relation. Most relations contain two parts, a Nucleus (the major, central material) and a Satellite (the ancillary, subsidiary material). For example, the BACKGROUND relation is given in Figure 2.

However, Rhetorical Structure Theory was only a descriptive theory of text organization, not a generative one. In order to overcome this problem, E. Hovy operationalized some relations from RST as plans to use them generatively to plan paragraphs, rather than analytically to describe paragraph structure, thus creating a first text structurer (Hovy, 1988). This was

FIGURE 2
The RST relation circumstance, (Mann & Thompson, 1988)

RELATION NAME: CIRCUMSTANCE

CONSTRAINTS ON THE NUCLEUS: none

CONSTRAINTS ON THE SATELLITE: none

CONSTRAINTS ON THE NUCLEUS AND SATELLITE COMBINATION: The Speaker sets a framework in the subject matter within which the Reader is intended to interpret the situation presented in the Nucleus.

EFFECT: The Reader recognizes that the situation presented in the the Satellite provides the framework for interpreting the Nucleus.

LOCUS OF THE EFFECT: Nucleus and Satellite

done by treating Nucleus and Satellite requirements as semantic preconditions on material to be conveyed. The effect field contains a description of the intended effect of the relation (i.e., the goal that the plan achieves, if properly executed). Since the goals in generation are communicative, the intended effect must be seen as the inferences that the speaker is licensed to make about the hearer's knowledge after the successful completion of the relation. Subsequent work along similar lines, extending the ideas, was performed by (Moore & Swartout, 1990; Maybury, 1990; Cawsey, 1990).

3. THE PRESENT: MAJOR ISSUES IN TEXT PLANNING

Hovy's text structurer was an early step toward the eventual ability to plan coherent discourse dynamically. However, being able to plan coherent paragraph-length discourses in a variety of domains using RST as plan operators is only a part of what is involved in robust and linguistically-motivated discourse planning. Many discourse phenomena which play a significant role in the structuring of monologic discourse were altogether unaddressed by this initial text planning attempt.

In order to address some of those open issues, a new text planner was devised by the author and colleagues. One of the decisive motivations for devising a new system was the need to separate declarative from procedural knowledge,[3] as well as identifying the distinct types of knowledge necessary to generate a text. With this aim in mind, different knowledge sources required for creating a discourse structure were identified and defined in

a prototype text planner (Hovy et al., 1992). The major knowledge resources that the author and colleagues have so far identified and represented declaratively are: *text types*, *communicative goals*, *discourse structure relations*, *schemas*, *theme development* and *focus shift*.

Being far from complete, this recent text planner captures most of the major resources which contribute significantly to the structure of discourse in a unprecedented and integrative way in Computational Linguistics. Instead of describing the text planner architecture in detail, the remainder of this paper describes those major aspects of planning coherent texts which are currently the burning issues of computational research in text generation, and which future text planners will have to address in order to contribute to the advance towards a unified theory of discourse structure. They are:

1. Text plans: the operationalized RST relations themselves were found inadequate, especially in their ability to capture communicative content. Text planners have to use a new kind of plan, one which separates "rhetorical" (i.e., structural) information from intentionality.
2. Discourse relations: intersegment discourse relations are still required to structure the discourse. Ongoing efforts to collect and taxonomize relations are described.
3. Schemas: predefined structures or schemas still remain necessary to control the combinatorics of longer, and especially, stereotypic texts.
4. Focus shift: information flow is one of the issues controlled by focus shift rules, since it constrains, together with discourse relations, the combinatorial possibilities of juxtaposed text spans.
5. Sentence planning: the problem of sentence planning -what syntactic class to assign to each portion of the material, etc - is one of the unresolved and less studied issues in text planning.
6. Text formatting devices: several discourse structure relations achieve their communicative purposes presentationally using text formatting devices such as itemized lists, headings and footnotes. For the first time, a computational account can be given of the communicative semantics of certain formatting devices in terms of linguistically based studies.

Though these issues have been addressed in subsequent studies by the author and others, none have been resolved. Taken together, however, the current state of text planning work represents a significant advance over what was known about the automated planning and generation of discourse five years ago.

3.1. *Text plans*

For use in Hovy's RST structurer, as we saw before, the discourse relations themselves were viewed as plans. The structurer's goals were all directly related to its relations, thereby limiting it to a "rhetorical" goal language.

planning to achieve goals such as "create a circumstance between the current material and some additional material". Later researchers (Moore & Swartout, 1990; Moore & Paris, 1991) argued that using relations as goals erroneously conflates "rhetorical" (i.e., structural) information with intentionality. These two types of information, which are needed simultaneously to govern the discourse, should be kept separate since they perform different functions: while intentional plans are appropriate to select material from a rich knowledge base, discourse relations are necessary to ensure textual coherence, prevent unintended inferences, govern focus shifts, etc. To illustrate this point, note that the same communicative purpose can be achieved in many ways; for example, the (intentional) goal to JUSTIFY clause (1) can be achieved using several (discourse) relations with clause (2):

> CAUSE: John knows how to deal with criminals, because he was in prison.
> CIRCUMSTANCE-LOCATION: "Having been in prison, John knows how to deal with criminals.
> SEQUENCE-TIME: "After he was in prison, John knew how to deal with criminals."

Both relation-based text structurers and intention-based text planners operate following the same stepwise refinement algorithm and using the same formalism. One can define a text plan P as a tuple (*name effects constraints preconditions decomposition*), where:

— The *name* is a unique identifier of the segment

— The *effects* are one or more communicative goals that the plan achieves, if properly executed. Since these goals pertain to the speaker's desire with respect to the hearer's state of knowledge, opinion, goals, etc., they are phrased in terms of the hearer's mental state.

— The *constraints* are facts in the knowledge base or the user model that must hold before the plan may be used.

— The *preconditions* are facts in the knowledge base or user model that should hold for felicitous communication. If they are violated, the hearer may be confused. In a dialogue situation the planner may be given the ability to ignore the preconditions, trusting the hearer to request help when communication fails.

— The *decomposition* is an unordered list of subgoals to be achieved. Each subgoal may be flagged as optional, in which case the planner can ignore it under appropriate conditions. The order of subgoal segments within this list must respect the coherence requirements of discourse structure relations. Subgoals are generally of two types:

— communicative intentions on portions of knowledge base contents, which can be achieved by other text plans (for example, a PERSUADE may call for a MOTIVATE or a DESCRIBE), and

— "primitive" Speech Acts on clause-sized knowledge base entities,

FIGURE 3
Text plan *Extended-Description* from Maybury (1990)

NAME:	Extended- description
HEADER:	Describe (S, H, entity)
CONSTRAINTS:	Entity? (entity)
PRECONDITIONS	
ESSENTIAL:	know-about (S, entity) want (S, know-about (H, entitiy))
DESIRABLE:	Know about (H, entity)
EFFECTS:	Know-about (H, entity)
DECOMPOSITION:	Define (S, H, entity) optional (Detail (S, H, entity)) optional (Divide (S, H, entity)) optional (Illustrate (S, H, entity)) Give-Analogy (S, H, entity))

(S and H stand for Speaker and Hearer respectively. Describe, Define, Detail, Divide, Illustrate, and Give-Analogy are communicative intentions)

such as INFORM, ASK, and ORDER, which are achieved by the sentence generator.

An example of Maybury's plan formalism appears in Figure 3.

All existing text planners mix structural and intentional information into the discourse structure. Work has however been started on building a planner that separates the two types of knowledge (Hovy et al., 1992)

3.2. *Discourse relations*

One of the central problems confronting discourse work is the number and inferential nature of discourse relations, which, as discussed earlier, are responsible for handling the language-related aspects of a text. The need for and use of discourse structure relations to ensure coherence has been acknowledged and widely discussed by researchers from several intellectual fields - from linguists (e.g., Grimes, 1975; Quirk & Greenbaum, 1973; Sanders et al., 1992; Redeker, 1990; Martin, 1992), to computational linguists (e.g., Hobbs, 1978; Mann & Thompson, 1988) ; to Artificial Intelligence researchers (e.g., Schank & Abelson, 1977; Dahlgren, 1988).

Taking as a point of departure the relations defined in Rhetorical Structure Theory (Mann & Thompson, 1988), which were later extended in Hovy's taxonomization of a collection of the relations proposed by over thirty researchers from various fields, later reorganized with Maier (Hovy,

1990; Maier and Hovy, 1991), and Martin's taxonomization of the conjunctive relations (Martin, 1992), a recent taxonomy has been proposed to handle the requirements of the new text planner (Hovy et al., 1992). The relations were divided into three major networks, according to Halliday's metafunctional split: semantic/ideational, interpersonal, and presentational/textual. The core set of relations, organized into a taxonomy, are reproduced in Figure 4 . As shown in the networks, the selection of ideational, interpersonal and textual relations is not exclusive. A discourse segment must be able to maintain three intersegment relations simultaneously (see Lavid & Maier, 1992).

3.3. *Schemas*

As plan and relation libraries grow, the number of possible texts grows alarmingly. So, as argued in for example (McKeown, 1985, Rambow, 1990, Mooney et al., 1990), one should capture the idiosyncratic regularities of discourse structure, which may depend on genre, domain, or even simply custom, in schemas and use them as frozen plans by simple schema instantiation. Where additional structuring is required -when no frozen plan exists to achieve the communicative intention- then discourse structure plans and intersegment relations can be used.

A schema is a predefined representation of a stereotypical paragraph structure which acts as a template to mandate the content and order of the clauses in a paragraph, or the order of a series of text spans in a text. This notion has been captured in linguistics and received different names: e.g., *macrostructures* (Van Dijk and Kintsch, 1983), *holistic structures* (Mann & Thompson, 1988) or *Generic Structure Potential* (Hasan, 1977, 1984); in the world of Artificial Intelligence and Computational Linguistics, the notions of *script* (Schank and Abelson, 1977) and *schema* (McKeown, 1985), respectively, have a similar function. Although schemas are a useful and widespread mechanism for text planning, some unresolved issues still remain. As yet no representation for schemas captures well the underlying semantic and rhetorical interrelations of the parts. Also, it is quite difficult to formalize the criteria for controlling the inclusion of additional growth points to the discourse, that is, the type and order of material to include. The only criterion which has been considered, to some extent, is the effect of focus shift on discourse structure, and it is to this that we now turn.

3.4. *Focus shift*

Textual coherence is a complex phenomenon which cannot be captured in its totality by one single type of structure; it results from the interaction

FIGURE 4
A taxonomy of discourse segment relations (Maier and Hovy, 1991)

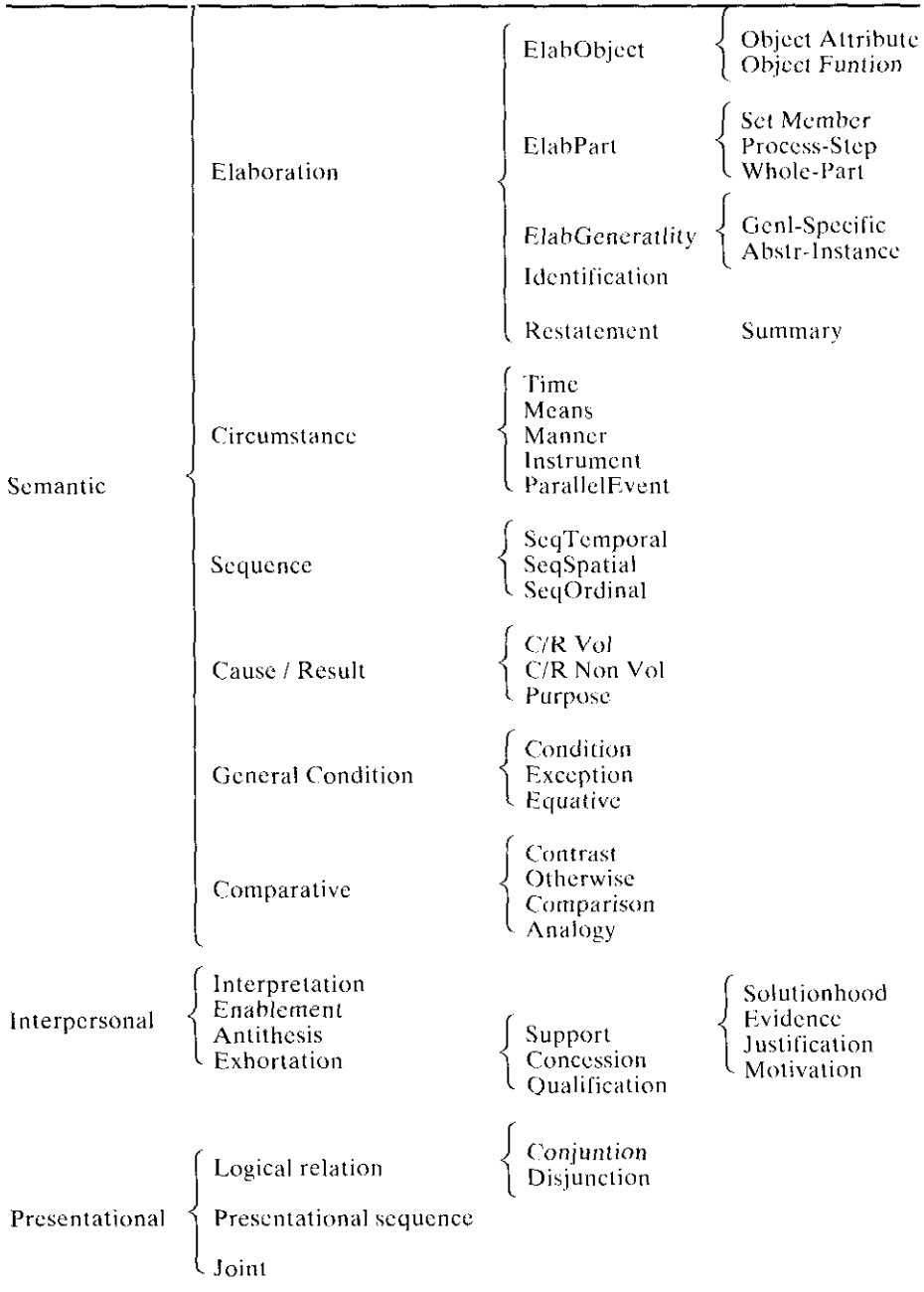

FIGURE 5

RST structure and two possible texts

1. (1) An old woman was baking one day, (2) and she made some gingerbread.(3) She had some dough left over, (4) so she made the shape of a little man. (5)Th she laid him on a baking tray and put him in the oven to bake. (6) She made eyes for him, a nose and a smiling mouth of all currants, (7) and placed more currants down his front to look like buttons.

2. (1) An old woman was baking one day, (2) and she made some gingerbread.(3) She had some dough left over, (4) so she made the shape of a little man. (5) She made eyes for him, a nose and a smiling mouth of all currants, (6) and placed more currants down his front to look like buttons. (7) Then she laid him on a baking tray and put him in the oven to bake.

of several considerations. One such consideration is *focus*, which we define as the locus of the principal inferential effort needed to understand the text.[4] In Artificial Intelligence focus has been identified as that element on which the participants center their attention as the discourse unfolds, and the process on the part of the speaker and the listener by which they concentrate their attention on some subset of their knowledge has been called focusing. The structuring capabilities of focus to ensure discourse coherence are shown by the example in Figure 5. Text (1) has been generated purely on the base of discourse relations : two ELABORATION satellites (5 & 6) provide the way the old woman made the shape of the little man. However, they offer no constraints on their order of appearance, being therefore insufficient to ensure textual coherence; the use of focus in text (2) makes the text more connected since it places the two clauses about shape together.

In the AI arena, researchers have been using the so-called focus shift rules and later a construct called a Focus Tree -which represents a focused concept at each node with as its branches all possible topic continuations (McCoy & Cheng, 1988; McCoy, 1985) to express the constraints on which material may occupy the focus position as a text progresses (Sidner, 1983; Grosz, 1981). Except for these efforts, however, these concerns have not been the subject of much computational work in text generation. Recently, a textual resource dealing with *theme development* -closely related to the notion of focus- has been the object of computational study, and introduced as constraining knowledge source in text planning. (See Hovy et al., 1992)

3.5. *Sentence planning*

Even taking into account the constraints imposed by focus, the exact form of the text is not yet fully specified. The same discourse relation can

exhibit several realizational alternatives: take, for example, the cause-effect relationship. This relation can be grammatically realized in different ways, as Halliday has shown presenting the different variations on a causal theme (Halliday, 1985: 381). (We only quote some of those alternatives):

a) She didn't know the rules. Consequently, she died.
b) She died, because she did not know the rules
c) Through not knowing the rules, she died

The question is, then, how to plan a sentence? How even to know when alternatives exist, without performing some grammar-based inspection of the material to be generated? Any solution must take into account several factors: focus, the desired overall style of the text, the rhythm of sentences, and other functional distinctions. Using the systemic-functional framework, a recent study captured the functional distinctions in the use grammatical variations of purpose clauses in instructional texts (Vander Linden et al., 1992).

Another issue is aggregation, i.e. the action of grouping together by shared features information which is represented in the computer's knowledge base as separate individuals. One can invent aggregation rules to improve the quality of a text. For example, the text below, which lacks rules for syntactically grouping trains into a single clause, is of poor quality:

> You can now choose several trains to get to Seville from Madrid. The Talgo, the AVE, and the Expresso will take you there. The Talgo arrives at 18.00. It leaves at 15.00. The Ave arrives at 18.00. It leaves at 16.00. The Expresso arrives at 20.00. It leaves at 16.00.

By creating some aggregation rules, the paragraph above -involving three parallel ELABORATION relations- resulted in the following:

> You can now choose several trains to get to Seville from Madrid. The Talgo, the AVE, and the Expresso will take you there. The Talgo and the AVE arrive at 18.00. The Expresso arrives at 20.00. The AVE and the Expresso leave at 16.00.

If aggregation rules are performed after discourse structuring, they only need to inspect the pairs of elements whithin the discourse segments that contain the material to be generated. Having access to the discourse structure seems then a preliminary step towards the production of good text.

3.6. *Text formatting*

Little written discourse -certainly no journal or conference papers, reports, overhead transparencies, etc.- is generated completely without headings, section names, occasional italicized portions, etc.; and much

discourse contains itemized lists, footnotes, indented quotations, boldfaced terms, and other formatting devices. Obviously this is because these text formatting devices convey some kind of meaning which writers select according to the purpose they assign to each portion of the text.

To date, however, the study of these issues has been disregarded in linguistics, or described in more or less intuitive terms. But for a text planning system a systematic account of the use of these devices integrated with the discourse production process is an urgent task. With this aim in mind, some researchers have carried out some experiments in order to define the communicative semantics of some textual devices. E. Hovy and Y. Arens (Hovy & Arens, 1990) defined some of those textual devices in terms of an extended version of RST. They discovered that certain textual formatting devices are highly correlated with specific configurations of the underlying text structure tree. For example, a series of nested *sequences*, is usually realized in the text as an enumerated list. Besides enumeration, they discovered other textual devices with structural definitions such as itemization (corresponding to the RST relation *list*), Appendix, footnote and parentheses (these three realize the relation *background*; they differ in the amount of material included in the relation's satellite); Section title or heading (they realize the relation *identification*, which links an identifier with the body of material it heads), etc.

Despite its experimental state, research in multimedia communication seems to offer a promising arena for the investigation of many issues which have to be addressed by a powerful theory of discourse structure.

5. CONCLUSION

Given the relative youth of computational studies of discourse, the number of competing theories and approaches points to a healthy and burgeoning field of inquiry. The major long-term problems, we believe, fall into three classes: the incorporation of models of monologic discourse into models of dialogue, issues related to discourse phenomena such as lexical cohesion, anaphora, thematic and information structuring in texts, and the development of models for the understanding and generation of non-plan-based monologues (such as reminiscences, storytelling, etc.). However, given the magnitude of the problem of discourse structure, the enterprise of text planning has come a long way in a short time. Moreover, current studies in text planning provide discourse analysis with an excellent research arena to explore different dimensions of discourse structure that have been dealt with independent and partially by different disciplines without arriving at an integrated theory. The studies presented here do not constitute the final word on the subject. They serve as signposts to further explorations into the fascinating field of discourse analysis in this decade.

NOTES

[1] In spite of the need for a unified theory, researchers have tended to concentrate on one type or the other, without paying enough attention to the differences and the commonalities between them. However, there have been recently some attempts at integrating both trends of research, as shown by some papers by Fawcett & Davies (1992), and Maier & Sitter (1992).

[2] This fact explains why research on discourse carried out in the area of parsing -whose main concern is the recognition of structure- has tended to be formalist in nature, while almost all research on generation -which is a goal-driven, planning task- has tended to be functional.

[3] For a thorough discussion on the separation of declarative from procedural knowledge, see Lavid (1992).

[4] See Lavid & Hovy, 1993. The notions of topic-focus, theme-rheme, given-new have been the subject of much research in Linguistics, with a great degree of overlap and terminological confusion. We take focus here in the sense of the Prague School (Danes, 1974) and (Halliday, 1967; Fries, 1981) to mean a salient element of the clause that usually appears in its latest, high-informational position.

REFERENCES

Cawsey, A. (1990). Generating Communicative Discourse. In R. Dale, C. Mellish, and M. Zock (eds.), *Current Research in Natural Language Generation* . Boston: Academic Press. 75-102.

Cohen, P.R. and Levesque, H.J. (1985). *Speech Acts and Rationality*. In *Proceedings of the 23rd ACL Conference*. Chicago. 49-59.

Dahlgren, K. (1988). *Naive Semantics for Natural Language Understanding*. Boston: Kluwer Academic Press.

Danes, F. (1974). Functional Sentence Perspective and the Organization of the Text. In F. Danes (ed.), *Papers on Functional Sentence Perspective.* The Hague: Mouton.

DiMarco, C. (1990). Computational Stylistics for natural language translation. Unpublished PhD. dissertation, University of Toronto, Toronto.

Fawcett, R.P., and Davies, B.L (1992). Monologue as a turn in dialogue: towards an integration of exchange structure and rhetorical structure theory. In R. Dale, E. Hovy, D. Röstner, and O.Stock (eds.), *Aspects of Automated Machine Translation*. Heidelberg: Springer Verlag Lecture Notes in AI number 587. 151-163.

Fries, P. H. (1981). On the Status of Theme in English: Arguments from Discourse. *Forum Linguisticum* 6: 1-38.

Grimes, J.E. (1975). *The thread of discourse*. The Hague: Mouton.

Grosz, B.J. (1981). Focusing and Description in Natural Language Dialogues. In A. Joshi, B. Webber, and I.Sag (eds.), *Elements of Discourse Understanding*, Cambridge: Cambridge University Press.

Grosz, B.J. and Sidner, C.L. (1986). Attentions, Intentions and the Structure of Discourse. *Journal of Computational Linguistics* 12 (3): 175-204.

Grosz, B.J. and Sidner, C.L. (1990). Plans for Discourse. In P.Cohen, J. Morgan, and M.Pollack (eds.), *Intentions in Communication*, Cambridge: MIT Press.

Halliday, M.A.K. (1967). Notes on Transitivity and Theme in English. *Journal of Linguistics* 3: 37-81.

Halliday, M.A.K. (1985). *An Introduction to Functional Grammar.* Baltimore: Edward Arnold Press.

Hasan, R. (1977). Text in the systemic functional model. In W. Dressler (ed.), *Current Trends in text linguistics*. Berlin, New York: Walter de Gruyter.

Hasan, R. (1984). The Nursery Tale as a Genre. *Nottingham Linguistic circular* 13: 71-102.

Hobbs, J. R. (1979). Coherence and Coreference. *Cognitive Science* 3 (1): 67-90.

Hovy, E.H. (1988). Planning Coherent Multisentential Text. In *Proceedings of the 26th ACL Conference*, Buffalo. 163-169.

Hovy, E.H. and Arens, Y. (1990). Allocating Modalities in Multimedia Communication. In *Proceedings of the AAI Spring Symposium on Knowledge-Based Human- Computer Communication*, Stanford University.

Hovy, E.H., Lavid, J., Maier, E., Mittal, V. and Paris, C.L. (1992). Employing Knowledge Resources in a New Text Planner Architechture. In R. Dale, E. Hovy, D. Röstner, and O.Stock (eds.), *Aspects of Automated Natural Language Generation* . Heidelberg: Springer Verlag Lecture Notes in AI number 587. 57-72

Kamp, H. (1981). A Theory of Truth and Semantic Representation. In J.A.G.Groenendijk, T.M.V. Janssen, and M.B.J. Stokhof (eds.), *Formal Methods in the study of language*. Amsterdam. 277-322.

Lambert, L. and Carberry, S. (1991). A Tripartite Plan-Based Model of Dialogue. In *Proceedings of the 29th Annual Conference of the ACL.* Berkeley. 47-54.

Landauer, T.K., Dumais, S.T., Gomez, L.M. & Furnas, G.W. (1982). Human Factors in Data Access. In *The Bell Technical Journal 61* (9). 2487-2507.

Lavid, J. (1992). A Computational Approach to the Theory of Discourse Structure: advances in Text Planning. *Atlantis 14.* 81-105.

Lavid, J. and Hovy, E.H. (1993). Information in Discourse: Focus, Theme, Given and Other Dangerous Things. (in preparation)

Lavid, J. and Maier, E. (1992). Textual Relations: Their Usefulness and Applicability for a Text Planning System. Paper presented at the *19th International Systemic-Functional Congress.* Macquarie University (Australia).

Maier, E. and Hovy, E.H. (1991). Organizing Discourse Relations using Metafunctions. In H.Horacek (ed.), *New Concepts in Natural Language Generation: Planning, Realization, and Systems*. London: Pinter (to appear).

Maier, E. and Sitter, S. (1992). An Extension of Rhetorical Structure Theory for the Treatment of Retrieval Dialogues. In *Proceedings of Cogsci.* Bloomington (Indiana).

Mann, W.C. and Thompson, S.A. (1988). Rhetorical Structure Theory: toward a functional property of text organization. *Text* 8 (3). 243-281.

McKeown, K.R. (1985) *Text generation: using discourse strategies and focus constraints to generate natural language text.* Cambridge, MA: Cambridge University Press.

Maybury, M.T. (1990). *Planning Multisentential English Text Using Communicative Acts*. PH.D. dissertation, Cambridge University.

McCoy, K.F. (1985). *Correcting object-related misconceptions.* Unpublished PhD.dissertation, Yale University, New Haven, CT.

McCoy, K.F. and Cheng, J. (1988). Focus of Attention: Constraining what can be said next. In C. Paris, W.R. Swartout and W.C. Mann (eds.), *Natural Language in Artificial Intelligence and Computational Linguistics*. Boston: Kluwer. 103-124.

Martin, J.R. (1992). *English Text: System and Structure.* Amsterdam: John Benjamins.

Mooney, D.J., Carberry, S., and McCoy, K.F. (1990). The Basic Block Model of Extended Explanations. In *Proceedings of the 5th International Workshop on Text Generation*, Pittsburgh.

Moore, J. D. and Swartout, W.R. (1990). Dialogue-based Explanation. In C. Paris, W.R. Swartout and W.C. Mann (eds.), *Natural Language in Artificial Intelligence and Computational Linguistics*. Boston: Kluwer. 49-82.

Moore. J.D., and Paris. C.L.(1991). Discourse structure for explanatory dialogues.Paper presented at the *AAAI Fall Symposium on Discourse*. Pacific Grove.

Morris, J. and Hirst, G. (1991). Lexical cohesion computed by thesaural relations as an indicator of the structure of a text. *Computational Linguistics 17* (1). 21-48.

Paris, C.L. (1987). The use of explicit models in text generation: tailoring to a user's level of expertise. Unpublished Ph.D. dissertation, Columbia University Press, New York, NY.

Polanyi, L. (1988). A formal model of the structure of discourse. *Journal of Pragmatics 12* .601-638.

Pollack, M.E. (1986). A Model of Plan Inference that distinghishes between the beliefs of actors and observers. In *Proceedings of the 24th Annual Conference of the Association of Computational Linguistics*. Chicago. 207-214.

Rambow, O. (1990). Domain communication knowledge. In *Proceedings of the 5th International Workshop on Text Generation*, Pittsburgh, PA. 87—94.

Ramshaw, L. A. (1991). A Three-Level Model for Plan Exploration. In *Proceedings of the 29th Annual Conference of the ACL*. Berkeley. 39-46.

Redeker, G. 1990. Ideational and Pragmatic Markers of Discourse Structure. *Journal of Pragmatics 14* .367-381.

Reichmann, R. (1985). *Getting computers to talk like you and me*. Cambridge, MA: MIT Press.

Rösner, D. (1986). Ein System zur Generierung von Deutschen Texten aus Semantischen Repräsentationen. Unpublished Ph. D. Dissertation, University of Stuttgart, Stuttgart, Germany.

Sanders, T. J. M., Spooren, W.P.M.S., and Noordman, L.G.M, (1992). Towards a Taxonomy of Coherence Relations. *Discourse Processes 15*. 1-35.

Schank, R.C. and Abelson, R. (1977). *Scripts, Plans, Goals and Understanding*. Hillsdale: Lawrence Erlbaum Associates.

Sidner, C.L. (1983). Focusing and Discourse. *Discourse Processes 6* .107-130.

Vander Linden, K., Cumming, S., and Martin, J. (1992). Using System Networks to build rhetorical structures. In R. Dale, E. Hovy, D. Röstner, and O.Stock (eds.), *Aspects of Automated Natural Language Generation*, Heidelberg: Springer Verlag Lecture Notes in AI number 587. 57-72.

Van Dijk, T.A. and Kintsch, W. (1983). *Strategies of Discourse Comprehension*. New York: Academic Press.

Webber, B.L. (1991). Structure and ostention in the interpretation of discourse deixis. *Natural Language and Cognitive Processes 6* (2). 107-135.