

# Parsimonious and Profligate Approaches to the Question of Discourse Structure Relations

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## Abstract

To computationalists investigating the structure of coherent discourse, the following questions have become increasingly important over the past few years: Can one describe the structure of discourse using interclausal relations? If so, what interclausal relations are there? How many are required? A fair amount of controversy exists, ranging from the parsimonious position (that two intentional relations suffice) to the profligate position (that an open-ended set of semantic/rhetorical relations is required). This paper outlines the arguments and then summarizes a survey of the conclusions of approximately 25 researchers — from linguists to computational linguists to philosophers to Artificial Intelligence workers. It classifies the more than 350 relations they have proposed into a hierarchy of increasingly semantic relations, and argues that though the hierarchy is open-ended in one dimension, it is bounded in the other and therefore does not give rise to anarchy. Evidence for the hierarchy is mentioned, and its relations (which are rhetorical and semantic in nature) are shown to be complementary to the two intentional relations proposed by the parsimonious position.

## How Many Interclausal Discourse Coherence Relations?

This paper proposes an answer to an issue that keeps surfacing in the computational study of the nature of multisentential discourse.

It has been argued fairly generally that multisentence texts (specifically, short texts such

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as paragraphs) are coherent by virtue of the rhetorical or semantic relationships that hold among individual clauses or groups of clauses (see, for example, [Aristotle 54, Hobbs 79, Grimes 75, Mann & Thompson 88]). In this view, a text is only coherent when the speaker aids the hearer's inferential understanding processes by providing clues, during the discourse, as to how the pieces of the text interrelate. Such clues are often cue words and phrases such as "in order to" (signalling a purpose for an action) or "then" (signalling the next entity in some temporal or spatial sequence); but they can also be shifts in tense and mode (such as in "She was gone. Had she been there, all would have been well"), and even appropriate pronominalizations.

Various researchers in various intellectual subfields have produced lists of such relations for English. Typically, their lists contain between seven and thirty relations, though the more detailed the work (which frequently means the closer the work is to actual computer implementation), the more relations tend to be named. I have collected the lists of over 25 researchers — from philosophers (e.g., [Toulmin 58]) to linguists (e.g., [Quirk & Greenbaum 73, Halliday 85]) to computational linguists (e.g., [Mann & Thompson 88, Hobbs 79]) to Artificial Intelligence researchers (e.g., [Schank & Abelson 77, Moore & Paris 89, Dahlgren 88]) — amounting to a total of more than 350 relations. The researchers and their lists appear below.

In this paper, I will call the assumption of these researchers, namely that some tens of interclausal relations are required to describe the structure of English discourse, the *Profligate Position*.

Unfortunately, the matter of interclausal relations is not simple, and not everyone agrees with this position. These relations are seldom explicitly signalled in the text, and even when they are, they seem to take various forms particular to their use in context. This fact has led some researchers, notably [Grosz & Sidner 86], to question the wisdom of identifying a specific set of such relations. They argue that trying to identify the "correct" set is a doomed enterprise, because there *is* no closed set; the closer you examine interclausal relationships, the more variability you encounter, until you find yourself on the slippery slope toward the full complexity of semantics proper. Thus though they do not disagree with the idea of relationships between adjacent clauses and blocks of clauses to provide meaning and to enforce coherence, they object to the notion that some small set of interclausal relations can describe English discourse adequately.

As a counterproposal, Grosz and Sidner sidestep the issue of the structure of discourse imposed by semantics and define two very basic relations, DOMINANCE and SATISFACTION-PRECEDENCE, which carry purely intentional (that is, goal-oriented, plan-based) import. They use these relations in their theory of the structure of discourse, according to which some pieces of the text are either subordinate to or on the same level as other pieces, with respect to the interlocutors' intentions. I will call this position, namely that two interclausal relations suffice to represent discourse structure, the *Parsimonious Position*.

From the point of view of text analysis, the Parsimonious approach seems satisfactory. Certainly one can analyze discourse using the two intentional relations. However, from the point of view of text generation, this approach is not sufficient. Practical experience has shown that text planners cannot get by on intentional considerations alone, but need considerably more rhetorical and semantic information in order to construct coherent text (there are many examples; see [McKeown 85, Hovy 88a, Moore & Swartout 88, Paris 88, Rankin 89, Cawsey 89]). In practical terms, this means that text planning systems require a rich library of interclausal relations.

Questions such as

- Does one really need semantic and/or rhetorical discourse structure relations?
- Just how many such relations are there?
- What is their nature? How do they relate to the two intentional relations?

will not go away. Until it is resolved to the satisfaction of the adherents both positions, further work on text planning and discourse analysis is liable to continue getting stranded on the rocks of misunderstanding and disagreement. This paper suggests a compromise that hopefully opens up the way for further development.

## An Unsatisfactory Solution

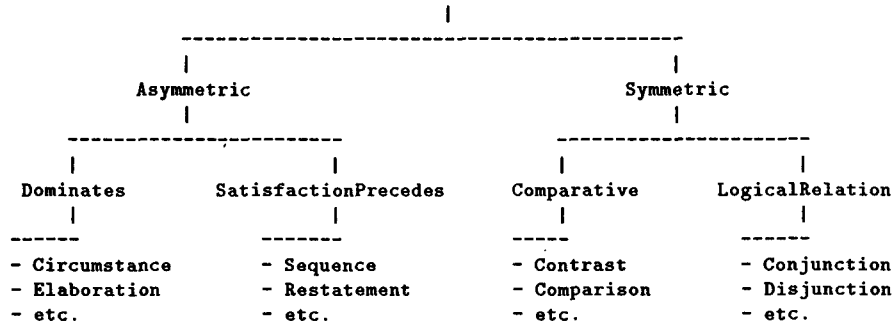
How can one reconcile the two sides? That is to say, how can one build a library of interclausal relations that are simultaneously expressive enough to satisfy the requirements of text planning systems but do not simply form an unbounded ad hoc collection of semantic relations with no regard to the intentional ones?

One answer is to produce a two-dimensional organization of relations, with one dimension constrained in the number of relations and the other unconstrained (and increasingly semantic in nature; see Objection 1 below). Such organization is a hierarchic taxonomy of limited width but of unbounded depth; the more general a relation is, the higher it is in the hierarchy and the fewer siblings it has.

An appealing hierarchy is shown in Figure 1. It displays a number of very desirable features. In particular, the top few levels are strictly bounded: no logical alternatives to ASYMMETRIC and SYMMETRIC exist, and one level lower, under ASYMMETRIC, following Grosz and Sidner there is no need to use any other relation than DOMINATES and SATISFACTIONPRECEDES at that level. Increasingly detailed relations appear at lower levels, which (as is discussed below) remain relatively bounded. Still, the more one specifies a particular relation to distinguish it from others, the more semantic it necessarily becomes (since increasing specification invariably introduces additional semantic features; that is the nature of the specialization process), and the lower it appears in the hierarchy. Though one does eventually approach the full complexity of semantics proper, the approach is not unprincipled; each relation is always constrained by its position in the hierarchy and inherits much of its structural and other features from its ancestors.

In this scheme, one can (and the Parsimonious do) perform discourse analysis and study discourse structure wholly at the level of DOMINATES

Figure 1: An Unsatisfactory Attempt at Hierarchicalizing Interclausal Relations.



and SATISFACTIONPRECEDES, and never come into conflict with the structural descriptions found empirically by the Profligate. One is simply not being as specific about the particular interclausal relations that make up the discourse.

However, this taxonomy is unsatisfactory. It is impossible in practise to place into the hierarchy with certainty most of the relations found necessary by the Profligate. For example, the relation CAUSE (of various kinds) is one of the most agreed-upon relations. But is it to be classified as a type of DOMINATES or of SATISFACTIONPRECEDES? Though it seems able to function either way, this question is impossible to answer, since none of the concepts involved are clearly enough defined (certainly nobody has provided a general definition of CAUSE — how could one?; it has been the topic of centuries of philosophical debate. And even the limited definition required for the purposes of Computational Linguistics in a particular application domain with a given ontology of terms has not been provided satisfactorily yet).

## A Better Solution

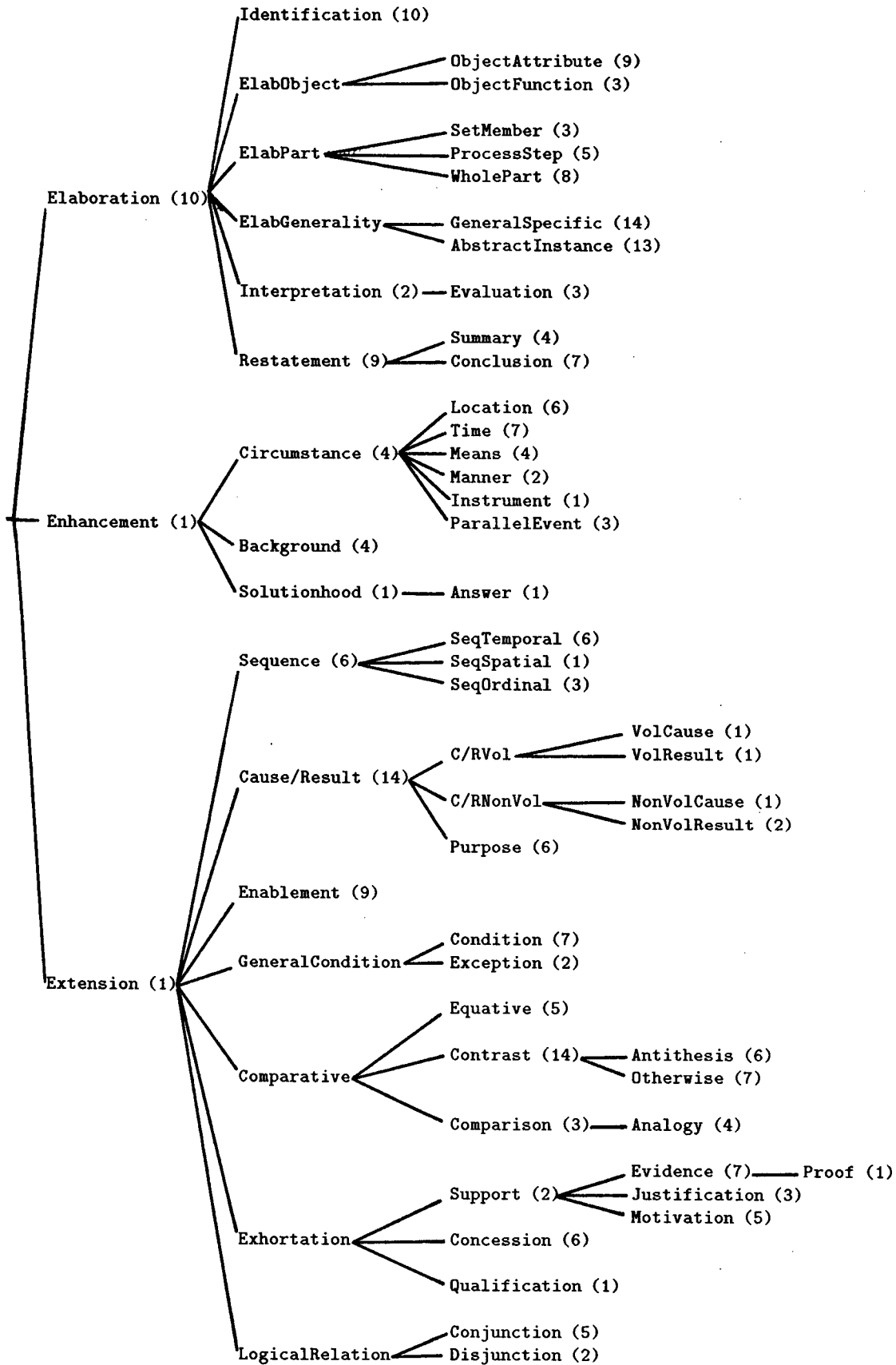
The answer to the dilemma: It is a mistake to classify rhetorical and semantic relations under the relations DOMINATES and SATISFACTIONPRECEDES. This insight does not destroy the hierarchy; most of its desirable properties are maintained. It does mean, however, that a new top-level organization must be found and that the role of intentional relations vis à vis rhetorical/semantic relations must be explained. I address the first point here, and the role of the intentional relations later on.

I have not found any highly compelling top-level organization. Ideally, the top level should partition the relations into a few (say, three or four) major groups that share some rhetorical or semantic property. In the absence of a more compelling suggestion (for which I continue to search), I use here the top-level trifurcation of [Halliday 85], which is based, roughly speaking, on the “semantic distance” between the contents of the two clauses. The three relations are ELABORATION, ENHANCEMENT, and EXTENSION. ELABORATION relations hold between entities and their immediate constituents or properties, and have a definitional flavor; ENHANCEMENT relations hold between entities and their circumstances of place, time, manner, etc.; and EXTENSION relations hold between entities and more distant entities such as causes, follow-ups, contrasts, etc. Halliday’s classification has been modified and regularized by Matthiessen (personal communication). For want of compelling arguments to the contrary, I use Matthiessen’s modification of Halliday’s ideas as the basis for the top level of the hierarchy.

In order to construct the hierarchy, I collected over 350 relations from 26 researchers in various fields. I merged the relations, coming up with a set of 16 on the second tier of the hierarchy, and then classified more particular subrelations where appropriate. The hierarchy of interclausal relations is given in Figure 2. The number associated with each relation indicates the number of different researchers who have listed the relation and may serve as a vote of confidence in it.

The following list contains each relation in the hierarchy together with its proposers (identified

Figure 2: A Hierarchy of Interclausal Relations.



by their initials and listed subsequently). In the parenthesized comments, *S* stands for speaker and *H* for hearer. The particular relations defined by each researcher and their respective classifications are provided in the full version of this paper.

**Elaboration:** MT, JH, JG, MP, GH, BF, KD, DSN, QG, MH  
**Identification:** KM, JG, HS, MP, KD, AC, MM, QG, ST, RJ  
**ElabObject:**  
**ObjectAttribute:** MT, HI, HL, KM, LP, JG, MP, MM, MH  
**ObjectFunction:** HL, KM, MP  
**ElabPart:**  
**SetMember:** MT, KM, JG  
**ProcessStep:** MT, HP, HI, MP, DL  
**WholePart:** MT, HI, HL, KM, JG, MP, AC, DL  
**ElabGenerality:**  
**GeneralSpecific:** MT, HP, JH, KM, JG, TNR, HS, MP, KD, AC, NS, RC, QG, MH  
**AbstractInstance:** MT, HP, JH, KM, LP, TNR, JG, HS, MP, MM, RC, QG, MH  
**Interpretation:** MT, KD  
**Evaluation (S opinion):** MT, KD, JH  
**Restatement:** MT, KM, KD, DSN, NS, RR, RC, QG, MH  
**Summary (short restatement):** MT, DSN, RC, QG  
**Conclusion (interp at end):** KM, JG, HS, KD, RR, RC, QG

**Enhancement:** MH  
**Circumstance:** MT, JG, DSN, QG  
**Location:** HI, HL, KD, QG, RJ, MH  
**Time:** HI, HL, TNR, KD, QG, RJ, MH  
**Means:** MP, QG, ST, MH  
**Manner:** QG, MH  
**Instrument:** QG  
**ParallelEvent:** KD, QG, RJ  
**Background:** MT, JH, HL, MP  
**Solutionhood (general prob):** MT  
**Answer (numeric prob):** KM

**Extension:** MH  
**Sequence:** MT, JH, LP, KD, DSN, RC  
**SeqTemporal:** HI, HP, LP, DL, NS, MH  
**SeqSpatial:** NS  
**SeqOrdinal:** LP, DSN, QG  
**Cause/Result:** JH, KM, TNR, JG, GH, KD, LP, RL, RR, RC, QG, RJ, SA, MH  
**C/RVol (volitional):**  
**VolCause:** MT  
**VolResult:** MT  
**C/RNonvol (nonvolitional):**  
**NonVolCause:** MT  
**NonVolResult:** MT, MP  
**Purpose:** MT, HP, KD, QG, SA, MH  
**Enablement:** MT, JH, HL, TNR, MP, KD, DSN, DL, SA  
**GeneralCondition:**  
**Condition:** MT, JG, LP, RL, DL, RC, MH  
**Exception:** RL, MH  
**Comparative:**  
**Equative (like, while):** JG, TNR, DL, QG, MH  
**Contrast:** MT, JH, LP, IR, TNR, MP, RL, GH, BF, KD, NS, DSN, RC, QG  
**Antithesis:** MT, DSN, JG, HS, KM, QG  
**Otherwise (if then else):** MT, LP, NS, RL, RC, QG, MH  
**Comparison:** KM, HS, MH  
**Analogy:** KM, JG, MP, RR

**Exhortation:**  
**Support:** RR, RC  
**Evidence (support claim):** MT, KM, JG, MP, BF, KD, ST  
**Proof:** MP  
**Justification (for S act):** MT, IR, DL  
**Motivation (for H act):** MT, MP, DSN, DL, MM  
**Concession:** MT, DSN, KD, RR, QG, MH  
**Qualification:** ST  
**LogicalRelation:**  
**Conjunction (Join, and):** MT, DSN, RC, QG, MH  
**Disjunction:** QG, MH

(Note: Some of the relations of QG and RJ are intra-clausal.)

The above initials refer to the following authors:

AC: Alison Cawsey [Cawsey 89]  
BF: Barbara Fox [Fox 84]  
DL: Diane Litman [Litman 85]  
DSN: Donia Scott et al. [De Souza et al. 89]  
GH: Graeme Hirst [Hirst 81]  
HI: Eduard Hovy, II domain [Hovy 88c]  
HL: Eduard Hovy, LILOG domain [Hovy 89]  
HP: Eduard Hovy, PEA domain [Hovy 88a]  
HS: Shepherd [Shepherd 26]  
IR: Ivan Rankin [Rankin 89]  
JG: Joseph Grimes [Grimes 75]  
JH: Jerry Hobbs [Hobbs 78, Hobbs 79, Hobbs 82]  
KD: Kathleen Dahlgren [Dahlgren 88], pp. 178-184  
KM: Kathleen McKeown [McKeown 85]  
LP: Livia Polanyi [Polanyi 88]  
MH: Michael Halliday [Halliday 85], chapter 7  
MM: Mark Maybury [Maybury 89]  
MP: Johanna Moore and Cécile Paris [personal communication, 1989], [Moore & Swartout 88, Paris 88, Moore & Paris 89]  
MT: Bill Mann and Sandra Thompson [Mann & Thompson 86, Mann & Thompson 88]  
NS: Nathalie Simonin [Simonin 88]  
QG: Quirk and Greenbaum, pp. 284-296 (mainly) [Quirk & Greenbaum 73]  
RC: Robin Cohen [Cohen 83], appendix II  
RJ: Ray Jackendoff [Jackendoff 83], pp. 166-202  
RL: Robert Longacre [Longacre 76]  
RR: Rachel Reichman [Reichman 78], chs. 2,3  
SA: Roger Schank and Robert Abelson, pp. 30-32 [Schank & Abelson 77]  
ST: Stephen Toulmin [Toulmin 58], pp. 94-113  
TNR: Sergei Nirenburg et al. [Tucker et al. 86]

## Some Evidence for the Hierarchy Structure

Some nonconclusive evidence supports parts of the hierarchy, though further study must be done to examine all the relations. This evidence is based

on sensitivity to generalization evinced by many cue words and phrases. For example, the cue word "then" is associated with SEQUENCE, and can be used appropriately to indicate its subordinates SEQTEMPORAL and SEQSPATIAL, as in:

SEQTEMPORAL: First you play the long note, *then* the short ones

SEQSPATIAL: On the wall I have a red picture, *then* a blue one

In contrast, the cue words for the two subrelations are specific and cannot be interchanged without introducing the associated connotation:

SEQTEMPORAL: *After* the long note you play the short ones

SEQSPATIAL: *Beside* the red picture is the blue one

Thus the relation associated with "then" subsumes the relations associated with "after" and "beside". Similar observations hold for a number of the relations (e.g., SOLUTIONHOOD and RESTATEMENT).

Preliminary investigation indicates possible additional evidence in the syntactic realization of some relations: When a relation typically gives rise to a dependent clause, then its subrelations tend to do so as well. More study must be done by a trained linguist.

## Role of Intentional Relations

What then of the two relations DOMINATES and SATISFACTIONPRECEDES? They do not appear anywhere in the hierarchy in Figure 2.

The answer is that these two relations express information that is independent of the rhetorical/semantic meanings of the relations in the taxonomy and only apply in discourses with intentional, plan-like nature. They derive from early work on a highly plan-oriented domain [Grosz 81], in which plan steps' preconditions led to underlying *precedence* orderings of plan steps and *satisfaction* of subgoals which were *dominated* by supergoals. However, not all discourse is plan-like; a large proportion of everyday close discourse between people achieves goals for which, it can be argued, no plans can be formulated (for some such goals see [Hovy 88b]): the banter between friends which serves to strengthen interpersonal bonds, the discussions in supermarket lines, the language and presentation styles employed in order to be friendly or attractive, etc. Such communications also exhibit internal structure, and also employ the rhetorical/semantic interclausal relations.

However, it is not clear how to generalize DOMINATES and SATISFACTIONPRECEDES to cover such cases as well. One possible generalization is to use the general relations HYPOTAXIS and PARATAXIS (that is, asymmetrical and symmetrical relationships):

HYPOTAXIS: Joe left because Sue worked ( $\neq$  Sue worked because Joe left)

PARATAXIS: He shouted when the horse jumped (= the horse jumped when he shouted)

respectively). But this does not work because both DOMINATES and SATISFACTIONPRECEDES are by their natures asymmetrical. Another possible generalization is to use the two syntactic relations MULTIVARIATE and UNIVARIATE (that is, containing an embedded syntactic type recursion (a grammatical rank shift) or not, as in:

MULTI: Sue's working caused [Joe to leave] (*S* embedded in *S*)

UNI: Joe left because Sue worked (two coequal *S*s)

respectively). This does not work either because some DOMINATES relations hold between syntactically independent complete sentences, so no syntactic embedding occurs.

Does this mean that the two intentional relations should simply be added into the hierarchy? No, because they can be realized in the discourse by various rhetorical/semantic relations; for example, SATISFACTIONPRECEDES can be expressed by SEQUENCE, as in:

First boil the water, *then* add the rice, *and then* stir

or by CAUSE, as in:

The sun heats the desert, *which causes* the air to rise, *which causes* a breeze

Thus, in the absence of other candidate generalizations, one can conclude that the relations DOMINATES and SATISFACTIONPRECEDES are independent of the rhetorical/semantic taxonomization and provide an additional dimension of information, used for those discourses that exhibit an appropriately intentional plan-like nature.

## Some Objections Answered

A number of objections may be raised to the taxonomization presented here. I attempt to respond to some of the more serious ones:

**Objection 1.** Does it make sense at all to organize into a single taxonomy such disparate entities? After all, RESTATEMENT and CONCESSION are primarily rhetorical while, say, PURPOSE and PROCESSSTEP are primarily semantic.

Why not? As a result of this study and previous work, I believe that “rhetorical” relations are simply the crudest or most generalized “semantic” ones; in other words, that no *purely* rhetorical or *purely* semantic relations exist. Some relations, typically those higher in the hierarchy, certainly fulfill a more rhetorical function (i.e., provide more information about the argumentational structure of the discourse) than a semantic function. But not even the topmost relations are entirely devoid of semantic meaning. Since all the relations have some semantic import (regardless of their structural import), this objection to their being arranged into a single taxonomy for the purposes of discourse structure description is groundless<sup>1</sup>.

**Objection 2.** What guarantee exists that the relations given in the taxonomy are indeed the “right” ones? Or the only ones? It is not difficult to come up with relations that differ in some way from those in the taxonomy and that do not neatly fall under a single item in it.

This is a standard objection to any set of terms proposed to fulfill some function. The standard response holds here too: there is no guarantee that these are the “right” relations, whatever “right” may mean. Similarly, there is no guarantee that the terms [VERB NOUN ADJECTIVE ADVERB . . . ] are the “right” and “only” terms for types of words; they have simply been canonized by long use and much experience. There is enough evidence from actual attempts at constructing working systems (text planners and discourse analyzers) that relations at this level of interclausal representation are *required* to guide inference and planning processes. Without such relations we simply cannot construct an adequate account of the structure of a discourse

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<sup>1</sup>This position is in contradistinction with that of Systemic Linguistics, which holds that semantic relations are of the type Ideational while rhetorical relations are of the type Textual. Since both kinds of relations serve the same function, namely to bind together different pieces of knowledge, and certain relations operate both interclausally and intracausally, there seems to me no reason to differentiate them into two different types. I categorize discourse structure relations with those called Ideational, and group separately all those phenomena that reflect the characteristics of the communicative setting: referentially available artifacts and concepts, the nature of the medium (telephone, paper, conversation, etc.), and the physical and social context (background noise, available time, etc.).

nor plan an adequate multisentence paragraph by computer.

The particular relations proposed here are certainly open to question, and their strongest support is that they are the amalgamation and synthesis of the efforts and proposed terms of over 25 different investigators from different fields, as noted previously. In addition, there is always the possibility that new interclausal relations will be needed that cannot in fact be subsumed under existing nodes in the taxonomy. While not impossible, I believe this is unlikely, based on my experience in compiling the hierarchy: After the top three levels had more or less been established halfway through this study, only one new second-level relation — IDENTIFICATION — had to be added. I expect that when new domains are investigated, the hierarchy will grow primarily at the bottom, and that the ratio of the number of relations added at one level to the number of relations added at the next lower level, averaged across all levels, will be well below 0.2.

**Objection 3.** The taxonomy is unbounded toward the bottom: it places one on the slippery slope toward having to deal with the full complexity of semantic meaning. Simply working on the structure of discourse is difficult enough without bringing in the complexity of semantic knowledge.

This is the Parsimonious Position objection. There is no reason to fear the complexity of an unbounded set of terms, whether semantic or not, as long as the terms are well-behaved and subject to a pattern of organization which makes them manageable. A hierarchicalization of the terms in which all the pertinent information about discursal behavior is captured at the top (which is maximally general, bounded, and well-understood) and not at the bottom (which permits unboundedness and redundancy) presents no threat to computational processing. Each discourse relation simply inherits from its ancestors all necessary processing information, such as cue words and realization constraints, adding its unique peculiarities, to be used for inferring its discursal role (in parsing) or for planning out a discourse (in generation). Increasing differentiation of relations, continued until the very finest nuances of meaning are separately represented, need be pursued only to the extent required for any given application. Thus “unbounded” growth of semantic relations is not a problem, as long as they can be subsumed under existing nodes in the taxonomy.

**Objection 4.** The hierarchy contains no explicitly structural relations, yet explicit signals of dis-

course structure are very common. Why are they not included?

In fact, the relations people use to signal discourse structure (such as parallelism, say) are included in the taxonomy. The most popular relation (one that appeared as a separate relation in a number of the studies cited) is PARALLEL, which is invariably signalled using some set of SEQUENCE relations, often after having been explicitly introduced by a separate clause. The fact that SEQUENCE relations can be used to signal both semantic sequentiality and rhetorical structure is no reason for alarm; if conditions should arise in which the two functions require different behavior, a more specific relation subordinated to SEQUENCE, dedicated to expressing purely rhetorical sequentiality (such as, say, SEQSTRUCTURAL), can be created, though it is likely that in the actual presentation, the rhetorical sequence will usually follow some temporal or spatial sequence in any case.

## Conclusion

A rather gratifying result of the synthesis presented here is that only 16 core relations, organized into 3 principal types, suffice to cover essentially all the interclausal relations proposed by the sources. This suggests that other relations not yet in the hierarchy are likely to be subtypes of relations already in it, preserving the boundedness of the number of relation types. The relations are rhetorical in nature, becoming increasingly semantic as they become more specific; the claim is that the rhetorical relations are simply least delicate (i.e., most general) semantic relations.

While some evidence is provided for the structure of the hierarchy, as well as for the claim that the relations are independent of the goal-oriented plan-based discourse structure relations proposed by [Grosz & Sidner 86], there is no claim that this hierarchy is complete or correct in all details. It is certainly open to elaboration, enhancement, and extension! The hope is that it will serve the community by proving to be a common starting point and straw man for future work on discourse structure.

## Acknowledgments

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own, Johanna Moore, Mick O'Donnell, and Cécile Paris, and to everyone who sent me their relations. I am still collecting relations and will continue to update this hierarchy.

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