

Toward a Taxonomy of Coherence Relations

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Understanding a discourse means constructing a coherent representation of that discourse. Inferring coherence relations, such as *cause-consequence* and *claim-argument*, is a necessary condition for a discourse representation to be coherent. Despite some descriptively fairly adequate proposals in the literature, there is still no theoretically satisfying account of the links that make a discourse coherent.

An adequate account of the relations establishing coherence has to be psychologically plausible, because coherence relations are ultimately cognitive relations. We are proposing a taxonomy that classifies coherence relations in terms of four cognitively salient primitives, such as the polarity of the relation and the pragmatic or semantic character of the link between the units.

A classification experiment using fragments of written discourse showed that the 12 classes of coherence relations distinguished in the taxonomy appear to be intuitively plausible and applicable. A second experiment investigating the use of connectives provided further evidence for the psychological salience of the taxonomic primitives and their relevance to the understanding of coherence relations.

1. COHERENCE IN A THEORY OF DISCOURSE REPRESENTATION

Understanding a discourse may be regarded as the construction of a mental representation of the discourse by the reader.¹ An acceptable discourse representation has a property that distinguishes it from the representation a reader might

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¹In our view there are no principled differences between spoken and written discourse with respect to the phenomena we address in this article. Therefore, whenever we use the terms *reader* and *writer*, we also intend the speaker and the listener.

make of an arbitrary set of utterances: The representations of the segments in the discourse are linked coherently. The question of how these coherence links are established is one that transcends the linguistic aspects of a discourse and that is of a cognitive nature, for it is evident that the representation is not only determined by linguistic properties of the discourse.

1.1 Current Accounts of Coherence

From research on coherence, it can be concluded that there are two respects in which a discourse can be coherent. The first approach of coherence focuses on the *content* of the discourse segments. This type of coherence has been called referential or topic continuity (cf. Garnham, Oakhill, & Johnson-Laird, 1982; Givón, 1983). In this approach a discourse is coherent if there is repeated reference to the same set of entities, for instance via argument-overlap (Kintsch & van Dijk, 1978); if there is a certain semantic congruence between two discourse units (Polanyi, 1986); or if there is a pattern corresponding to stereotypical situations, such as visiting a restaurant or a birthday party (Schank & Abelson, 1977).

The second approach of research on coherence focuses on the *relation* that exists between two or more discourse segments. In the simple case, this relation exists between two or more subsequent sentences. In the more complicated case, the relation exists between higher level segments, such as paragraphs or complete chapters. In this paper research is reported that is related to the second approach, which will be called a *discourse structure approach* to coherence. We will pursue the idea that coherence relations (and hence coherence) can be represented in general conceptual terms, abstracting away from the context-specific content of the segments. In the literature, these relations have variably been called rhetorical predicates (Grimes, 1975; Meyer 1975); rhetorical relations (Grosz & Sidner, 1986); relational propositions (Mann & Thompson, 1986); and coherence relations (Hobbs, 1979, 1983, 1985). After Hobbs, the term *coherence relation* will be used. We prefer this term because, in our view, the essential characteristic of the relations is that they establish coherence in the cognitive representation.

A coherence relation is an aspect of meaning of two or more discourse segments that cannot be described in terms of the meaning of the segments in isolation. In other words, it is because of this coherence relation that the meaning of two discourse segments is more than the sum of the parts.

The account advocated here is one of coherence and *not* of cohesion; the most salient difference between the two is that in cohesion the linguistic realization is pivotal. In a cohesion analysis the connectivity of the discourse is primarily tied to the explicit marking of semantic relations. According to Halliday and Hasan (1976, p. 13), these explicit clues make a text a text (although Halliday & Hasan, pp. 298–299, acknowledge that cohesion is a necessary though not a sufficient condition for the creation of a text). In a coherence approach, cohesive elements like connectives in the discourse are viewed as important though not necessary

features of discourse; they are linguistic markers, expressing the underlying conceptual relations that are of a cognitive nature. It is the cognitive representation of the discourse that is considered as the phenomenon to be explained. Because cohesion does not concern connectivity at the level of the cognitive representation of the discourse, taxonomies cast in the cohesion framework (e.g., Martin, 1983) will not be discussed in this article.

1.2 Discourse Structure Approaches to Coherence

There are two possible requirements that a satisfying theory of discourse structure should meet: descriptive adequacy and psychological plausibility. If an account of discourse structure makes it possible to describe the structure of all kinds of natural texts, it fulfills the requirement of *descriptive adequacy*. In recent years, Mann and Thompson have developed a theory of discourse structure that is closely related to the notion of coherence relations as defined above (cf. Mann & Thompson, 1986, 1987, 1988; Thompson & Mann, 1987). Their Rhetorical Structure Theory (RST) is a descriptive framework for the organization of text. Among the relations incorporated in RST are *cause*, *solutionhood*, *sequence*, *evidence*, and *elaboration*. Mann and Thompson aim at developing a text-analytic model that is descriptively adequate, and they claim success for different genres of natural text (see especially Mann & Thompson, 1988).

The requirement of *psychological plausibility* concerns the status of coherence relations as cognitive entities: A psychologically plausible theory of discourse structure should at least generate plausible hypotheses on the role of discourse structure in the construction of the cognitive representation. It has been suggested in the literature that the role of coherence relations (or rhetorical relations) remains unclear in a theory of discourse interpretation. For instance, Grosz and Sidner (1986) claim that “a discourse can be understood at a basic level even if [the reader] never does or can construct . . . such rhetorical relationships” (p. 202). They consider the relations as no more than a useful “analytic tool” for the discourse analyst. If Grosz and Sidner are right, an account of coherence relations is concerned only with the description of the discourse as a linguistic object, and not with its cognitive processes and representations.

In our view, however, a discourse structure approach is not necessarily restricted to descriptive analyses of discourse, because coherence relations should be considered as cognitive entities. Such a claim leads to the prediction that coherence relations and their linguistic marking affect the cognitive representation of a discourse (i.e., discourse understanding). And indeed, several psycholinguistic experiments concerning the role of coherence relations in discourse understanding indicate such an effect. For instance, the explicit marking of such relations in text seems to influence the degree of organization of written reproductions (Meyer, Brandt, & Bluth, 1980). Using a discourse completion task, Spooren (1989) found that subjects' choices varied systematically with the presence or absence of an explicit contrastive marker. Furthermore, some on-line

experiments suggest that readers make use of the linguistic markers of coherence relations during processing: Linguistic marking appears to lead to faster processing of the following discourse segment (Haberlandt, 1982; Sanders, 1986). These experiments suggest that coherence relations are psychological entities rather than merely an analytic tool.

In fact, Mann and Thompson's RST is also presented as a cognitive theory of language understanding and production, in which "relational propositions" allow people to perceive relationships between parts of text (see especially Mann & Thompson, 1986). These relational propositions are very similar to what we call coherence relations. However, from a psychological point of view, Mann and Thompson's ideas are not very convincing, because they assume that all relational propositions are cognitively basic. If, for example, a relation like *evidence* occurs in a discourse, people interpret the discourse by referring to the cognitively basic notion of the *evidence* relation. Given the lack of theoretical foundation for adopting this and no other set of relations, such an assumption is rather implausible.

It seems far more attractive to assume that the set of coherence relations is ordered and that readers use their knowledge of a few cognitively basic concepts to infer the coherence relations. In this view, a relation like *evidence*, or, as we would call it, *claim-argument*, is regarded as composite, because it can be analyzed in terms of a limited set of more elementary notions, such as causality, which are taken to be cognitively basic and which also apply to other relations. The claim is that readers make use of these elementary notions to derive the proper coherence relation. Two arguments favor such a position. The first is that it results in a more economic theory of the role of coherence relations in discourse understanding. The other argument has a bearing on the linguistic realization of coherence relations: One and the same linguistic marker can express only a limited set of relations. For example, the conjunction *and* can express a causal and an additive relation but not a concessive relation. This implies that somehow similarities between coherence relations must be expressed and hence that they must be decomposed into more basic elements.

Hence, the aim of this article is *not* to develop a complete and descriptively adequate taxonomy of coherence relations. We strive for an economic theory that generates a limited set of classes of coherence relations. What we are aiming at here is to identify the primitives in terms of which the set of coherence relations can be ordered.² In other words, our claim is that the principles discussed in this article apply to all coherence relations, whatever other properties they may have. The taxonomy of coherence relations presented in this article is intended as a contribution to a psychologically plausible theory of discourse structure.

²In a way, our aim resembles Longacre's (1976) when he states that his goal is to find underlying categories that are part of "our cognitive/notational apparatus as human beings" (p. 20).

As far as descriptive adequacy is concerned, the taxonomy proposed here can be extended, using segment-specific features, to arrive at a complete and descriptively adequate set of coherence relations à la Mann and Thompson (1988). Such an enterprise would result in an ordered set of relations, with the taxonomy as its foundation. Such a theoretical foundation is absent in Mann and Thompson's proposals. They confine themselves to the presentation of an almost unordered list of arbitrary length.³ The example of a classification that is presented in Mann and Thompson (1988, p. 256) is not sufficient—as is already noted by the authors—because it consists of a division of the list into two groups, and not of a more systematic account of "the relations among the relations" (i.e., the fact that some of the relations have something in common and others do not).⁴ In this respect Hobbs's (1983, 1985) proposals can be considered as more sophisticated. Hobbs presents a classification of coherence relations in terms of a limited set of organizing principles. We will comment on some details of his proposal in section 5.2 of this article.

2. A TAXONOMY OF COHERENCE RELATIONS BASED ON COGNITIVE PRIMITIVES

The object of this article is to propose a categorization of coherence relations on the basis of what we call the *relational criterion*. A property of a coherence relation satisfies the relational criterion if it concerns the informational surplus that the coherence relation adds to the interpretation of the discourse segments in isolation (i.e., if it is *not* merely a property concerning the content of the segments themselves). This does not imply that the meaning of the connected segments is neglected. Because coherence relations connect representations of discourse segments, the meaning of the segments must be compatible with the coherence relation. What the relational criterion does imply, however, is that we will focus on the meaning of the relation and not on the meaning of each specific segment.

The taxonomy orders coherence relations by four primitives that satisfy the relational criterion. First, an overview of the taxonomy and the definitions used in it will be presented. After that, the four primitives will be worked out in detail.

³Mann and Thompson (1986) do present a systematic classification for a small subset of relations: *evidence, justification, reason, and motivation*.

⁴In Mann and Thompson (1988) descriptive adequacy seems more central than theoretical claims; compare with their thoughts on a further categorization of the list they have proposed:

Several people have suggested that we create a taxonomy of the relations in order to present the important differences among them. However, no single taxonomy seems suitable. Depending on one's interests, any of several features and dimensions of the relations could be made the basis for grouping them. (p. 256)

2.1 Defining the Coherence Relations

How are the coherence relations defined? First, the two discourse segments (often clauses) that are related in the discourse have to be identified. The first segment is called S_1 , the second segment S_2 . It is assumed that S_1 and S_2 directly or indirectly express the propositions P and Q that are conceptually related.

The coherence relation is defined by the way in which S_1 and S_2 map onto P and Q . The problem in identifying the coherence relation is to find P and Q and to relate P and Q to S_1 and S_2 . P and Q can either be the propositions (locutions) that are expressed by S_1/S_2 or the speech acts (illocutions) that are expressed by S_1/S_2 . P and Q can also be inferences of S_1/S_2 (e.g., generalizations), but we will not elaborate this point further. In determining the coherence relation four questions are central, corresponding to the four primitives in the taxonomy.

It is assumed that only two kinds of relations can exist between P and Q : a causal relation and an additive relation. Because a causal relation implies an additive relation, one has to be as specific as possible in identifying the relation. The first question in identifying the coherence relation is therefore: Is the relation between P and Q a causal relation? If it is not, then the relation is an additive one. This first question concerns what we call the *basic operation* of the coherence relation.

The second question is whether a relation exists between the propositions expressed in S_1 and S_2 , or between the illocutions expressed in S_1 and S_2 . In the first case the coherence relation is called semantic; P and Q are the propositions expressed by S_1 and S_2 . In the second case P and Q are the illocution of S_1 or S_2 ; the relation is then called pragmatic. This question refers to what we call the *source of coherence* of the relation between S_1 and S_2 .

The third question refers to the order in which P and Q are expressed in the discourse. If P and Q correspond to S_1 and S_2 , respectively, the relation is said to be of a basic order; if P and Q correspond to S_2 and S_1 , respectively, it is said to be of a nonbasic order. This is the question concerning the *order of the segments* in the coherence relation.

The fourth question is whether P and Q in the basic operation correspond to S_1 and S_2 , or whether P and Q correspond with the negative counterparts of S_1 and S_2 . In the first case the coherence relation is called positive; in the second case it is called negative. This is the question of the *polarity* of the coherence relation.

2.2 Basic Operations

The primary distinction in the taxonomy is that between causality and addition. Of the four logical operators, causality (implication) and addition (conjunction) are chosen as starting points for the taxonomy because they justify the pre-theoretical intuition that discourse segments are either strongly connected (causal) or weakly connected (additive). Of the other logical operators, negation plays a different role within the taxonomy, because it is a unary operator, whereas the other operators are binary. The natural language correlates of disjunction are

regarded as more complex. This fourth operator will be further discussed in section 5.4 of this article.

An additive operation exists if only a conjunction relation $P \& Q$ can be deduced between two discourse segments, that is, if all that can be deduced is that the discourse segments are true for the speaker.⁵ A causal operation exists if an implication relation $P \rightarrow Q$ can be deduced between two discourse segments, in which P is antecedent and Q is consequent.

The two basic operations are not equivalent to their logical counterparts, because they are not truth-functional. The causal relation in (1) is logically true if both P and Q are true. However, for most speakers the causal relation in example (1) does not exist, because the antecedent is considered *irrelevant* for the conclusion in the consequent.

- (1) If Sweden is larger than Denmark, then Jürki is older than Lauri.

It appears that whether the causal basic operation holds does not depend solely on the truth value of the antecedent and the consequent, but also on the link between the antecedent and the consequent. Hence, the logical implication relation $P \rightarrow Q$ is a necessary, but not sufficient, condition for a causal basic operation we intend. The basic operation we intend is more like the notion of *relevant implication* as proposed by Anderson and Belnap (1975). In such "relevance logics" some of the intuitively less acceptable principles of classical logic are abandoned and other axioms are introduced to meet conditions of relevance like the one appealed to in (1). For instance, Anderson and Belnap argue for an alternative treatment of conditional propositions in which the idea of "relevance" is crucial: A conditional "if P then Q " is true only if P is relevant to the conclusion of Q . Of course, this raises the question of how relevance should be determined. This discussion goes beyond the scope of this article, but see Anderson and Belnap (1975) and Van Dijk (1977, pp. 54–58).

2.3 Source of Coherence: Semantic and Pragmatic Relations

The second primitive is called the *source of coherence*. The two values of this primitive are *semantic* and *pragmatic*. A relation is semantic if the discourse segments are related because of their propositional content. In this case the writer refers to the locutionary meaning of the segments. The coherence exists because the world that is described is perceived as coherent. For example, the sequence in (2) is coherent because it is part of our world knowledge that illness may cause death. In semantic relations the state of affairs that is referred to in P in the causal basic operation is the cause of the state of affairs referred to in Q .

⁵For the moment we assume that coherence relations are *binary*, that is that they exist between two discourse segments. Clearly, our proposal can be extended to relations between more than two discourse segments (*n*-ary relations), without major difficulties, because the extension to more than one segment does not affect the meaning of the relation.

- (2)D De eenhoorn stierf omdat hij ziek was.
 (2)E The unicorn died because it was ill.⁶

A relation is pragmatic if the discourse segments are related because of the illocutionary meaning of one or both of the segments. In pragmatic relations the coherence relation concerns the speech act status of the segments. The coherence exists because of the writer's goal-oriented communicative acts. In the pragmatic relation (3) the state of affairs that is referred to in *P* is not the cause of the state of affairs that is referred to in *Q*, but of the saying of *Q*.

- (3)D Jan komt niet naar school, want hij belde zojuist.
 (3)E John is not coming to school, because he just called me.

In a pragmatic relation it is of secondary importance what relation exists at the locutionary level. The latter can be of several types, for instance causality, as in (4), or what, for example, Mann and Thompson (1986) call *generalization-instance*, as in (5). It can also be absent, as in (3).

- (4)D Jan komt niet naar school, want hij is ziek.
 (4)E Jan is not coming to school, because/for he is ill.
 (5)D Dat is een vogel, want het is een kerkuil.
 (5)E That is a bird, because/for it is a barn owl.

The primitive *source of coherence* is similar to van Dijk's (1979) semantic-pragmatic distinction, Halliday and Hasan's (1976) and Martin's (1983) internal-external distinction, and Redeker's (1990) distinction between ideational and pragmatic relations. Because the distinction between semantic and pragmatic relations is often somewhat difficult to make, we will present some considerations that may be of use in determining the source of coherence between two segments.

1. A pragmatic relation refers to the illocutionary meaning of an utterance, whereas a semantic relation refers to the locutionary meaning. Therefore, the discrepancy between locution and illocution that occurs in indirect speech acts can be of use in determining the source of coherence of a relation. In the case of an indirect speech act, the coherence is arrived at by means of the illocutionary meaning of one or both of the segments; see (6), in which the intended meaning is something like: "You know where to find the beer, get it yourself." So, in (6) the second segment is related to the illocutionary meaning of the first segment. Because no other interpretation is possible, (6) is a clear case of a pragmatic relation. In (7) both a semantic and a pragmatic interpretation are possible.

- (6) The beer is in the fridge. I'm busy.
 (7) The beer is in the fridge. I put it there yesterday.

2. Because pragmatic relations refer to the illocutionary meaning of an utterance, and because illocutions cannot be embedded syntactically (in general, directives and questions cannot be subordinated), it follows that pragmatic relations cannot be embedded either. Compare (8), a (semantic) *consequence-cause* relation, with (9), a (pragmatic) *claim-argument* relation.

- (8)D Misschien is Jan thuis omdat hij ziek is.
 (8)E Maybe John is at home because he is ill.
 (9)D Misschien is Jan thuis, aangezien hij ziek is.
 (9)E Maybe John is at home, since he is ill.

Example (8) is ambiguous, but (9) is not. The two interpretations of (8) are clarified in (10) and (11).

- (10)D [Dat Jan thuis is omdat hij ziek is] is misschien zo.
 (10)E [That John is at home because he is ill] may be the case.
 (11)D Omdat hij ziek is, is het misschien zo [dat Jan thuis is].
 (11)E Because he is ill, it may be the case [that John is at home].

The semantic relation in (8) has both a wide scope reading of *misschien* (*maybe*), corresponding to (10), and a narrow scope reading, corresponding to (11). In the case of the pragmatic relation (9), only the narrow scope reading is available; see (13). That (12) is not a possible reading is accounted for if the coherence relation is taken to exist at the illocutionary level.

- (12)D *[Dat Jan thuis is, aangezien hij ziek is] is misschien zo.
 (12)E *[That John is at home since he is ill] may be the case.
 (13)D Aangezien hij ziek is, is het misschien zo [dat Jan thuis is].
 (13)E Because he is ill it may be the case [that John is at home].

The difference between semantic and pragmatic relations holds not only for causal coherence relations but also for additive ones. In (14), a semantic relation (*opposition*) survives embedding in a negative context, whereas its pragmatic counterpart (*concession*) in (15) does not.

- (14)D Het is niet zo [dat Jan ziek is, maar Peter niet] (, ze zijn allebei ziek).
 (14)E It is not the case [that John is ill but Peter is not] (, they are both ill).
 (15)D ?? Het is niet zo [dat Jan weliswaar klein is, maar gevaarlijk] (, hij is alleen maar klein).

⁶Example (2)E is ambiguous between a pragmatic and semantic reading (cf. Rutherford, 1970). The ambiguity will be discussed extensively below.

(15)E ?? It is not the case [that John may be small but dangerous] (, he is just small).⁷

2.4 Order of the Segments: Basic and Nonbasic Order in Relations

The third primitive is called *order of the segments*. Given the two basic operations, the writer can connect two discourse segments in two orders. The order in the relation is *basic* if the information in the first discourse segment, S_1 , expresses P in the basic operation $P \& Q$ or $P \rightarrow Q$, and if the second discourse segment, S_2 , expresses Q in the basic operation. In the *nonbasic* order S_1 expresses Q and S_2 expresses P in the basic operation. Because additive relations are symmetric, *order of the segments* does not discriminate between different classes of additive relations.

Note that this primitive is defined in terms of the basic operation. Therefore, with this primitive we do *not* refer to the information distribution of the segments in their context, often described in terms of given-new, foreground-background, topic-focus, and so forth. For a further discussion, see section 5.2 of this article.

2.5 Polarity: Positive and Negative Relations

The fourth primitive is *polarity*. A relation is *positive* if the two discourse segments S_1 and S_2 function in the basic operation as antecedent (P) and consequent (Q), respectively. A relation is *negative* if not S_1 or S_2 but their negative counterparts, not- S_1 or not- S_2 , function in the basic operation. Positive relations are typically expressed by such conjunctions as *and* and *because*, whereas negative relations are expressed by conjunctions like *but* and *although*; see examples (16) and (17).

(16)D Omdat hij politieke ervaring had, werd hij tot president gekozen.

(16)E Because he had political experience, he was elected president.

The causal basic operation underlying the positive relation in (16) links the antecedent *having political experience* with the consequent *being elected president*. S_1 and S_2 express the antecedent and consequent, respectively. The coherence relation in (17) is the instantiation of the causal basic operation linking the antecedent *not having any political experience* and the consequent *not being elected president*.

(17)D Hoewel hij geen politieke ervaring had, werd hij tot president gekozen.

(17)E Although he didn't have any political experience, he was elected president.

⁷In the context of another discussion, Rutherford (1970) presents several tests for the distinction *semantic-pragmatic*.

The second discourse segment (S_2) expressed *not-Q*, that is, the negation of the consequent of the basic operation.

Positive relations can be turned into negative relations by adding a lexical negation to one of the discourse segments, as is shown by examples (16) and (17). This does not mean that the presence of a lexical negation is a prerequisite for negative relations: (18) is a negative relation, as is suggested by the presence of the conjunction *but*.

(18) He had a questionable war record, but he was elected president.

2.6 A Typology of Classes of Coherence Relations

By combining the four primitives of the taxonomy, a set of classes of coherence relations can be generated. Theoretically, for every one of the two basic operations, eight possible coherence relations exist. Because of the symmetry of the additive basic operation, only four types of additive relations are distinguished. The resulting 12 classes and their descriptive labels are shown in Table 1.

The relations given for each class are taken to be more or less prototypical examples of the classes they represent. For three classes we present more than one relation, namely, Classes 5, 7, and 10. For Classes 5 and 7, we take *condition-consequence* and *consequence-condition* to be the more or less prototypical relations: They are the only causal relations treated in propositional

TABLE 1
Overview of the Taxonomy and Prototypical Relations

Basic Operation	Source of Coherence	Order	Polarity	Class	Relation
Causal	Semantic	Basic	Positive	1.	Cause-consequence
Causal	Semantic	Basic	Negative	2.	Contrastive cause-consequence
Causal	Semantic	Nonbasic	Positive	3.	Consequence-cause
Causal	Semantic	Nonbasic	Negative	4.	Contrastive consequence-cause
Causal	Pragmatic	Basic	Positive	5a.	Argument-claim
				5b.	Instrument-goal
				5c.	Condition-consequence
Causal	Pragmatic	Basic	Negative	6.	Contrastive argument-claim
Causal	Pragmatic	Nonbasic	Positive	7a.	Claim-argument
				7b.	Goal-instrument
				7c.	Consequence-condition
Causal	Pragmatic	Nonbasic	Negative	8.	Contrastive claim-argument
Additive	Semantic	—	Positive	9.	List
Additive	Semantic	—	Negative	10a.	Exception
				10b.	Opposition
Additive	Pragmatic	—	Positive	11.	Enumeration
Additive	Pragmatic	—	Negative	12.	Concession

logic, for instance. *Goal-instrument* and *instrument-goal* were added because, apart from similarities, there is an important difference with respect to the conditional relations as there seem to be two basic operations underlying them (see note 8). *Argument-claim* and *claim-argument* were added as the more frequent representatives of Classes 5 and 7. The difference with respect to *condition-consequence/consequence-condition* is the hypothetical status of the condition in the latter pair (see Longacre, 1983, section 3.4, for the same distinction between causal and conditional relations).

In Class 10, *exception* is included next to the prototypical relation *opposition*. The difference between these two relations is segment-specific: In an *exception* relation one of the segments gives a general statement and the other a specific statement. *Exception* is included to show that additive relations, though logically symmetric, can become asymmetric because of a difference in specificity. Because asymmetry is a property of all the causal relations, *exception* resembles negative causal relations.

As explained earlier, we do not intend our proposal to be a descriptively satisfying analytical instrument, although the classes of relations in the taxonomy can be further specified using segment-specific properties to characterize a descriptively adequate set of coherence relations. For instance, *consequence-cause* can be characterized using only the four primitives of the taxonomy. But there are other relations belonging to Class 3: Presumably a relation like *reason* (Mann & Thompson's, 1988, *volitional cause*) has all the properties of *consequence-cause* and an additional property that the consequence refer to a volitional action. A property like "volitionality" would be a candidate for further specification of the proposed taxonomy. In section 5 of this article we will discuss several properties that individuate other relations within the 12 classes.

In this section the coherence relations belonging to the 12 classes will be illustrated. The examples come from newspapers, advertisements, circulars, and the so-called Eindhoven corpus (Uit den Boogaart, 1975). When relevant, the linguistic context is provided in parentheses.

1. Causal, semantic, basic order, positive

Cause-consequence

- (19)D Doordat er een lage drukgebied ligt boven Ierland, wordt het slecht weer.
 (19)E Because there is a low-pressure area over Ireland, the bad weather is coming our way.

2. Causal, semantic, basic order, negative

Contrastive cause-consequence

- (20)D (Een probleem voor de Artificiële Intelligentie is de soms indrukwekkende efficiëntie van het menselijk geheugen.)

Hoewel het aantal overeenkomsten tussen gezichten enorm is, hebben wij er niet de minste moeite mee zeer grote aantallen mensen van elkaar te onderscheiden.

- (20)E (A problem for Artificial Intelligence is the sometimes impressive efficiency of the human memory.)

Although the number of similarities between faces is enormous, we do not have the slightest difficulty in distinguishing a very large number of people.

3. Causal, semantic, nonbasic order, positive

Consequence-cause

- (21)D Een pianoconcert van Beethoven werd van het programma genomen, omdat de solist Anthony di Bonaventura ernstig ziek werd.
 (21)E A piano concerto by Beethoven was removed from the program, because the soloist Anthony di Bonaventura fell seriously ill.

4. Causal, semantic, nonbasic order, negative

Contrastive consequence-cause

- (22)D (Met de vrijlating van Hetzel eindigde één van de meest sensationele processen die West-Duitsland sinds jaren heeft beleefd.)
 Hans Hetzel werd in 1969 tot levenslange dwangarbeid veroordeeld wegens moord, hoewel hij bij hoog en bij laag had volgehouden onschuldig te zijn.
 (22)E (The release of Hans Hetzel ended one of the most sensational trials West Germany has seen in years.)
 In 1969 Hans Hetzel was sentenced to life-long hard labor because of murder, although he had stoutly maintained his innocence.

5. Causal, pragmatic, basic order, positive

Argument-claim

- (23)D Door nesten of dode vogels kan een schoorsteen verstopt raken.
 Laat uw schoorsteen dus ieder jaar nakijken en zonodig veegen.
 (23)E Nests or dead birds may clog up chimneys.
 Therefore, have your chimney checked once a year and swept when necessary.

Instrument-goal

- (24)D We geven ook de Portugese benamingen van de voornaamste bezienswaardigheden om het vragen te vergemakkelijken.

- (24)E We will also present the Portuguese names for the most important places of interest to make the questioning easier.⁸

Condition-consequence

- (25)D (Film- en fotomateriaal kunt u verkrijgen bij de souvenirwinkels in de wandelsafari en bij het safarirestaurant.)
Klaar? Dan gaan we nu op safari.
- (25)E (Film and photomaterials can be obtained from the souvenir shops on the walking safari and from the safari restaurant.)
Ready? Then we're now off on safari.

6. Causal, pragmatic, basic order, negative

Contrastive argument-claim

- (26)D (De hoeveelheid berichten over ongelukken in de dagbladen zegt maar weinig over de belangrijkste doodsoorzaken.)
Al schreven de kranten vorig jaar diverse keren over enkele gasongevallen, als gasgebruiker loop je heel wat minder risico dan als verkeersdeelnemer.
- (26)E (The number of reports about accidents in the newspapers does not say much about the most important causes of death.)
Although the papers wrote about gas accidents several times last year, the risk run by the gas user is much smaller than that of the traffic participant.

7. Causal, pragmatic, nonbasic order, positive

Claim-argument

- (27)D (Veel mensen schijnen alleen de top van het struikje van de broccoli te eten.)
Dat is zonde, want de stronk smaakt ook goed.
- (27)E (Many people seem to eat only the flower head of the broccoli.) That is a pity, because the stalk tastes good too.

Goal-instrument

- (28)D (Als u van plan bent een huis te gaan kopen, en u wilt gebruik maken van een subsidieregeling, dan heeft de Postbank iets voor u.)

⁸In many *goal-instrument* and *instrument-goal* relations, two causal basic operations can be identified, namely, one in which *P* is a volitional action ("presenting the Portuguese names") and *Q* is the state of affairs that is positively evaluated ("making the questioning easier"); the second is an operation in which *P* is the wish for a state of affairs to be achieved ("making the questioning easier") and *Q* is the action bringing that state about ("presenting the Portuguese names"). We think that the first is more essential for characterizing the *goal-instrument* relation, among other things because the second operation is not as close to the literal information in the discourse (it concerns the *wish* for a state of affairs to be achieved) as the first.

De koper zal in het algemeen direct zijn woonlasten met de toegezegde subsidie willen verminderen. Daartoe biedt de Postbank aan deze subsidie voor te financieren.

- (28)E (If you intend to buy a house and you want to make use of a subsidy arrangement, the Postbank has something for you.)
In general the buyer will want to diminish his costs of living with the promised subsidy. To that end the Postbank offers to finance this subsidy in advance.

Consequence-condition

- (29)D (Het boek wordt besloten met een wijze raad van een Middeleeuwse vinoloog:)
Wijn is een zeer gezonde drank, die de levensduur van de mens niet onaanzienlijk kan verlengen, mits de wijn in geringe hoeveelheden en met niet al te grote regelmaat wordt genoten.
- (29)E (The book ends with a wise piece of advice by a medieval judge of wine:)
Wine is a very healthy beverage that can lengthen man's life not insignificantly, provided that the wine is drunk in small quantities and not too regularly.

8. Causal, pragmatic, nonbasic order, negative

Contrastive claim-argument

- (30)D U moet er wel rekening mee houden dat er langs de hele Joegoslavische kust haaien voorkomen, al wordt dat bepaald niet van de daken geschreeuwd.
- (30)E You will have to take into account that there are sharks along the whole Yugoslavian coast, although this is certainly not shouted from the rooftops.

9. Additive, semantic, positive

List

- (31)D (Uit het onderzoek blijkt dat diepvriezers en koelkasten de afgelopen jaren steeds zuiniger zijn geworden.)
Het energie-verbruik van een koelkast is 17% minder geworden en een diepvriezer verbruikt 18 à 20% minder stroom dan tien jaar geleden.
- (31)E (It appears from the investigation that deep freezers and refrigerators have become more economical in recent years.)
The energy consumption of a refrigerator has decreased by 17%, and a deep freezer uses 18 to 20% less electricity than 10 years ago.

10. Additive, semantic, negative

Exception

- (32)D Een diersoort kan een zekere bejaging verdragen, maar de Californische condor kan dat niet.

- (32)E A species can stand a certain amount of hunting, but the California condor cannot.

Opposition

- (33)D (Niet alle Nederlandse bedrijven deden het gisteren even goed op de Amsterdamse effectenbeurs.)
Bergoss verbeterde twaalf punten, evenals Van Hattum, Holec en Smit-Tak. Philips verloor daarentegen tien punten.
- (33)E (Not all Dutch companies did equally well at the Amsterdam stock exchange yesterday.)
Bergoss improved by 12 points, as did Van Hattum, Holec, and Smit-Tak. By contrast, Philips lost 10 points.

11. Additive, pragmatic, positive

Enumeration

- (34)D Reageerbuisbaby's doen vragen rijzen over ethische en maatschappelijke aspecten. Bovendien, wat te denken van de juridische problemen die ze oproepen?
- (34)E Test-tube babies raise questions concerning ethical and social aspects. Moreover, what about the legal problems they evoke?

12. Additive, pragmatic, negative

Concession

- (35)D (De Consumentenbond raadt het drinken van bronwater af.)
De consumptie van bronwater is in Nederland de laatste jaren sterk gepropageerd, maar bij een onderzoek in Duitsland naar de samenstelling van flessewater zijn minder gunstige ervaringen opgedaan.
- (35)E (The consumer's association advises against the drinking of mineral water.)
The consumption of mineral water has been advocated strongly over the last few years in the Netherlands, but the results of an investigation in Germany on the composition of bottled water were not so good.

3. CLASSIFICATION AND LABELING OF COHERENCE RELATIONS

3.1 Introduction

Most of the coherence relations that have been proposed in the literature can be categorized into one of 12 classes, by the use of the four primitives that make up our taxonomy. Our first claim, therefore, is that the taxonomy provides a successful classificatory framework to describe coherence relations and relations between coherence relations. But apart from that, we also claim that it has

psychological plausibility, in that language users actually make use of the primitives in production and reception of discourse. In order to substantiate these claims two experiments were carried out.

The aim of the first experiment was to find out whether other analysts agree with our intuitive classification of the coherence relations. To this end a set of sentence pairs connected by coherence relations was presented to a number of discourse analysts, together with a list of labels, short definitions, and examples of each relation in the taxonomy. Their task was to choose one label from the list for each of the sentence pairs. The dependent variable was whether or not the subject's choice of a particular relation (the subject's choice) agreed with the original relation.

There are two ways of looking at the data obtained in the experiment. The first is that of strict agreement between the subjects' choices and the original relations. The second is in terms of class agreement: The primitives of our taxonomy do not identify individual coherence relations, but classes of relations. For example, if a subject's choice was *claim-argument*, whereas the original relation was *instrument-goal*, the subject's choice is incorrect in terms of strict agreement, but correct in terms of class agreement: *argument-claim* and *instrument-goal* both belong to Class 5.

The first hypothesis investigated was that there would be considerable agreement (both strict agreement and class agreement) between the subject's choices and the experimenters' classification. The second hypothesis to be tested was that the subjects' choices would group along the lines of the taxonomy: Confusions should be more frequent between related classes than between unrelated classes.

3.2 Method

3.2.1 Material

Two examples of each coherence relation were selected for the experiment. The items were in Dutch. They came from newspaper articles, advertisements, circulars, and the so-called Eindhoven corpus (Uit den Boogaart, 1975). The items were pairs of sentences that were connected by explicit markers. Most of the examples presented in section 2.6 were included in the experiment.

A set of 34 items was selected, based on the criterion that each item be a clear case of the coherence relations it exemplifies. There were also 10 filler items, to prevent subjects from inferring the number of experimental items corresponding to each coherence relation.

3.2.2 Procedure and Subjects

The 34 sentence pairs were presented on paper. The order of presentation was not varied between subjects. As a rule the sentence pairs were presented with their original context. When the context was absent or ambiguous, suitable contextual information was supplied.

In a training session the subjects were asked to read carefully through a list of

TABLE 2

Experiment 1: Percentages of Strict Agreement for Each Relation in the Taxonomy

1. Cause-consequence (26)	65.4	7a. Claim-argument (26)	92.3
2. Contrastive cause-consequence (26)	30.8*	7b. Goal-instrument (22)	86.4
3. Consequence-cause (26)	96.2	7c. Consequence-condition (26)	88.5
4. Contrastive consequence-cause (26)	23.1*	8. Contrastive claim-argument (26)	38.5*
5a. Argument-claim (23)	43.5*	9. List (25)	28.0*
5b. Instrument-goal (24)	79.2	10a. Exception (26)	69.2
5c. Condition-consequence (8)	37.5*	10b. Opposition (26)	100.0
6. Contrastive argument-claim (26)	30.8*	11. Enumeration (25)	88.0
		12. Concession (24)	54.2

Note. Between parentheses is the number of original relations.
*Relation with remarkably low strict agreement (< 50%).

17 relations. In this list the relations given in section 2.6 were labeled and defined. The definitions were basically the same as the definitions given in section 2.6. Each definition was accompanied by a simple example.

After the training session, the 34 sentence pairs plus the 10 filler pairs were presented to the subjects on paper. The sentence pairs were numbered. The subjects read each item, looked through the list of relations, and chose an appropriate label. The subjects were instructed to choose the most specific label fitting the example. For instance, if they were hesitating between *list* and *opposition*, they were to choose *opposition*. After they had chosen a label, the subjects had to write down the number and label of each item on an answer sheet. The subjects were 14 researchers and advanced students from the Discourse Studies Group of Tilburg University.

3.3 Results

Due to the number of missing data in the choices of one of the subjects, the data from this subject were removed from all analyses. Of the remaining 442 responses, 31 could not be categorized (7.0%). The data were analyzed in terms of strict agreement and class agreement. There was strict agreement if a subject chose the original relation. There was class agreement if a subject chose a relation belonging to the same class as the original relation. Table 2 gives a summary of the data in terms of strict agreement.

The amount of agreement with the original relations was moderate ($K = 0.60$, $z = 47.61$, for the analysis in terms of strict agreement; $K = 0.60$, $z = 34.34$, for the analysis in terms of class agreement).⁹ Relations from Classes 2, 4, 5, 6, 8, and 9 were least agreed on (less than 50%), with the exception of *instrument-*

⁹ K was calculated following Hubert (1977, p. 297), who presents a K -type index for comparing categorizations to a standard. The interpretation of the K coefficient is based on the suggestions by Landis and Koch (1977, p. 165).

TABLE 3

Experiment 1: Number and Percentage of Agreements Between Original and Chosen Relations for Each of the Four Primitives

Basic operation	Causality	Addition
	238 (83.5)	114 (90.5)
Source	Semantic	Pragmatic
	118 (65.2)	198 (86.1)
Order of segments	Basic	Nonbasic
	124 (98.9)	99 (90.9)
Polarity	Positive	Negative
	226 (97.8)	179 (99.4)

Note. Because additive relations are symmetric, *order of segments* involves only 238 correctly identified causal relations; that is, if either the original relation or the subject's choice was an additive relation, the primitive *order of segments* was neglected.

goal (Class 5). In the other cases there was considerable agreement, in conformity with the first hypothesis. Table 3 shows the agreement between the subjects' choices and the original relations in terms of the primitives of the taxonomy. Of the four primitives in the taxonomy, *polarity* is most evident for the judges. *Source of coherence* was least agreed on.

In addition to the test of agreements between original and chosen relations, an analysis of the disagreements was conducted: The second hypothesis was that in the case of disagreement the subjects would choose a coherence relation belonging to a related class. The prediction, then, was that the observed number of responses corresponding in three primitives with the original class is significantly higher than chance. The chance proportion was estimated as follows.

Given a 12 by 12 matrix of classes of coherence relations as stimuli and as responses, each cell of this matrix can be described in terms of the number of agreements in primitives between row and column categories. The proportion of three primitive agreements under the null hypothesis is equivalent to the number of cells with three primitive agreements divided by the total number of cells. Because this is an analysis of disagreements, the diagonal of the matrix (which gives the cases of complete agreement between original and chosen categories) was disregarded. The chance proportion for three primitive agreements is $48/132$ (0.36).

Two analyses were carried out: an analysis per subject and an analysis per item. The observed number of agreements on three primitives was compared with the chance proportion. In the subject analysis, all 13 subjects had three-agreement scores higher than expected, $\chi^2(1) = 11.08$, $p < .01$. In the item analysis, 21 out of 26 items¹⁰ had agreement scores higher than expected, $\chi^2(1) = 9.85$, $p < .01$.

¹⁰There were eight items with perfect agreement scores.

These results confirm the hypothesis that differences between the subjects' choices and the a priori classification tend to be restricted to one of the four primitives and thus follow the groupings of the taxonomy.

3.4 Discussion

If the strict agreement had been perfect, the results would have justified the choice of labels, but the experiment would not have been informative as to the categorization of coherence relations. Because of the systematic nature of the confusions, one can conclude that some relations are more closely related than others.

Agreement was lowest for the Classes 2, 4, 5, 6, 8, and 9. To begin with, the contrastive causal relations (the Classes 2, 4, 6, and 8) were frequently classified as *concession* (Class 12), a contrastive additive relation. There is hardly any confusion of the contrastive causal relations with other contrastive additive relations like *opposition* (Class 10). This systematic confusion can be explained along the lines of the taxonomy. In the taxonomy, causality is an important factor in categorizing relations. In negative causal relations there is a causal link between S_1 and S_2 . Spooren (1989) suggested that causality is also involved in case of *concession*, and that it does not involve the link between S_1 and S_2 , but only the link between the explicit information in the discourse segments S_1 and S_2 and their inferences. (That is why *concession* was not classified as a causal relation but as an additive relation.) By contrast, in *opposition*, causality is irrelevant, and hence it was not confused with contrastive causal relations.

The relations of Class 5 concern *argument-claim*, *condition-consequence*, and *instrument-goal*. The confusion with respect to the *argument-claim* relations can be accounted for by one item, which was frequently called *goal-instrument* or *cause-consequence*. Because the other *argument-claim* item did elicit the correct response in most of the cases, the bad response must be ascribed to the poor quality of the first item. Next, *condition-consequence* was frequently judged as a *goal-instrument* relation, which differs in the basic order of the relation. This finding suggests a refinement of the analysis of the *goal-instrument* relation that was presented in the typology in section 2.6. Probably, *goal-instrument* structures have to be analyzed as more complex structures than the other coherence relations mentioned, because they have two basic causal operations.¹¹ As to Class 9, the *list* relation was frequently called *enumeration*, a difference in the source of coherence primitive.

It is remarkable that the confusion with respect to the source of coherence primitive is unidirectional. Semantic relations are given labels of pragmatic relations: *List* was called *enumeration*, and *contrastive cause-consequence* and *contrastive consequence-cause* were frequently called *contrastive argument-*

¹¹Such an analysis would result in a *goal-instrument* discourse pattern, which resembles the analysis Hoey (1983) presents of what he calls *problem-solution* patterns. In this way the analysis would also account for similarities between *goal-instrument* and *problem-solution* structures (see note 8).

claim and *contrastive claim-argument* respectively. For the contrastive relations a possible explanation might be that it is hard to imagine that negatively related states or events are semantic in nature. The speech act interpretation is more liable: The negative component of the relation is located in the speaker's claims.

A further finding is that hardly any mistakes were made regarding the polarity primitive. At the same time, much confusion concerning semantic and pragmatic relations is found in the negative polarity classes. It would seem that negative polarity dominates the other primitives.

Source of coherence is the most dubious primitive. The fact that the confusion between pragmatic and semantic relations is found over the whole range of classes strongly suggests a systematic confusion regarding this primitive. However, it is also possible that the confusion is caused by the stimulus material, and especially by the lack of contextual information in it.¹² Further experimentation is needed to determine this.

The overall conclusion of this experiment is that the subjects' classification agreed considerably with the a priori classification. Furthermore, we have shown that in case of disagreement it was most likely that the subjects chose a related class. Both results lend strong support to our claim that the taxonomy is a successful framework to express the nature of coherence relations in a linguistically interesting manner.

An account for the analysts' judgments is one thing; quite a different matter is whether the taxonomy provides the correct distinctions to account for production behavior of naive subjects. This question was the object of the second experiment.

4. LEXICAL MARKING OF COHERENCE RELATIONS

4.1 Introduction

The taxonomy of coherence relations describes classes of coherence relations using general cognitive primitives that concern the relational surplus of the related segments. We claim that language users actually make use of these primitives during reception and production. Coherence relations are frequently expressed by linguistic devices such as connectives. The question we wanted to address in this experiment was whether people are able to infer the coherence relations between sentences and to express them by the appropriate linguistic devices.

Thirty-two sentence pairs were presented to the subjects. The sentences were originally linked by a connective. The connective and all other explicit indications concerning the relation between the sentences were removed. The task of the subjects was to relate the sentence pairs by choosing a connective from a set

¹²Redeker (1988) found that confusion of the source of coherence was reduced when more information concerning the context of the related sentences was given.

of 18 connectives. The dependent variable was whether or not the subject's choice of a particular connective (the subject's choice) agreed with the original connective. The investigators assigned the 18 connectives to the 12 classes of the taxonomy.

As in the first experiment, there are two ways of looking at the data: in terms of strict agreement (the subject's choice is identical to the original connective), and in terms of class agreement (the subject's choice concerns a connective that marks a related relation). In some cases several connectives express the same relation: *Maar (but)* and *daarentegen (on the contrary)* both express the relation of *opposition*. It seems pointless to classify a subject's choice of *maar* as incorrect if the original was *daarentegen*. Therefore, no hypothesis was formulated about strict agreement.

The first hypothesis was that the subjects' choices would agree with the original connectives, if the choices were looked at in terms of class agreement. The second hypothesis was that any discrepancies between the subjects' choices and the original connectives could be described in terms of the taxonomy: It is more likely that a discrepancy concerns a choice for a related class than for an unrelated class.

4.2 Method

4.2.1 Material

The experimental material was basically the same as in the first experiment; that is, two examples of each coherence relation were selected for the experiment. For a description of the material, see section 3.2.1 of this article. There were two modifications. The first is that *condition-consequence* was not included in this experiment. The second difference is that there were no filler items.

4.2.2 Procedure

The 32 sentence pairs were presented on paper. As a rule, the sentence pairs were presented with their original context. When the context was absent or ambiguous, suitable contextual information was supplied. The sentences of each sentence pair were numbered and presented in their original order as independent clauses. Because subordinating conjunctions induce a verb final order in Dutch and because the presentation of a sentence in either main or subordinate sentence format presumably affects the choice of the connective, all of the examples were presented in the same format: The inflected verb of each sentence was presented in parentheses in sentence-initial position. See (36) for an example of the presentation of an item.

(36)D Een maand van tevoren trad nog een wijziging op in de jaarkalender van de schouwburg.

1. (werd) een pianoconcert van Beethoven van het programma genomen
2. (werd) solist Anthony di Bonaventura ernstig ziek

- (36)E One month before there had been yet another change in the program of the theater.
1. (was) a piano concerto by Beethoven removed from the program
 2. (fell) the soloist Anthony di Bonaventura seriously ill

The list from which the subjects chose the connectives was composed on the basis of the experimenters' intuitions about prototypical markers of the relations. The list is presented in the appendix to this article. The subjects were instructed to go through the list carefully and to choose the most specific connective fitting the example. For instance, if they were hesitant about choosing between *en (and)* and *terwijl (whereas)*, they were to choose *terwijl*. After they had chosen a connective, the subjects had to write down each complete sentence pair on the answer sheet.

4.2.3 Subjects

The subjects were 15 undergraduate students from the Department of Language and Literature of Tilburg University. They were paid for their participation.

4.3 Results

To establish the amount of agreement between a subject's choice and the original connective, the choices of the subjects were classified in terms of the primitives of the taxonomy. Of the 480 responses, 4 (0.8%) could not be classified. In the case of maximal agreement, the subject's choice agrees in all four primitives with the original connective. In case of maximal disagreement the subject's choice agrees with the original in none of the four primitives.¹³

Table 4 (p. 24) presents the percentages of maximal agreement for each of the separate classes in the taxonomy. The classes are those introduced in section 2.6 of this article.¹⁴

The amount of agreement with the original connectives was moderate ($K = 0.60$, $z = 36.71$, for the analysis with all *maar* connectives in one class; $K =$

¹³There is one connective for which it is difficult to relate the subject's choice to the original. The connective *maar (but)* can express several relations—*opposition*, *exception*, *contrastive cause-consequence*, *contrastive argument-claim*, and *concession*—which in terms of the taxonomy belong to different classes. There is no way to decide which relation a choice *maar* was intended to mark. Consequently, we have analyzed the data in two ways: In the first, all of the subjects' choices for *maar* and the original connectives *maar* were treated as belonging to one, arbitrarily chosen, class (Class 2, that of *contrastive cause-consequence*). The other way was to treat the subjects' choices for *maar* as maximally opposed to the original connective. Note that this latter analysis is extremely conservative: If the original connective is *maar*—Class 4 (causal, semantic, nonbasic order, negative), and the subject's choice is *maar*, this choice is categorized as Class 11 (additive, pragmatic, positive), the class of *enumeration*.

¹⁴Class 6 contains the relation *contrastive argument-claim* relation. Class 12 contains the relation *concession*. Both are prototypically marked by *maar*, and therefore they were classified as belonging to Class 2.

TABLE 4

Experiment 2: Percentages of Maximal Agreement for Each of the Classes in the Taxonomy

Class	1	2	3	4	5	7	8	9	10	11
	66.7	66.0	90.0	79.3	50.0	75.3	35.6	60.0	73.3	53.3

Note. Connectives belonging to Classes 6 and 12 were treated as belonging to Class 2.

0.51, $z = 33.96$, for the analysis with all choices for *maar* categorized as maximally opposed to the original connective). There was a fair amount of class agreement between the subjects' choices and the original connectives: Of the choices, 63.9% were maximally in agreement with the original connectives, 26.7% agreed on three primitives, 8.2% agreed on two primitives, and 1.3% agreed on one primitive. Therefore, the results support the hypothesis that there would be a considerable amount of agreement between the subjects' choices and the original connectives in terms of class agreement.

As in the first experiment, the disagreements were analyzed according to the hypothesis that agreement on three primitives is more frequent than is to be expected on the basis of chance. Two analyses were carried out. In the first analysis the number of responses corresponding to the original in three primitives was calculated per subject and divided by the total number of disagreements. In the second analysis the number of responses corresponding in three primitives was calculated per item and divided by the total number of disagreements. The resulting proportions were compared with the chance proportion. In the subject analysis, all 15 subjects had more agreements in three primitives than expected, $\chi^2(1) = 13.07$, $p < .001$. In the item analysis, 26 out of 31 items¹⁵ had more agreements on three primitives than expected, $\chi^2(1) = 14.23$, $p < .001$. These results strongly support the second hypothesis.

Table 5 specifies for each of the primitives how many of the subjects' choices agreed with the original connective on that primitive. Inspection of the data in Table 5 shows that agreement is lowest on the primitive *source of coherence*. Most of the disagreements occur with pragmatic connectives.

4.4 Discussion

The results of the second experiment suggest a strong relationship between prototypical markers and (classes of) coherence relations. Furthermore, a clear pattern emerges from the disagreements: There was least agreement concerning connectives that differ only in the source of the coherence. This holds for the three classes with a remarkably low degree of maximal agreement (less than 60%): the pragmatic Classes 5, 8, and 11 (mostly confused with the semantic Classes 1, 4, and 9, respectively). To a smaller extent it is also true for the other,

¹⁵On one item all subjects agreed on all four features with the assumed category.

TABLE 5

Experiment 2: Number and Percentage of Agreements Between Original and Chosen Connectives for Each of the Four Primitives

Basic operation	Causality	Addition
	374 (96.9)	78 (86.7)
Source	Semantic	Pragmatic
	214 (84.9)	148 (66.1)
Order of segments	Basic	Nonbasic
	169 (89.4)	162 (87.1)
Polarity	Positive	Negative
	197 (95.2)	257 (95.5)

Note. Because additive relations are symmetric, order of segments involves only 374 correctly chosen causal connectives.

semantic, classes. (Class 1 is mostly confused with Class 5, Class 3 with Class 7, Class 4 with Class 8, and Class 9 with Class 11.)¹⁶ These confusions strongly resemble the confusions found in the first experiment. (See the discussion in section 3.4 of this article for some tentative explanations.)

Although these results are merely suggestive, they lend support to our claim that the primitives of the taxonomy provide the right distinctions to describe the naive language users' choice of connectives to signal coherence relations. This, then, supports the psychological plausibility of the primitives underlying the taxonomy.

5. CONSEQUENCES OF THE RELATIONAL CRITERION

The results of the experiments lend support to the proposed taxonomic principles. The purpose of this section is to sketch the main differences between the proposed taxonomy and other proposals presenting a systematic account of coherence relations. The aim of our taxonomy is to categorize coherence relations on the basis of a *relational criterion*, that is, a criterion concerning the meaning of two or more discourse segments that cannot be described in terms of the meaning of the segments in isolation. The discussion in this section will focus on the question of whether the criteria for distinguishing relations that figure in the literature are relational or only concern the connected segments.

¹⁶Three classes behave differently but systematically. Class 2 (containing the *contrastive cause-consequence* relation) is confused with Class 4 (containing the *contrastive consequence-cause* relation) and with Class 10 (containing the *opposition* and *exception* relations). Conversely, Classes 4 and 10 are mostly confused with Class 2. It is no surprise that there is much confusion concerning Class 2, since all *maar*-replies were attributed to this class.

5.1 Descriptive Relations

Several systematic lists of relations have been proposed with the main aim of using them as a descriptive tool in analyzing the structure of written discourse (Cooper, 1983; Fahnestock, 1983; Grimes, 1975; Longacre, 1983; Mann & Thompson, 1988; Meyer, 1975). In general, many relations presented in these proposals are further specifications of classes present in our proposal.¹⁷ They are not included in our taxonomy because the distinguishing properties of "relations" like *attribution*, *equivalent*, and *situation* are not relational. In (37), for example, the attributive meaning aspect is part of an additive relation.

- (37) John has got large quantities of pigs. They are pink and they produce a lot of meat.

The second segment of (37) has specific properties: It contains a pronoun that is coreferential with an element or class of elements referred to in the first segment. Such pronouns serve as the subject of which a property is predicated (the attribute). However, the coherence in a discourse like (37) is not established by an attribution relation, but by an additive relation.

The "attributive" meaning can be located in the second segment and therefore is not part of the coherence relation. This is further indicated by the fact that it may occur within a proper coherence relation, for example, in the causal one that is intended in (38).

- (38) John likes pigs. They are pink and they produce a lot of meat.

Hence, such descriptive "relations" are not coherence relations at all. This may be illustrated best by Meyer's (1975) rhetorical predicates that are "primarily responsible for giving prose its overall organization" (p. 31). That rhetorical predicates are not identical to coherence relations becomes clear from the fact that rhetorical predicates can also relate propositions within a simple clause; see (39), in which the attribute of *having a color* is connected through the rhetorical predicate *attribution* with the subject *parakeets* (Meyer, 1975, p. 224).

- (39) Parakeets or budgerigars are vividly colored birds [. . .]

5.2 Linkage Relations

Another type of relation frequently found in other proposals is *background* (cf. Grimes's, 1975, and Meyer's, 1975, *setting location* and Mann & Thompson's, 1988, *circumstance* and *background*). The clearest criterion for distinguishing this

¹⁷Another group consists of relations that look very similar to ours but carry different names. Examples are *evidence* (cf. pragmatic causals: argumentative relations), *explanation* (semantic causals), and *collection* (semantic additives).

type of relation is formulated by Hobbs (1983), who states that *linkage* relations "arise out of the need to link what the Speaker says that is new and remarkable with what is known to the Listener" (p. 46). According to Hobbs the sentences in (40) cohere because the background relation holds between the two sentences. However, it seems far more in accordance with a coherence perspective to consider (40) coherent because events cohering in the world are described.

- (40) And one Sunday morning about five o'clock I sat down in the Penn Station.
And while I was sitting there a young cat came up to me, [. . .].¹⁸

Hobbs's foreground-background principle of information distribution is of course essential for the functioning of language. The linkage criterion appears to be a systematic property of all types of information presented in a context. Why is this important distinction not included in the proposed taxonomy? The reason is that principles like the foreground/background distinction cut across the primitives in the taxonomy. We take the four primitives in the taxonomy to be part of the conceptual meaning (semantics) of the coherence relations themselves. Apart from its semantic properties, each coherence relation has properties concerning information-distribution in the discourse, such as: Which segment presents the foregrounded information, which segment presents the topic, and which segment gives the new information? In a *cause-consequence* relation, for instance, the first as well as the second segment can denote the topic, and the same goes for a *consequence-cause* relation. This example demonstrates the difference between the foreground/background distinction and the primitive *order of the segments*.

In conclusion, the foreground/background distinction is an important context-dependent property of information-distribution, but it should be discussed in terms of discourse principles other than the primitives of the taxonomy presented here. Probably, there are interesting interactions between the order of the segments and principles of information-distribution like foreground/background. (In fact, Mann & Thompson's, 1988, nucleus-satellite distinctions may be taken as such.) But these interactions fall beyond the scope of this article.

5.3 Temporal Relations

In comparing the present taxonomy with other taxonomic proposals like those by Hobbs (1983) and Longacre (1983), there is one group obviously absent from our proposal: the temporal relations. Hobbs's proposal includes *strong temporal relations*, and Longacre mentions *temporal* as a class, next to, for example, *alternation* and *implication*. In other proposals temporal relations are also included (cf. Mann & Thompson's *sequence*). All of these relations concern cases like (41):

- (41) John picked up the phone. He dialed a number.

¹⁸This example is a slight modification of Hobbs's (1985, p. 12) example.

It is perhaps needless to say that we do not claim that temporal relations do not occur in natural discourse. What we do claim, however, is that temporal relations belong to the classes of additive relations and that the properties distinguishing temporal relations from other additive relations concern the referential meaning of the individual segments.

There are two reasons why we do not propose temporality as a basic categorizing principle. The first is that the temporal meaning aspect is to a large degree determined by the referential content of the segments, more than, for instance, the causal meaning aspect. Given the tense and the aspect of the segments, the temporal properties of two related segments are more or less fixed. A first consequence is that in an unmarked sequence of two segments, the reader does not have the freedom to ignore the temporal meaning aspect. A second consequence is that the order of the segments in a temporal sequence cannot be reversed freely without disturbing the coherence relation. In a linguistically marked temporal sequence reversal is at best marginal; in an unmarked sequence it is impossible (cf. (41)a).¹⁹

In both respects temporal relations differ from causal relations: Causality is not 'read off' from the related segments, and hence it is possible to ignore the causal meaning aspect: In (42) a relation *consequence-cause* is most plausible, but contexts can easily be imagined in which a relation *contrastive consequence-cause* ("It has been a policy of the DA to prosecute only severe violations of the law") or *enumeration* ("John has had a bad day") is intended. Furthermore, the segments can be reversed, as in (42)b.

(41)a *John dialed a number. He picked up the phone.

(42)a John has to stand trial. He got a parking ticket.

(42)b John got a parking ticket. He has to stand trial.

The second reason for not including temporality as a basic categorizing principle is that it is not productive like causality and additivity are. Causal and additive relations can be both semantic and pragmatic. Temporal relations are only semantic: Only segments with specific properties (viz., states of affairs or events) can be involved in a temporal relationship. If a segment does not have those properties, it is not a candidate for being part of a temporal sequence. No such restrictions hold for causal and additive relations.²⁰

¹⁹Reversal is only possible if the temporality is implied by another relation, such as *consequence-cause* in (i).

(i) He hit his head. He didn't watch out.

²⁰The nonproductivity of additive relations on the primitive *order of segments* is an exception to this rule. As explained earlier, the nonproductivity of additive relations is caused by the logically symmetric character of the additive basic operation. However, unlike the nonproductivity of temporal relations, the nonproductivity of additive relations disappears if symmetry is regarded with respect to context (see the account of the difference between *opposition* and *exception* in section 2.6).

As temporal relations establish coherence for "describing a coherent set of states or events in the 'world'" (Hobbs, 1983, p. 40), it seems plausible to treat the temporal meaning aspect as pertinent to only a subset of the relations in the taxonomy. Temporal relations are very similar to all of the relations we have characterized as semantic.

5.4 Alternation Relation

Another difference between our proposal and related accounts is that in our proposal the relation of *alternation* is missing. The main reason for not adopting this as a separate class is the unclear status of *alternation*. For instance, Longacre (1983) considers it a separate class of relations on a par with *conjoining*, *temporal*, and *implication*, whereas Halliday and Hasan (1976) discuss it under the heading of *additive* relations (p. 246). There is also confusion about the nature of the *alternation* relation. Longacre (1983, p. 91) considers *or* primarily exclusive. In contrast, Gamut (1982, 1, pp. 227-230) and Levinson (1983, pp. 138-140) consider the inclusive use of *or* as basic.

In the absence of a more elaborate analysis of alternation relations, we suggest that *alternation* relations can be analyzed as contrastive additive relations. Such a standpoint matches the logical properties of disjunction: An (inclusive) alternation relation can readily be reformulated in terms of logical conjunction and negation; $P \text{ or } Q$ is equivalent with $\sim (\sim P \ \& \ \sim Q)$. This proposal is supported by the observation of several authors that alternation and contrastive relations are related. For example, Longacre (1983) states: "While contrast turns on two points of difference, alternation turns on one point of difference" (p. 91).²¹ In the same vein, Liberman (1973) suggests that disjunction and conjunction are semantically closely related. He argues that depending on the content of the related segments, the conjunction *but* either displays the filtering properties of *and* or those of *or*.

6. CONCLUSIONS AND OUTLOOK

A list of coherence relations, such as the one proposed by Mann and Thompson (1986), does not present natural classes of coherence relations. Although Mann and Thompson (1988) have recently presented some groupings within their list, a systematic categorization organizing the whole set of coherence relations is not provided, because they primarily aim at descriptive adequacy. By contrast, the taxonomy presented here postulates systematic categorizations, which has empirical consequences. Because these categorizations and the relations are of a cognitive nature, the taxonomy can be given a psychological interpretation.

²¹Compare also the following quote from Halliday and Hasan (1976), which demonstrates the interpretive relationships between an alternative marker such as *or* and some of the contrastive markers: "If it is associated with statements, *or* takes on the internal sense of 'an alternative interpretation,' 'another possible opinion, explanation, etc. in place of the one just given'" (p. 246).

In this article we have presented some evidence for the plausibility of the proposed categorizations. It appears that our distinctions are agreed upon by other judges. However, more evidence is needed. In the following, we will discuss three areas of research in which the proposed taxonomy and its plausibility can be further investigated and extended.

A first area is the study of language acquisition. Children acquire connectives and coherence relations in a more or less fixed order (see Bloom, Lahey, Hood, Lifter, & Fiess, 1980; Wing & Scholnick, 1981; and, for a review, Kail & Weissenborn, 1985). We expect the system that underlies this order to correspond to the taxonomy of coherence relations.

A second area is text analysis. The taxonomy of coherence relations must produce categories of relations that can be used in the analysis of texts and must lead to intersubjectively reliable judgments about text structure (see van Wijk, 1990). However, before such a descriptive goal can be achieved, it is imperative that the classes of coherence relations are described in extenso. In this way, our proposal may prove to be complementary to the work of Mann and Thompson (1988), whose results in this field are encouraging.

A final area is psycholinguistic research. We conceive of the taxonomy as a psychological model for the interpretation of coherence relations. That interpretation is considered to be a process of checking the primitives of the taxonomy.²² The result of this checking is that a certain coherence relation is or is not inferred. For the moment, we see three possible ways in which the proposed taxonomy can be used in psycholinguistic research.

First, adopting coherence relations as the basis of an account of discourse representation creates a framework to explain experimental findings in discourse understanding, like those of Haberlandt (1982) and Meyer, Brandt, and Bluth (1980). As mentioned before, both studies found that explicit marking of relations influences processing. Because we consider the coherence relations as conceptual relations that may be marked linguistically, these findings are interpreted as evidence for the role of coherence relations in discourse understanding. Linguistic markers function to guide the selection of the correct coherence relation. The theory of coherence relations might also provide a framework for the findings of research on discourse analysis and discourse understanding at a more global level (cf. Hoey, 1983; Meyer, 1985).

Second, and more specific, the taxonomy offers a fruitful account of the phenomenon of implicit coherence relations. It is well known that coherence relations can remain implicit, that is, that another relation can be intended than the one explicitly expressed. An example is (43).

(43)D Jane is jarig en Robin heeft al haar vriende. uitgenodigd.

(43)E It is Jane's birthday and Robin has invited all her friends.

²²Resembling the procedures for accessing the lexicon; see Levelt (1989, section 6.3) for an overview.

A causal relation can exist between the two segments in (43), for example, when (43) appears in a context like: "Robin wants to surprise Jane." Alternatively, an additive relation may be intended, as in a context like: "Both our neighbors have visitors tonight." In cases like (43), a reader has to decide which interpretation is meant in a certain context. In his or her choice the reader is guided by certain restrictions: It is possible to express a *cause-consequence* relation by means of an explicitly stated *list* relation, but not, for example, by means of an explicitly stated *concession* relation. Restrictions of this type can be expressed using the primitives of the proposed taxonomy: The *cause-consequence* relation differs from the *list* relation in only one respect, namely, the basic operation. It differs in two respects from the *concession* relation, namely, the source of coherence and polarity.

Third, it is a well-known result in psycholinguistics that negative utterances are processed more slowly than their positive counterparts. For example, in general it takes longer to verify denials than affirmatives (see Wason & Johnson-Laird, 1972), and it takes longer to judge the truth or falsity of *unless* sentences than that of the equivalent *if* sentences (Clark & Lucy, 1975; Noordman, 1979), although these effects are context-sensitive (Wason, 1965; Noordman, 1985). Our experiments show that these findings can be extended to the level of coherence relations. The polarity primitive in the taxonomy—which refers to the same kind of positive-negative relations—appeared to be dominant. Thus, the taxonomy may present a framework to discuss these and other findings in the literature along the same lines.

In conclusion, the proposed taxonomy offers an a priori plausible categorization of coherence relations. Some evidence for the categorization has been presented in this article. The taxonomy is an explicit theory of coherence that can generate predictions about discourse understanding. Although more precise descriptions of the classes that figure in the taxonomy are needed in order to answer questions like, What relation exists in this particular context?, it seems a suitable starting point for a psychologically plausible theory of coherence relations.

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APPENDIX

LIST OF PROTOTYPICAL MARKERS (EXPERIMENT 2)

Class Coherence Relation

1 Cause-Consequence

D S_1 , zodat S_2 | Omdat/Doordat S_1 , S_2

E S_1 , so that S_2 | Because/In consequence of (the fact that) S_1 , S_2

2 Contrastive Cause-Consequence

D Hoewel S_1 , S_2 | S_1 , maar S_2

E Although/Despite the fact that S_1 , S_2 | S_1 , but S_2

3 Consequence–Cause

- D S_1 , omdat/doordat S_2
- E S_1 , because/in consequence of S_2

4 Contrastive Consequence–Cause

- D S_1 , hoewel S_2
- E S_1 , although/despite the fact that S_2

5 Argument–Claim

- D S_1 , dus/daarom S_2 | Aangezien S_1 , S_2
- E S_1 , so/therefore S_2 | Since S_1 , S_2

5 Instrument–Goal

- D S_1 , om te/daarmee S_2 | S_1 , opdat S_2
- E S_1 , (in order) to S_2 | S_1 , so as to S_2

5 Condition–Consequence

- D Mits S_1 , S_2
- E Provided that S_1 , S_2

6 Contrastive Argument–Claim

- D Al S_1 , S_2 | S_1 , maar S_2
- E Although S_1 , S_2 | S_1 , but S_2

7 Claim–Argument

- D S_1 , want S_2
- E S_1 , for/because S_2

7 Goal–Instrument

- D S_1 , daartoe S_2 | Opdat S_1 , S_2
- E (In order) to S_1 , S_2 | S_1 . To that end S_2 . | So as to S_1 , S_2

7 Consequence–Condition

- D S_1 , mits S_2
- E S_1 , provided that S_2

8 Contrastive Claim–Argument

- D S_1 , al S_2
- E S_1 , although S_2

9 List

- D S_1 , en/ook S_2
- E S_1 , and/also S_2

10 Exception

- D S_1 , maar S_2
- E S_1 , but S_2

10 Opposition

- D S_1 , maar S_2 | S_1 , daarentegen S_2
- E S_1 , but/however S_2 | S_1 . By contrast S_2

11 Enumeration

- D S_1 , bovendien S_2
- E S_1 , moreover S_2

12 Concession

- D S_1 , maar S_2
- E True, S_1 . But S_2 | S_1 . Yet, S_2