The space of coherence relations and their signalling in discourse[*]

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Abstract: I present an overview of the concept of coherence in discourse, and explore how one of the essential elements to that coherence, relational coherence, has been studied and partitioned in different discourse traditions. I then introduce one of the theories that deals with discourse coherence, Rhetorical Structure Theory (RST). Through the description of RST, I investigate fundamental concepts in the study of coherence relations such as the classification of relations and their signalling in discourse.

Keywords: coherence relations, discourse relations, rhetorical relations, cohesion, cohesive harmony, conjunction, Rhetorical Structure Theory, discourse organization, discourse markers, discourse signalling

1. What discourse coherence means, and how we can find it

Coherence refers to a property of discourse that makes each instance of discourse felicitous in context. The lay meaning characterizes coherent discourse as one that 'makes sense', and the term is often used in the negative, i.e., when discourse is not coherent or does not make sense. I will present, in this paper, a conceptualization of coherence as an internal property of discourse, which characterizes it as constructed out of component parts. Briefly, discourse coherence, or text coherence, is the result of weaving together entity relations and propositional relations. I will refer to this property as either discourse or text coherence, and by 'text' I mean any type of discourse, whether written or spoken, although conversation features additional characteristics that make it coherent, mainly related to turn taking.

The successful weaving of entity and propositional relations results, then, in coherent text. Entity relations refer to the different types of relations among entities in the discourse, either of identity or of similarity, and is broadly the realm of cohesion (Halliday & Hasan 1976). An example of an identity relation is the link between a pronoun and its antecedent. A similarity

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relation links two expressions in discourse via semantic relations, such as synonymy or hyponymy. The presence of cohesive links is not necessarily enough for text cohesion. An important component of that cohesion is also the participation of cohesive items into the transitivity structure of the clause, a phenomenon that Hasan (1984) beautifully described as *cohesive harmony*. Propositional relations are different from entity relations, in that they connect units of discourse (at the most basic level, clauses), and relate them in terms of their content. Examples of propositional relations are condition or summary.

Both entity and propositional relations are well studied in the literature, and the idea that together they either contribute to or constitute discourse coherence has long been widely accepted (Cristea et al. 1998; Halliday & Hasan 1976; Kehler 2002; Kehler & Rohde 2013; Kintsch & van Dijk 1978; Koornneef & Sanders 2013; Poesio et al. 2004). My goal in this paper is to present this view of coherence as a framework for understanding discourse, to then focus specifically on propositional relations, and their role in the construction and interpretation of discourse. In particular, I am interested in the types of signals that guide that interpretation, i.e. the signals that help us recognize propositional relations. I propose that coherence relations are identified in the processing of discourse by a variety of signals, beyond discourse markers or conjunctions, which have been postulated to be the most common, or sometimes the only type of signals for coherence relations. The research and the ideas I discuss here are not novel: they have, however, not been summarized and presented in condensed form. I distill research from several areas, in discourse analysis, functional linguistics, psycholinguistics and computational linguistics, to provide a unified review of research in coherence relations.

I start then by outlining the concept of discourse coherence within the context of systemic functional linguistics, and its view of texture as the property that makes texts texts. In Section 2, I also present the distinction between entity relations (anaphoric or cohesive relations) and propositional relations (discourse or coherence relations), and a discussion of theoretical and terminological issues, settling on the term 'coherence relations' to refer to the phenomenon under study. Section 3 focuses on coherence relations, with a brief historical overview of the main approaches to these relations, one of which, Rhetorical Structure Theory (RST), is described in detail in Section 4. In Section 5, I tackle the issue of comparing different taxonomies of coherence relations in different theories, and in Section 6 I describe how coherence relations are

signalled in discourse. Finally, Section 7 closes with a summary discussion.

2. The texture of discourse[1]

Texts have texture. The word 'text' shares a root with 'textile' and 'texture', referring to the weaving of different materials that results in both fabric and text. In fabric, the weaving brings together threads laid out vertically (the warp), onto which horizontal threads (the weft) are threaded through, often in a loom, a centuries-old technology. In text, a similar process weaves relations between entities and relations between propositions. Halliday & Hasan (1976) define this property of texts as texture, the quality that makes a particular set of sentences a text: what holds them together to give them unity in the context in which they are used. Texture is created through relationships of choice, the words and grammatical structures that writers and speakers deploy over other possible choices. Halliday and Hasan explain texture through cohesion: "relations of meaning that exist within the text, and that define it as a text" (Halliday & Hasan 1976: 5). It is important to emphasize here that in Halliday and Hasan's view, texture is related to context, what Hasan (1985) defines as context of situation, as opposed to context of culture, which helps define which registers are possible in a culture and how they are organized (see also (Martin 1992). I will not discuss the contextual aspects of texture, because the focus here is its text-creating nature, but it is certainly an important part of the definition, and any explanation of text coherence needs to rely on how the text fits into the particular context where it is produced and interpreted.[2]

Texture is achieved through cohesive devices which tie to each other. In fact, it is the cohesive tie that creates cohesion, rather than the individual units which make up the tie. One example is in (1), a tweet[3] from the Canadian Prime Minister Office. In the example a tie is created between the nominal group *their homeland* and the hashtag *#WelcomeRefugees*. The

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[1] I have borrowed the title for this section from the title of Renkema's (2009) book.
[2] Hasan (1985) also discusses structural cohesion, separate from the non-structural cohesion that includes reference, lexical cohesion and conjunction. Structural cohesion contributes to the texture of a text through parallelism, Theme-Rheme structure and the Given-New organization of discourse. These aspects are usually treated separately, and I will not have more to say about them here, other than their nature is different from the nature of what is usually considered cohesion and conjunction, i.e. hey are structural, not textual, in nature.
[3] From a link (https://storify.com/CanadianPM/welcomerefugees) out of the Government of Canada website (https://www.canada.ca/en.html), accessed June 12, 2017. Note that the link is no longer available.

reader needs to interpret *their* as referring to the *refugees*. This is an example of personal reference.

(1) Let's #WelcomeRefugees who were forced to flee their homeland because of war and
conflict: http://ow.ly/VK1sf

In Example (2), also from an official Government of Canada website,[4] we see a relation between the word *plans* in the second sentence and the two plans mentioned in the first (the Canada Pension Plan and the Québec Pension Plan). The word *plans* acts as a superordinate term, an umbrella for both types of plan, and would be classified as an instance of lexical cohesion, one achieved through open-class lexical items, as opposed to the closed-class pronoun in Example (1) above.

(2) If you have contributed to both the CPP and QPP, you must apply for the QPP if you live in
Quebec or for the CPP if you live elsewhere in Canada. Please note that you do not have to
apply to both plans.

The next example, also from a government website,[5] illustrates conjunction, a type of cohesive device that "provides the resources for marking logico-semantic relationships that obtain between text spans of varying length, ranging from clauses within clause complexes to long spans of a paragraph or more" (Halliday & Matthiessen 2014: 609). As we shall see in Section 3, the Hallidayan notion of conjunction includes only relations signalled by a conjunction (*because, while*) or a class of conjunctive adverbs (*on the other hand, as a result*). In Example (3), the conjunction *although* signals a concessive relation, a contrast between the percentage of Indigenous women in the general population, and their proportion in terms of murdered women.

(3) Indigenous women and girls in Canada are disproportionately affected by all forms of
violence. Although Indigenous women make up 4 per cent of Canada's female population,
16 per cent of all women murdered in Canada between 1980 and 2012 were Indigenous.

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[4] https://www.canada.ca/en/services/benefits/publicpensions/cpp.html, accessed February 3, 2019.
[5] https://www.rcaanc-cirnac.gc.ca/eng/1449240606362/1534528865114, accessed February 3, 2019.

The original classification of cohesion divides cohesive devices into five main categories, whereas later versions of the theory (Halliday & Matthiessen 2014) reorganize the categories into four (see **Error! Reference source not found.**). Hasan (1985) also had a slightly different classification, with a distinction between relations of co-reference (reference) and relations of co-classification (substitution and ellipsis), and with a detailed organization of lexical cohesive relations. Most notable in Hasan's treatment is her extensive study of cohesive harmony (Hasan 1984, 1985), which comes about when chains interact with each other not only across sentences and clauses (as they do in, e.g. reference), but also within clauses, in the transitivity system, for instance, as 'actor and action' or 'action and acted-upon'. Chain interaction produces cohesive harmony in a text by bringing together lexical and grammatical cohesive devices, and incorporating them into the structure of the clause.

Other classifications of cohesive devices exist, especially for lexical cohesion, which seems to be the most complex to categorize (Cruse 2000; Tanskanen 2006), and has been operationalized for various computational applications (e.g., Burstein et al. 2010; Hoque et al. 2018; Morris & Hirst 1991).

Table 1: Classifications of cohesive devices

Cohesive devices in Halliday & Hasan (1976)	Cohesive devices in Halliday & Matthiessen (2014)
1. Reference	1. Conjunction
2. Substitution	2. Reference
3. Ellipsis	3. Substitution and ellipsis
4. Conjunction	4. Lexical organization
5. Lexical cohesion	

The relative change in position of conjunction is perhaps not accidental. Whereas the

other categories create cohesion by relating entities, conjunction does so through combinations of clauses and sentences. It is for this reason that I believe that conjunction is a separate category, which can be referred to as propositional coherence. This is not the view in Halliday and Hasan, for whom conjunction is firmly a part of cohesion. It is, however, a view in other approaches to discourse, and frequently held in computational treatment of discourse, where coherence and structural (grammatical) relations are used to search for antecedents of referential expressions (Cristea et al. 1998; Hobbs 1979). Similarly, in the psycholinguistic and processing literature, coherence relations are shown to play a role in the interpretation of anaphoric relations (Kehler et al. 2008; Kehler & Rohde 2013; Koornneef & Sanders 2013). Poesio et al. (2004) consider these two aspects as the two sides of the coherence coin, and refer to them as entity-based vs. relational coherence. This is the view I take here: entity-based and propositional coherence are intricately related, but ultimately different phenomena. This paper is concerned with the space occupied by propositional or relational coherence, and how we interpret it in discourse.

A bit on terminology is in order at this point. From now on, I will use **cohesion** to refer to the entity-based relations in Halliday & Hasan (1976) that include relations of reference or similarity, i.e. all types in **Error! Reference source not found.** except conjunction. For propositional coherence, i.e. the coherence brought about by propositional relations, I will use the term **coherence** or **coherence relations**. These are relations included as part of conjunction in Halliday and Hasan's approach, but also any relations between propositions that are conveyed through either a conjunction or a variety of other means. Relations among propositions are also referred to as discourse relations or rhetorical relations, but 'coherence relations' seems to be the most widespread and theory-neutral label. Finally, I will use **discourse markers** to refer to conjunctions, connectives or lexicalized prepositional phrases that typically signal the connection between two propositions (*if, however, in contrast*).

3. Coherence relations through the ages

In line with other approaches, most notably RST, I propose a top-down examination of coherence relations, that is, one that views relations between propositions in discourse as relations that help create coherence. In this section, I review different approaches to rhetorical,

coherence and conjunctive relations, and explain where RST (Mann & Thompson 1988) fits in with other proposals. My goal in this section is to describe some of the general principles that apply to coherence relations, regardless of the particular theory.   There is a long trajectory of research that tries to capture the phenomenon that I here describe as coherence relations. Some of this work harks back to work by Ballard and Longacre (Ballard et al. 1971; Longacre 1976, 1983) on a "taxonomy of the deep structure of interclausal relations" (Longacre 1983: 79), in part following even earlier work by Fuller (1959). Beekman & Callow (1974) and Grimes (1975) also investigated inter-clausal relations, some of it in the context of Bible studies and Bible translation. The work of Hoey (1979) is worth mentioning as well, because he maps the overall structure of discourse, in particular the problem-solution structure, to how particular linguistic devices signal it.

The next big step was by Halliday & Hasan (1976), as described in the previous section. Their treatment of conjunctive relations addresses relations across clauses, as part of a description of the clause complex, the combination of clauses that constitutes part of the fabric of discourse (Halliday & Matthiessen 2014). The clause complex belongs to the domain of grammatical, not discourse, structure. It is, however, the basis for the combination of units, of whatever length, into a small set of groupings, starting with the basic choice between a paratactic or a hypotactic relation, i.e., relations where the two parts are of equal importance (**paratactic**), or relations where one of the components is subordinate to the other (**hypotactic**). Consider Example (4) with two instances of a causal relation, both hypotactic.[6] The example has been broken down into clausal units (more on units of discourse below), separated by brackets and labelled with subscript numbers after each unit. The first causal relation in question spans units 4 and 5, the first one a dependent clause. Then, unit 6 adds an additional cause for the reduced environmental impact mentioned in unit 5. Unit 6 is dependent on unit 5 (or the combined 4–5 sentence). This makes it also a hypotactic relation. The difference in the two relations is that, while the 4–5 relation is within the same clause, thus part of the system of clause complexing, the relation between 6 and 4–5 occurs across clauses. This is the crucial point at which coherence

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[6] From https://www.ec.gc.ca/pbjo-bpog/default.asp?lang=En&n=4D1F2C17-1, accessed March 1, 2016. Archived version: http://web.archive.org/web/20160401084844/https://www.ec.gc.ca/pbjo-bpog/default.asp?lang=En&n=4D1F2C17-1, accessed February 3, 2019. The example has been modified, with the insertion of brackets for clauses and clause numbers.

relations abandon the clause complex/sentence domain, which is concerned with grammatical relations and join the discourse level (Halliday & Matthiessen 2014: 609; see above) The analysis of this portion of the text is shown in Figure 1.

(4) [There are two 2010 Winter Games venues in Whistler, located on the shared traditional territory of the Squamish and Lil'wat First Nations, two of the Four Host First Nations.]$_1$ [The Sliding Centre is the site of the luge, bobsleigh, and skeleton events.]$_2$ [Whistler Creekside is the site for alpine skiing events.]$_3$ [Because Whistler Creekside is the location for both the alpine technical and speed events,]$_4$ [this reduced the originally projected environmental impact in this area by 90%.]$_5$ [This is because original development plans identified both Whistler and Blackcomb Mountains as the location for these events.]$_6$
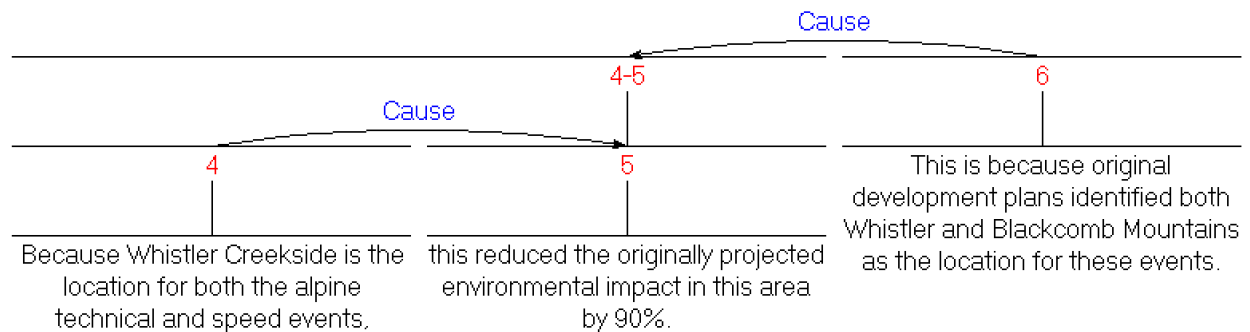

Figure 1. Partial analysis of Example (4)

Mann et al. (1992: 41) describe discourse structure as having three different types of structures:

- Holistic structure. This can be best described as genre structure or text type, i.e., the structural characteristics of a text that indicate what kind of genre it belongs to. This structure accounts for the inverted pyramid scheme arrangement of news items, or the opening and closing elements in letters (Martin & Rose 2008).
- Relational structure. What I here have referred to as propositional relations or coherence relations.
- Syntactic structure. Arrangement of syntactic constituents at the sentence or clause level.

Coherence relations are in the middle, in the realm of relational structure. Because they are

in a middle point, however, they often interact with the other two structural elements. The interaction with genre leads to certain types of relations being more frequent in some genres than in others.[7] The fact that relations have clauses as minimal units results in a close interaction with the syntactic structure of discourse. It is precisely this close interaction that has led researchers to place coherence relations closer to one or the other of the two outlying structures. This is what I would call the space of coherence relations, i.e. the place that they occupy in the continuum between genre and syntactic structure at either extreme.

Halliday & Hasan (1976) place their conjunction in a space closer to syntactic structure, and always defined by conjunctions or conjunctive adverbs, which indicate the type of relation that joins the two discourse units. Units are not exclusively intra-sentential, as some conjunctions and adverbials (i.e. *however, in conclusion*) may join sentential units to each other, or one sentence to a unit made up of several other sentences. In this view, conjunctive relations are present only when a conjunction signals them. Martin (1992) proposes a revision of these concepts, in the form of conjunctive relations. The most relevant aspect of his approach is that he makes a distinction between congruent and metaphorical realizations (for conjunctive relations, but also for other linguistic phenomena). A congruent realization always involves a conjunction or a conjunctive adverb (*by, because, while, finally*). A metaphorical realization conveys the type of connection through other means, such as verbs, prepositional phrases or entire clauses (*enable, cause, contrasts with, I'll finish by noting*). This can be viewed as a process of grammaticalization.

It is this cline of grammaticalization that Matthiessen & Thompson (1988) discuss, with the grammaticalization occurring from discourse to syntax. They study the concept of **subordination**, and conclude that its traditional meaning (e.g., Quirk et al. 1985) can be unpacked into two different aspects, one closer to discourse, and one within the realm of syntax. At the discourse end is **hypotaxis**, the combination of discourse units in logico-semantic relation (i.e. coherence relations). The units, at the lower level in discourse, are clauses, and most commonly adverb clauses. **Embedding**, on the other hand, is firmly a syntactic phenomenon, and it includes the type of embedding that inserts restrictive relative clauses and clauses as

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[7] See the work of Matthiessen and colleagues in identifying different lexicogrammatical realizations of rhetorical relations in different genres (Matthiessen & Teruya 2015).

Participants into a main clause. Hypotaxis is a recurring and recursive phenomenon, which may take place intra- or inter-sententially. Mann et al. (1992) make this point with regard to concession. They argue that concession can be viewed in terms of discourse relations, abstracting away from the individual conjunctions (or lack thereof) used to signal it. Thus, in one of their text examples, concession appears in two separate instances, one with an adverbial clause and *even though*, and another time in a main clause with the conjunction *but*. The two instances share more similarities than differences, even though one is intra-sentential and the other one occurs across sentences.

Opposed to hypotaxis is **parataxis**, the combination of units with similar relative importance in the discourse, the discourse equivalent of coordination at the sentence level. Together hypotaxis and parataxis account for relations both at the sentence and the discourse level, unifying in similar phenomena the recursive combination of discourse units. This basic distinction between hypotaxis and parataxis, or between subordination and coordination, is considered to be a fundamental property of discourse organization (Asher & Vieu 2005; Fabricius-Hansen & Ramm 2008).

The conclusion in Matthiessen & Thompson (1988) is that clause combining in grammar is the result of the grammaticalization of rhetorical units in discourse, as defined by rhetorical relations, a proposal also put forward by Givón much earlier (Givón 1979). They present this first as a hypothesis, and make predictions that would hold true if the hypothesis were correct. One of the most relevant predictions for our purposes relates to grammatical marking. If the nucleus-satellite structure has any grammatical marking, it would be of a kind that would render the two distinct from each other, characterizing one as nucleus and the other one as satellite. Two types of marking are suggested, connective and finiteness. In both cases, it is the satellite that receives the grammatical marking, either in the form of a conjunction or through a non-finite verb. This type of grammatical marking has received the most attention in studies of coherence relations and I will argue, in Section 6, that signalling has focused disproportionately on the syntactic level, but other signals exist that help hearers and readers identify relations.

In sum, coherence or rhetorical relations organize discourse and create coherence in a space between structural organization at the genre level and the syntactic level. While there are a variety of theories that deal with coherence relations, most of the differences hinge on where on

that cline the theory positions itself. For instance, RST focuses on the discourse end of the cline, since it postulates an organization of discourse that includes all types of units, from elementary clausal units to larger units which may be composed of several sentences or even paragraphs. The approach is inclusive, i.e. one where every part of the discourse contributes to a coherent whole. Similarly, Segmented Discourse Representation Theory (SDRT) (Asher & Lascarides 2003) aims at representing whatever instance of discourse is analyzed as a whole, with relations connecting the parts. There are, of course, many differences between RST and SDRT, among them the type of relations and how they are defined (intentionally in RST; semantically in SDRT). The two approaches, however, agree on analyses that encompass an entire piece of text (written or spoken). See also (Martin 1992, ch. 4) for a different view of coherence relations as conjunctive relations, and a comparison to RST.

Differences of granularity within the theories also exist. For example, the analyses in the Rhetorical Structure Theory Discourse Treebank (RST-DT; (Carlson et al. 2002) emphasize the areas closer to syntax. Although the trees in the treebank analyze entire texts, and include higher-level relations, they also break text down into very small units, analyzing some relations that are probably within the realm of syntax rather than discourse. This is the case with embedded clauses. Some examples in the corpus segment an clause that is part of the transitivity structure of another clause (e.g., as a Goal) and its matrix as two units, and postulate a relation between them. In my opinion, this is actually a syntactic relation, not one of discourse. Let us consider the example in (5) from the RST-DT perspective. The sentence is divided into four elementary units of discourse,[8] which I have enclosed in square brackets and labelled with numbers for each unit. In the RST-DT, the analysis proposes that *I think* is a satellite in an Attribution relation. In other words, it supports a unit that describes the content of the thinking, with the satellite merely presenting the source. While this is in part the case, the relation between *I think* and the content of the thinking is, syntactically, one of matrix and complement clause, and really a syntactic relation, notwithstanding the fact that the status of *think* as a matrix verb is questionable (Thompson 2002). The relation between units 3 and 4, presented as a Consequence relation in the RST-DT analysis, is also better captured as a syntactic relation.

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[8] There is a fifth part in the sentence, at the end: *a KerrMcGee spokeswoman said*. I have left it out, because it adds a further complication with the introduction of another Attribution relation.

(5) [When the plant was destroyed] $_1$ [I think] $_2$ [everyone got concerned] $_3$ [that the same thing would happen at our plant…]$_4$ [wsj_0641]

Also at the discourse end of the cline is the approach of Hobbs and Kehler (Hobbs 1979; Kehler 2002, 2004; Kehler & Rohde 2013). Their theory proposes a set of coherence relations that take place at all levels of language, with an emphasis on inter-sentential relations, and a particular interest in determining the relationship between coherence relations and anaphora resolution (Kehler & Rohde 2013). Relations, in Hobbs' approach, are relations not at the surface level, but between the inferences triggered by discourse units (in his examples, mostly clauses and simple sentences). Kehler follows that same approach, postulating relations among ideas, i.e. propositional relations.

At the grammar end are the approaches of Halliday & Hasan (1976) and Martin (1992), as discussed above. Similarly, the coherence relations of Sanders and colleagues (Sanders et al. 1992, 1993) and Knott & Dale (1994) are closer to the syntactic domain, as they are motivated by the presence of conjunctions or discourse markers, including an attempt to create a taxonomy of relations out of what they call cue phrases. The approach of Sanders and colleagues is interesting, because it is based on cognitive principles. Sanders et al. (1992) argue that the relations have to be psychologically plausible, i.e. they should map to cognitive entities. They propose a classification based on four cognitive primitives: basic operation (causal or additive); source of coherence (semantic or pragmatic); order of segments (basic or non-basic); and polarity (positive or negative).

Although relations signalled by cue phrases occur across sentences, most of the high-level multi-unit relations that RST or SDRT postulate would not be analyzed in these approaches. The analyses in the Penn Discourse Treebank (PDTB) (Prasad et al. 2008a; Prasad et al. 2008b) are also motivated by conjunctions and discourse markers. Relations, whether intra- or inter-sentential, are postulated only if a clear marker exists, or one can be inserted. For example, (6) and (7) are examples taken from Prasad et al. (2014: 922). They show two instances of a causal relation. The first one connects the two sentences in the first unit to the second sentence, through the discourse marker *as a result*. In Example (7), the same relation is postulated, because, although no explicit marker is present, *as a result* could be inserted between the two sentences to

convey the same meaning. The first example, in the PDTB, is an example of an **explicit** relation, whereas the second one is **implicit.**

(6) [Jewelry displays in department stores were often cluttered and uninspired. And the merchandise was, well, fake.]$_1$ [As a result, marketers of faux gems steadily lost space in department stores to more fashionable rivals—cosmetic makers.]$_2$

(7) [In July, the Environmental Protection Agency imposed a gradual ban on virtually all uses of asbestos.]$_1$ [By 1997, almost all remaining uses of cancer-causing asbestos will be outlawed.]$_2$

A slightly different example of connection in the PDTB is the case of Alternative Lexicalizations. Example (8), also from Prasad et al. (2014: 926), is one such example, where the connection is conveyed by *one reason is*. This is not labelled as an implicit relation, because inserting *because* or some such connective would seem redundant in this example.

(8) [Now, GM appears to be stepping up the pace of its factory consolidation to be in shape for the 1990s.]$_1$ [One reason is mounting competition from new Japanese car plants in the U.S. that are pouring out more than one million vehicles a year at costs lower than GM can match.]$_2$

In all of these cases, relations are closer to their syntactic realization, and analyses do not always aim at incorporating all parts of a text. Figure 2, inspired by Bateman & Rondhuis (1997), tries to capture this information visually, mapping the space that different theories assign to coherence relations, between discourse (genre or text type) and syntax.[9] Closest to the syntactic end of the spectrum are the theories of Knott and Dale, and also Sanders and colleagues, because their emphasis is on relations that are signalled by some marker, thus firmly within the syntactic domain, or rather, within the lexicogrammar, in Hallidayan terms (Halliday & Matthiessen 2014). Martin's conjunctive relations move further up, because he allows for metaphorical realizations, i.e. those not so firmly grounded on the syntax, and not directly in the

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[9] Matthiessen (2002) also provides an account of the space occupied by rhetorical relations, mapping the clause complexing system across the language system, including the phonological level (e.g. tone groups).

system of conjunctions or discourse markers. His approach enlists other aspects of the lexicogrammar, such as finiteness. He also includes what in other approaches may be described as patterns (Hunston & Francis 2000) or constructions (Goldberg 2006), as is the case with expressions such as *I'll finish by noting* or *while I just suggested.* Martin (1992: 269), in fact, describes conjunction as the gateway to discourse semantics, the place where the lexicogrammar is deployed to make meaning in terms of genre and register. Finally, and still anchored in the syntactic end, we find the approach of the PDTB, because it is lexically motivated. The bar moves further up, since PDTB does include alternative lexicalizations, through expressions other than conjunctions.

A different group of approaches starts at the top, and varies in how they extend down to the syntactic level. Hobbs and Kehler remain mostly within the scope of discourse, since they do not discuss in great detail the encoding of rhetorical relations in syntax. Similarly, Mann and Thompson, in RST, are mostly concerned with the arrangement of propositions, and with the effect that the language producer (speaker or writer) wants to create with that particular arrangement. Mann & Thompson (1988: 250) discuss only briefly the signalling of relations, to state that they had found "no reliable, unambiguous signals for any of the relations". This apparent lack of signalling was a puzzle to Mann, and featured in the discussions in the RST website, which he initially wrote (Mann & Taboada 2018).

Segmented Discourse Representation Theory (SDRT) (Asher & Lascarides 2003) aims at accounting for all of discourse, and includes information that ranges from the syntax to the discourse (albeit in modular form); that is why its bar in Figure 2 spans the entire space. SDRT's coverage is also broader because it attempts to provide an account of various discourse phenomena, from pronoun resolution to word sense disambiguation and presuppositions. SRDT definitions are semantic, as opposed to the more pragmatic definitions in RST, which are based on intentions.
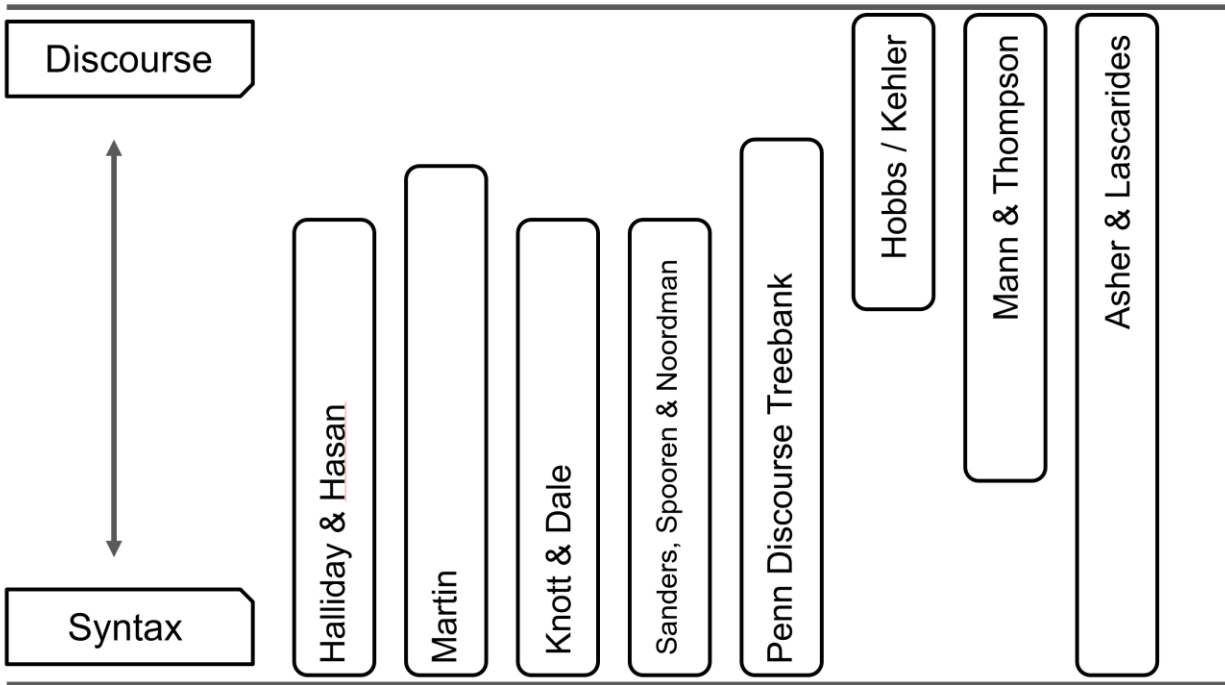
Figure 2. The space of coherence relations

The space occupied by the two groups of theories could be viewed as 'bottom-up' vs. 'top-down', i.e. theories such as those of Halliday and Hasan start at the bottom, at the level of syntax, and build up to construct discourse. Theories such as RST start at the top, being concerned with the organization of discourse, and progress towards the bottom, towards an understanding of how that organization is conveyed in language. The two types of approaches can also be seen as part of the 'swings and roundabouts' that Webber & Prasad (2009) discuss, as a set of swings in discourse research between theory-driven interpretations and data-driven analyses. Their account specifically mentions a swing from Halliday and Hasan in the 1970s, with a focus on data, to Mann and Thompson in the 1980s, who focused on theory, along many other approaches to coherence relations in that time (Grosz & Sidner 1986; Moser & Moore 1996; Polanyi 1988).

In summary, I would like to emphasize that the space where specific theories position themselves, between generic structure and discourse at one end and syntax at the other, is an underdefined space. Many of the debates about the nature of different theories of coherence relations are debates about where those separations lie. That is probably not a terribly important

difference across approaches. As long as we agree that what we disagree about is the delicacy of the discourse analysis, we can probably agree to disagree. A more difficult divide to bridge is the type of definition we give to coherence relations. I broach that subject in Section 5. Before that, I provide a brief introduction to RST, because what it has to say about coherence relations is relevant to the rest of the discussion, and in particular to the issue of signalling of discourse relations in Section 6.

4. Rhetorical Structure Theory: One approach to coherence relations

Rhetorical Structure theory postulates that discourse is segmented, i.e. it is made up of segments that combine to form a discourse structure, thus contributing to creating coherence in discourse. Units are, in the original formulation (Mann & Thompson 1988), mostly simple sentences, independent (main) clauses and adjunct clauses. Those are minimal units, and larger units, which are combinations of those, are also considered units of discourse, which Mann and Thompson more generally labelled **spans**. Mann and Thompson specifically exclude clauses that are embedded in the transitivity structure of a main clause, because those properly belong in the domain of syntax. The status of relative clauses is less clear, since they sometimes act within the phrase (as modifiers to a noun), but they are also sometimes discourse constituents. Marcu and colleagues, in the annotation of the RST Discourse Treebank (Carlson & Marcu 2001; Carlson et al. 2002, 2003; Marcu 1997, 1999) introduce the term Elementary Discourse Units (EDUs), used for the smallest units that enter into a rhetorical relation, and include a much more fine-grained segmentation, which separates complement clauses from their matrix (in our terms above, embedding, not hypotaxis). As has been previously argued (Taboada & Mann 2006b; Tofiloski et al. 2009), the issue of granularity in segmentation is open, and different approaches and applications may choose how deep the segmentation ought to be.

Central to RST is the concept of **nuclearity**. The hypotactic organization of discourse is seen as a pervasive text-organizing device (Matthiessen & Thompson 1987). In any text made up of multiple units, some units or combinations of units realize the central goals of the writer, while others realize goals which are supplementary or ancillary to the central goals. To abstract away from the idea of main and subordinate clauses, and convey that the asymmetry occurs at all levels of discourse, RST uses the term **nucleus** to refer to the central unit, and **satellite** to

indicate a unit that contributes to the nucleus. Relations are typically made up of one nucleus and one or more satellites (hypotaxis), but there are also multinuclear relations, joined through parataxis. A basic test for nuclearity is the deletion test: If a unit can be deleted without major loss of information in the discourse, then it is probably a satellite. If it cannot be deleted, its status is more likely that of a nucleus. The deletion technique has been successfully deployed in extractive text summarization, where, after constructing RST-like discourse trees, satellites at various levels are deleted to produce a summary (Dias & Pardo 2015; Marcu 1997; Ono et al. 1994; Pardo & Rino 2002; Teufel & Moens 2002, to name just a few).

This basic principle, that discourse is structured in terms of nuclei and satellites, has led to a more rigorous definition by Marcu (1996), of the **nuclearity principle**, used in analysis, whereby spans of texts can be connected through rhetorical relations only if their nuclei are connected. In other words, in a complex relation, if a relation is postulated between two spans, then the relation should also hold between the nuclei (in the absence of the satellites). Although RST ties the structure of nuclei and satellites to specific relations (relations are, by definition, either hypotactic or paratactic), other researchers suggest that nuclearity is more dynamic, being assigned for each instance of a relation, and depending on contextual factors, most notably information structure (Asher & Vieu 2005; Stede 2008).

RST has proposed slightly different taxonomies of relations, but they can all roughly be categorized along two axes: nucleus-satellite vs. multinuclear; and subject matter vs. presentational relations. In subject matter relations, the intended effect is that the reader recognize the relation. Presentational relations are more pragmatic in nature, and are meant to increase some inclination on the reader, such as desire to act or positive regard for the nucleus. These two classifications are often presented as orthogonal, but they can be integrated, as seen in **Error! Reference source not found.**, where multinuclear relations are also classified along subject matter and presentational lines. Joint is usually described as a "non-relation", i.e. the simple juxtaposition of items, and for this reason it is probably more presentational in nature than the other multinuclear relations. The list of relations presented here is the current one on the RST website (Mann & Taboada 2018), but slight modifications exist.

Table 2: RST relation classification

	Nucleus-satellite	**Multinuclear**
Subject matter	Cause, Circumstance, Condition, Elaboration, Evaluation, Interpretation, Means, Otherwise, Purpose, Result, Solutionhood, Unless	Conjunction, Contrast, Disjunction, List, Restatement, Sequence
Presentational	Antithesis, Background, Concession, Enablement, Evidence, Justify, Motivation, Preparation, Restatement, Summary	Joint

Relations are defined in terms of four principles, the most important of them being the Effect, that is, the intention of the text creator in arranging material in this specific way. **Note:** provides two sample definitions, of Condition (subject matter relation) and Concession (presentational), with examples all taken from the RST website (Mann & Taboada 2018).

The theory is probably best explained through an example. Figure 3 shows an analysis of a small text, an excerpt of a book review originally published on the website Epinions.[10] The text, overall, is structured around a Contrast: *Do not read this book first; read other books in the series before*. In order to understand the commands issued in the second part of the text, the satellite of a Background relation explains that this book belongs in a series, and it is the sixth in that series. Then, a Condition relation accounts for the fact that the reader may not have read other books in the series. The second part of the text builds a Sequence of recommended steps.

RST analyses are represented in the form of trees. Each span (unit or EDU) is labelled with a number. Nuclear spans are indicated by a straight line above them. Satellites have curved arrows pointing away from the satellite and towards the nucleus that they contribute to. The relation label is placed between the nucleus and the satellite, or on top of the nuclei.[11]

Table 3: Two sample RST definitions

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http://www.epinions.com/review/Hot_Six_by_Janet_Evanovich_and_narrated_by_Debi_Mazar/2004218900/96355 7?rs=2&rso=2. Accessed March 16, 2016. Now available at: http://web.archive.org/web/20090505172324/http://www.epinions.com:80/reviews/Hot_Six_by_Janet_Evanovich_a nd_narrated_by_Debi_Mazar. Accessed February 3, 2019.

[11] The graphical representation of the analysis was done with the RSTTool (O'Donnell 1997).

	Condition	Concession
Constraints on N	None	W has positive regard for N
Constraints on S	S presents a hypothetical, future or otherwise unrealized situation (relative to the situational context of S)	W is not claiming that S does not hold
Constraints on N+S	Realization of N depends on realization of S	W acknowledges a potential or apparent incompatibility between N and S; recognizing the compatibility between N and S increases R's positive regard for N
Effect	R recognizes how the realization of N depends on the realization of S	R's positive regard for N is increased
Example	[Employees are urged to complete new beneficiary designation forms for retirement or life insurance benefits]$_N$ [whenever there is a change in marital or family status.]$_S$	[Tempting as it may be,]$_S$ [we shouldn't embrace every popular issue that comes along.]$_N$

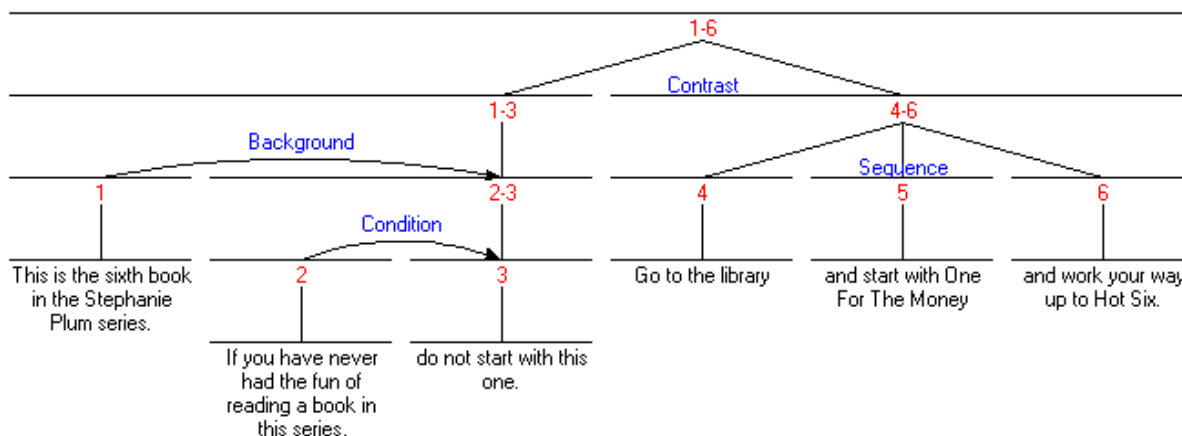**Note:** N= nucleus; S = satellite; W = writer; R = reader.

Figure 3. Sample RST analysis

Most analyses postulate a tree structure for discourse, at least in RST. Other approaches,

such as SDRT, propose graphs, and comparisons between the two formalisms have been offered (Danlos 2008). An important challenge to the tree structure comes from Wolf and Gibson (2005, 2006). They suggest that tree representations do not adequately capture all discourse phenomena, and propose graphs instead, re-annotating a portion of the RST Discourse Treebank with a graph formalism (Wolf et al. 2005). Wolf and Gibson found, in their analyses of coherence relations, what appeared to be crossed dependencies and nodes with multiple parents, which cannot be easily represented via trees. Egg & Redeker (2010) argue that the problems encountered by Wolf and Gibson are related to other types of links in discourse. That is, in cases where crossed dependencies seem necessary for the analysis, this is because anaphoric connections are present (a fact that Wolf and Gibson do acknowledge). This is a problem that Knott et al. (2001) also discuss. The conclusion is that relations of cohesion and coherence are conflated, and this leads to problems in the analysis of propositional coherence. In Wolf and Gibson's case, the problem is crossed dependencies and nodes with multiple parents. In Knott et al. (2001), the problem is underspecification in the Elaboration relation. As I pointed out in Section 2, cohesion and coherence are intimately related, and thus it is not surprising that we find it difficult to tease them apart in analysis. This is not to say that there is no merit in graph-based representations, or representations other than trees; it seems, however, that the case against trees may be based on a conflation of coherence with cohesion.

The summary above is necessarily a very brief introduction to the theory. The original papers provide more detail, especially on the background and development of the theory (Mann et al. 1992; Mann & Thompson 1988; Matthiessen & Thompson 1988). The RST page contains a summary, and a relatively large number of analyses, some of them not published elsewhere (Mann & Taboada 2018). Taboada & Mann (2006a, 2006b) provided a survey of research on RST, summarizing some of the open issues, and listing representative publications up to that date.

The theory itself has remained largely unchanged, except for adjustments to the inventory of relations. One recent development is Matthiessen's efforts (Matthiessen & Teruya 2015) on integrating RST into Systemic Functional Linguistics. The two theories have been closely linked, and RST started out as part of an SFL-inspired project on natural language generation (Mann 1983). The original descriptions, however, did not highlight this connection, and the clause

complexing and conjunctive systems in SFL have often been treated as independent of RST. Matthiessen is attempting a closer integration, mapping RST relations to the expansion and projection systems in SFL (Halliday & Matthiessen 2014). This is enhanced with a connection between genres and the types of relations that are relatively more or less frequent in different genres.

In summary, RST has provided an important framework for the study of text structure and coherence, and has remained robust over the years. Most of the changes have to do with the number and type of relations. In the next section, we explore those taxonomies, in RST and cognate theories.

5. Taxonomies of coherence relations

There is extensive research on how many and what types of relations any theory of discourse relations should include, and that extends to how many relations should be allowed in RST. I will not revisit those efforts here, except to say that the issue is not closed (Hovy & Maier 1993; Knott & Dale 1996; Maier & Hovy 1991; Sanders et al. 1992; Taboada & Mann 2006b). My main concern with taxonomies in this section is as part of the effort to define what constitutes a coherence relation. Some relations, such as Elaboration and Attribution, have had an uneasy status, and this may be due to an unclear definition of the nature of coherence relation. Knott et al. (2001), for instance, deal with the issue of Elaboration, concluding that its status is questionable because Elaboration conflates entity relations with the propositional nature of linking via coherence relations (see also Bärenfänger et al. 2008). Attribution is difficult to classify for a different reason, because it interacts with the embedding mechanism of clausal structure. Many Attributions are projections within the clause complex, i.e. a projection of a clause onto another (Halliday & Matthiessen 2014: 515). This is the reported speech of traditional grammars, whereby the words of somebody else are presented as complement of a reporting verb (Huddleston & Pullum 2002; Quirk et al. 1985). In the Penn Discourse Treebank (PDTB), Attribution is not considered a relation proper, because it relates a proposition, the reported speech, to an entity, the person to whom the speech is attributed (Dinesh et al. 2005; Prasad et al. 2007), although text that contains reported speech is annotated with an Attribution label, because the PDTB authors are interested in distinguishing whether arguments in a relation

are to be taken from the perspective of the author of the text or somebody else's; in other words, whether they should be attributed to the author or not. In 'classical RST' (the version of the theory stemming from Mann, Thompson and Matthiessen publications in the 1980s and early 1990s), there is no Attribution relation, because the attribution component, the reported speech, is syntactically a complement to a reporting verb, and complements are not considered units of discourse. Huddleston & Pullum (2002: 1024) see no difference between *She said **that she lived alone*** (indirect reported speech, with the complement clause underlined) and *This proves **that he was lying*** (a content clause as internal complement to the verb *prove*). In RST-style annotations of the RST Discourse Treebank (Carlson et al. 2002), however, reported that speech clauses are segmented as Elementary Discourse Units (EDUs), and related to the reporting verb through an Attribution relation (with the reporting unit as satellite to the reported speech), because, in general, complement clauses are segmented as EDUs.

Those two issues, with Elaboration and Attribution, capture the tension in defining the space of coherence relations. On the one hand, relations are defined in opposition to cohesive links, but they often overlap, because both cohesive links and coherence relations contribute to the creation of texture in discourse. On the other hand, coherence relations are part of the clause complexing system, the combination of clauses to link propositions or ideas in discourse. This is the space that they occupy, and the space where tensions may arise.

Taxonomies can be described in terms of their starting points, as outlined in Section 3, that is, whether they start at the syntactic level, with conjunctions, or at the discourse level, with intentions. Additionally, Martin (1992: 170 ff.) proposes that some taxonomies are "universalist in orientation", gathering a set of relations which may be grammaticalized in different languages. Other taxonomies, the majority in fact, focus on individual languages, and this is mostly the case for those that start from the bottom up, that is, from syntax, because they are anchored in the lexical and grammatical markings that particular languages employ to signal the presence of a relation. Recent efforts, however, have tried to propose taxonomies that not only work across different theories and annotation styles, but also that are universalist, because they apply to multiple languages (Benamara & Taboada 2015; Rehbein et al. 2015; Sanders et al. in press). In typology, this is a well-established area of study. For instance, the papers in Dixon & Aikhenvald (2009) survey a number of languages, and their approach to clause linking. The taxonomies of

relations, however, are not always homogeneous; again, because they start from the bottom up.

A significant effort in this regard has been the work of the pan-European TextLink project,[12] a consortium of institutions with the goal of facilitating discourse research and sharing discourse annotation resources. Part of this work involves the creation of a taxonomy to unify different approaches to discourse relations. Although the goal is not fully achieved yet, a number of publications have shed light on the commonalities across approaches to discourse relations (Rehbein et al. 2015; Sanders et al. in press).

6. Signalling coherence relations

In the sense of rhetorical relations as relations of coherence, relations are present whether signalled by a particular device or not. This is the long-held view within RST. The concern in RST has been to explain how coherence, and the impression of coherence, is achieved when relations are apparently not signalled. Signalling has traditionally been taken to refer to conjunctions or discourse markers which link propositions. I propose that signalling is actually quite prevalent, if we broaden our definition of signalling devices.

Before we delve into signalling, let us start with some basic definitions of signalling, as opposed to marking, and how we can define relations that are signalled and not signalled. It is generally acknowledged that relations are recognized when a **discourse marker** (a conjunction or conjunctive adverb) is present, as in Example (9), from a crime prevention web page (CRA = Canada Revenue Agency),[13] where the conditional relation between units 2 and 3 is clearly identifiable thanks to the conjunction *if*. There is a relation between the first and the second sentence as well (between unit 1 and units 2–3), but, in the absence of a conjunction, the relation may be harder to recognize. It could be a Sequence, paraphrased as follows: *First, the scammers state that the person they call owes money to the CRA; secondly, they issue a threat*. We could say that the Conditional relation is **signalled** or **explicit,** whereas the Sequence relation is **unsignalled** or **implicit**.

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[12] http://textlink.ii.metu.edu.tr/. Accessed February 3, 2019.
[13] http://www.rcmp-grc.gc.ca/en/news/2016/10/beware-scammers-impersonating-canada-revenue-agency. Accessed February 3, 2019.

(9) [The scammers tell taxpayers that they either owe money to the CRA or have a tax refund.]₁ [Taxpayers are threatened with arrest or jail time]₂ [if they do not take immediate action and provide money or personal or financial information.]₃

When coherence relations are defined from the bottom up, i.e. starting at the syntactic level, then a coherence relation is often defined in terms of its signalling, and at that end, we find what have been labelled *explicit relations*. When relations are defined from the discourse level, we find more apparent *implicit relations*, as is the case in many RST analyses (Mann & Taboada 2018). There is a downward limit, though, to how much signalling is present. Green (2014) proposes that, in cases where the clauses are tightly connected in the syntactic structure (infinitival clauses, participle clauses, relative clauses), less signalling is necessary. A tight syntactic linking helps signal the integration, with more frequent signalling happening once adverbial and coordinated clauses are considered. Another way to interpret this result is that the syntactic linking is the signal itself.

The point here is that frequency of signalling by conjunctions and connectives varies with type of integration. It goes from very clear at the lowest level (hypotaxis and parataxis at the clause level) to less clear at the discourse level. But if we postulate that relations are similar, just positioned at different ends of the syntax-discourse cline, then the fact that there is no connective or discourse marker does not mean that there is no relation; it simply means that the relation has not been signalled. Matthiessen & Teruya (2015: 241) propose that (bold and italics in the original) "[l]exicogrammatical realizations are either **direct realizations**, marking the relations themselves, or **indirect realizations**, providing 'clues' that will enable listeners or readers to *infer* relations." Indirect realizations, then, are different from direct (or explicit) realizations in that they do not pick out the rhetorical relation for the listener/reader, but instead provide information to help narrow down the set of possible relations in that context. Indirect realizations include the Theme-Rheme structure of texts, also aided by cohesive resources (repetition, reference, among others).

There is by now ample evidence that connectives are not the only means by which relations are signalled, and that devices at multiple levels of language play a role in helping guide inferences about what type of connection is intended between any two given discourse

units. The research is so abundant that it would be difficult to properly summarize it here, but two groups of studies will act as representative samples, the first group corpus-based and the second experimental.

In a study of the RST Discourse Treebank (RST-DT), Das & Taboada (to appear) analyze the more than 21,000 relations in the corpus, and found that almost 93% of those had some identifiable signal. These signals were not only connectives and discourse markers, but a variety of other indicators, such as semantic relations (antonyms for a Contrast relation, e.g. *stop* and *go*); syntactic structures (parallelism, subject-verb inversion); or graphical markers (punctuation, bulleted lists). A similar study by Duque (2014), but focusing on cause and result relations in an RST-annotated corpus of Spanish (da Cunha et al. 2011) found that 97% of the causal relations in the corpus were signalled, by devices such as conjunctions, anaphors, gerunds or genre structure.

Asr (2015) and Asr & Demberg (2015) postulate that connectives are only inserted when they are needed in terms of information density. When other signals are present, a connective contributes unnecessary information, and results in a too dense segment. They tested this hypothesis with both corpus and experimental methods. One of the experiments involved presenting pairs of sentences with a signal in the first part (an implicit causality verb or negation), and with or without a connective. They were asked to associate the first part of the relation with a visual representation soon after hearing it. In the experiment, participants correctly predicted the relation before they heard the connective. This result was then confirmed with a corpus analysis, showing that relations that had a specific cue in the first part were more frequently unsignalled by a connective in the corpus. The methodology for the experiments was based on the work of Rohde & Horton (2014), who designed an eye-tracking experiment using the visual world paradigm to test whether different types of connectives (*because* for cause; *so* for consequence) lead to anticipatory looks to either the cause or the consequence of an event. Their results confirm this hypothesis; in addition, they found that implicit causality verbs (*admire, please, scold*) resulted in more causal readings, perhaps obviating the need for the explicit causal connective. The idea that too much (or too little) information is undesirable is formalized in Asr and Demberg's work through the Uniform Information Density theory (Levy & Jaeger 2007), but ultimately it can be traced back to Gricean pragmatics and the Maxim of

Quantity: "make your contribution as informative as is required" (Grice 1975).

The conclusion of much work on signalling, then, is that the connective is a shortcut, a way to make the relation absolutely clear. In most cases, however, other signals or simply default causality are sufficient to infer the relation. The amount of signalling, nevertheless, is relative, and greatly depends on several factors. The most prominent factor is the type of relation, with some relations being very frequently signalled (by connectives or something else), and some relations being signalled less often (Andersson & Spenader 2014; De Marneffe & Jin 2015; Maier et al. 2016; Sporleder & Lascarides 2008; Taboada 2006). Another factor that plays a role in the level of signalling is the genre of the text, with some genres/registers, such as historical exposition, exhibiting high degrees of signalling, especially in the form of connectives, whereas other genres, such as advertising, being low in explicit signalling (Berzlánovich & Redeker 2012; Matthiessen & Teruya 2015; Vivanco 2005).

7. Summary

Coherence relations play an important role in the interpretation of discourse as such; they create the links between propositions that guide how texts (whether written or spoken) are produced and processed. They are intimately related to the other strand in the perception of coherence, relations among propositions in the text. I have provided an overview of this area of linguistic study, focusing on the wide space that coherence relations occupy, with syntax at one end and discourse at the other. By characterizing the syntax-discourse area as one that can be partially or completely filled by coherence relations, we can place different approaches to the study of coherence relations at either end of that space. Some approaches focus on how coherence relations become grammaticalized in coordination and subordination between clauses; other approaches emphasize the discourse aspects, and how sentences or paragraphs are connected in discourse. Yet others see coherence relations as spanning that entire space.

One particular aspect of coherence relations where the syntax-discourse space is important is in how we portray relation signalling. When the emphasis is on the syntactic end, then we tend to look for discourse markers (conjunctions or connectives) as signals for relations. If there is no such emphasis, however, we find that many other linguistic and contextual devices

serve as signals for relations, including expectations about the genre, structural characteristics (punctuation, layout) or syntactic structure (parallelism, finiteness).

Many avenues for future developments in the study of coherence relations suggest themselves. There are numerous active areas of research investigating signalling, taxonomies, cross-linguistic differences and similarities, and much development is taking place in computational linguistics at its applications. My proposal here is that, regardless of the specific theory one may choose to work with, most differences between theories are superficial, whereas the similarities are profound.

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