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Coherence and Discourse relations
A Discourse-analytical perspective

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A. Introduction to Discourse analysis: **Discourse and coherence**

Discourse: what is it?

- a sequence of written or oral utterances, **arranged** into a **coherent whole** (Zufferey & Moeschler 2012: 143)
- Discourse (a TEXT) as a linguistic unit **in usage**
  - and not "a grammatical unit like a clause or sentence" (Halliday & Hasan 1976: 1–2)
- Discourse as a **social behavior** which is defined by its **function**: descriptive, argumentative, legitimating, etc

Connectedness & Structure

a. *She speaks three languages. She is a linguist.*

b. *The winter of 1963 was very cold. A lot of barn owls died.*

- Fundamental, constituting characteristic(s) of discourse:
  - it is more than a random set of sentences
  - it shows **connectedness**
  - We can distinguish what is a text and what is not -> TEXT has **structure** (Halliday & Hasan 1976)

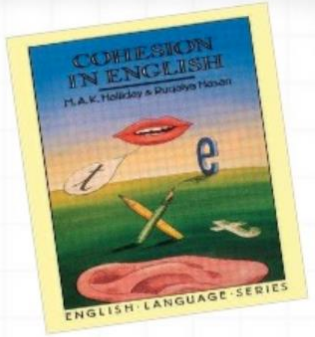
Discourse vs. Sentence

- In traditional discourse-analytical models, discourse connectedness & Structure are modelized via a set of rules / conventions of well-formedness
  - Discourse-Connectedness = Sentence grammaticality, as studied in syntax
    - Speakers have judgments of well-formedness in both cases
  - Syntactic grammaticality vs. Discourse acceptability
    - The unity of a text (discourse) is of different kind
      - Text is realized by sentences but it does not have the same structural integration among its parts as we find among the parts of a sentence or clause (Halliday & Hasan 1976)

How to measure discourse connectedness?

M.A.K.Halliday and Ruqaiya Hasan

Cohesion in English



- Investigate the resources that English has to create text
- the rules of well-formedness imply the notions of **cohesion**
  - Cohesion - a set of explicit cues – is what makes a text a text

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COHESION (Halliday & Hasan 1976)

- Determines the well-formedness of a discourse according to the appropriateness of a sentence in a context:
  - is a sentence a possible continuation of the preceding one?
- The interpretation of one linguistic element depends on another element in the same text
  - Defined by purely linguistic (lexical and grammatical) mechanisms
- In a cohesion analysis, the connectivity of the discourse is primarily tied to the explicit marking of semantic relations.
  - In cohesion, the linguistic realization is pivotal (Sanders Spooren & Noordman 1992)

Text/Discourse = Grammar ?

- Although Halliday and Hasan do not regard a text as a grammatical unit, they do assume that there is a system of rules which relate linguistically determined patterns of connection – that is, cohesion – with texts in the same way that a grammar is said to pair sounds and meanings.
- Thus they argue that “although a text does not consist of sentences, it is REALIZED or encoded in sentences” (1976: 2; from Blakemore 2004:233).

Cohesion cues (Halliday & Hasan 1976)

- **Substitution**: similarity between different instantiated entities of the same type:
  a. Dan wanted a beer. Al took **one too**.
  b. These biscuits are stale. Get some fresh **ones**.
- **Ellipsis**:
  c. Where are you going? – ⌀ To the gym
  d. Would you like to hear another verse? I know twelve ⌀ more.
- **Reference**: identity between entities (pronouns, definite descriptions):
  e. **Dan** lived near a bar. Every night **he** went there.
  f. John loves Mary. However, **he** is afraid to kiss **her**.
  g. John fired Paul because **he** is a communist.

Cohesion cues (Halliday & Hasan 1976)

- **Conjunction/pragmatic connectives**:
  - h. Dan is getting fat **because** he drinks too much.
  - i. John loves Mary. **However**, he is afraid to kiss her.
- **Lexical cohesion**: similarity between entities of the same type based on sense relations (hyperonymy, part-whole)
  - j. Dan is thirsty. The bar is next door.
  - k. Why does this little boy wriggle all the time? Girls don't wriggle.
- **Verbal tenses**
  - l. Max opened the door. The room was pitch dark.
  - m. Max switched off the light. The room was pitch dark

Cohesion and connectedness

- Cohesion is **necessary** but **not a sufficient** condition for the creation of text (Halliday and Hasan 1976).
- **How about this?**

  Dan drinks a lot in summer. Summer, winter, fall and spring are the seasons. For seasons, Armstrong was one of the best cyclists. They have a hard time in Spain. Spain will win tonight. [...]

  - It's cohesive... but it does not show connectiveness

➢ Cohesion is not a sufficient condition for connectedness

Cohesion and connectedness

- **And this?**

  a. John was happy. It was a Saturday.

  b. Greenpeace has obstructed a nuclear transport in the South German state of Bavaria. Demonstrators chained themselves to the rails.

  - It's a discourse:
    - It shows connectedness, but no cohesion

➢ So: cohesion is not a necessary condition for connectedness either (Sanders & Pander Maat 2006)

Issues with the notion of COHESION

- Halliday and Hasan's taxonomy is not concerned with providing a theory of utterance understanding (Blakemore 2004: 233)
  - Cohesive devices are superficial symptoms of a deeper relation
- Major issue:
  - Relationship between the linguistic surface code (text) and the meaning representations
- We need a focus on 'underlying' conceptual connectedness rather than on the overt linguistic elements

From COHESION to COHERENCE

- Following Hobbs (1979), the terms **coherence** and **coherence relations** are used to develop such an account (focusing on the underlying conceptual connectedness)
- Hobbs shows that coherence determines coreference, not the other way around:

  a. Georges left his house at 8 a.m. Indeed, this man leaves his home every morning at 10 a.m.

  b. Marc stopped by to see Mary to discuss her chemistry assignment. Mary is very good at chemistry.

  (a) contains cohesion markers but is not coherent

  (b) is coherent without containing cohesion markers

COHESION

In a cohesion analysis the connectivity of the discourse is primarily tied to the explicit marking of semantic relations. These explicit cues make a text a text.

BUT: Cohesion is necessary but not sufficient condition for the creation of text (Halliday and Hasan, 1976).

COHERENCE

Cohesive elements like connectives are viewed as important but not necessary features of discourse: they are linguistic markers expressing the underlying conceptual relations that are of a cognitive nature (Sanders, 1992).

Coherence and cohesive relations are the threads that make up a text.

Texture (quality that makes a particular set of words and sentences a text)

Figure from Taboada (2015)

Halliday and Hasan (1976)

Discourse is coherent if

all of its pieces belong together → coherence (relational coherence)

and they have some common thread → cohesion (entity-based coherence)

after Taboada (2015)

Cognitive dimension of Coherence

- In contrast with cohesion, coherence is a cognitive, mental notion, rather than an inherent property of text or discourse
  - it is a notion which people use when interpreting utterances
- Hence: the connectedness is located at the level of the cognitive representation
- Coherence and context
  - The notion of coherence is more tightly related to the context (extra-linguistic situation and world knowledge), than the notion of *cohesion*, since is not limited to simple linguistic markers:
    - A causal link between S1 and S2 in (19): S2 is a reason for S1

    Marc stopped by to see Mary to discuss her chemistry assignment. Mary is very good at chemistry.

Two types of Coherence

- From research on coherence, it can be concluded that there are two respects in which discourse can be coherent (Sanders, Spooren & Noordmann 1992)
- **Referential** coherence or topic continuity:
  - focuses on the *content* of the discourse segments and discourse-topichood:
    - referential chain: Coherence by repeated reference to the same set of entities (person, object)

      E.g. *The man*, *Al* , *he*, ∅
- **Relational** coherence:
  - Discourse structure approach to coherence
  - Conceptual relations between two discourse segments
    - subsequent sequences or higher level segments (paragraphs, chapters)

Two types of coherence

- Both for referential and relational coherence, linguistic indicators / markers can be identified
  - These are taken as processing instructions:
    - Referential: pronouns, anaphors...
    - Relational: connectives, lexical cue phrases
- For both types there is a
  - linguistic work showing the regularities in grammatical coding
  - psycholinguistic work demonstrating relevance in processing
    - Psycholinguistically, linguistic markers of coherence are signals or processing instructions
- Both types are covered in computational linguistics (identification of referential and relational structures)
  - The main task when studying referential structures is coreference resolution

Relational coherence

- Coherence (relations) can be represented in general conceptual terms
  - Abstracting away from the context-specific content of the segments
  - A standard terminology has never settled in: *rhetorical predicates, relational propositions* (Mann & Thompson 1986), ***rhetorical relations*** (Grosz & Sidner 1986), ***coherence relations*** (Hobbs 1979, 1985), ***discourse relations***
    - E.g. *Cause-Consequence*, *temporal, condition*, *List*

Relational coherence: what is a Coherence/rhetorical relation

- Coherence relations reflect cognitive principles that we apply when we try to make sense of the real world (Hobbs)
- Coherence relations: “the building blocks of discourse structure” (Evers-Vermeul & Sanders 2015)
- Coherence relations as cognitive elements of the discourse representation (Hobbs 1979, 1985; Sanders et al. 1992, 1993; Kehler 2002)
- Coherence relations . . . should be thought of in psychological terms as a set of conceptual relations used by readers and writers when processing text (Knott and Sanders 1998: 136)
  - This hypothesis is based on the assumption that the hearer of a text constructs a representation of the information it contains which integrates the propositions expressed into a larger whole.
    - Thus coherence relations are the various ways in which this integration takes place.

What is a Coherence/rhetorical relation

- Aspect of meaning of 2 or more d-segments that cannot be described in terms of the meaning of the segments in isolations (Sanders, Spooren & Noordman 1992)
  - It is because of this coherence relation that the meaning of two discourse segments is more than the sum of the parts.
- A rhetorical relation is a **pragmatic function** that one utterance (or larger stretch of text) fulfils with respect to another (Jasinskaja & Karagjosova 20)
- It is not uncommon to think of them as **relational speech acts** (Asher and Lascarides, 2003). Like speech acts in a more traditional sense, such as *statement, request, promise*, etc., rhetorical relations express what a sentence *does*, i.e. what it effects in communication. However, Rhetorical Relations do so by expressing what a sentence does *to another sentence*.

B. Discourse relations and Discourse structure

Coherence relations and computational linguistics/NLP

- In computational linguistics, discourse analysis covers a wide range of structural phenomena, such as **identification of relational structures**. The main task when studying relational structures are related to **coherence relation assignment** [Asher and Lascarides 2003, Mann and Thompson 1988].
- Annotated corpora are necessary in order to build advanced applications such as automatic text generation systems [Bouayad-Agha 2000], automatic summarizers [Marcu 2000b] or machine translation systems [Marcu et al. 2000]. These systems rely on different linguistic information, including the discourse level. Consequently, it is important to have a corpus which is annotated at different linguistic levels. Aforementioned systems could take advantage of the available *automatic discourse analyzers* [Marcu 2000b, Pardo et al. 2004], in order to improve their output (Iruskieta & al 2013).

Why study discourse?

- During the last decades, having an explicit representation of discourse structure has become a pressing need for many applications in **computational linguistics**, such as automatic summarization and human–computer interactions.
- During the same period, the development of new theories and methodologies in **psycholinguistics** has also meant that the study of language processing could go beyond the level of isolated sentences. This evolution also implied the need for a cognitively motivated representation of discourse structure, accounting for discourse coherence.
- In this context, theoretical models of discourse structure have started to emerge since the 1980s in order to provide such explicit representations

Discourse relational devices (DRD) & Relations (DR)

- Many frameworks and models propose an account of DRs, DRDs and D-structure
  - basically elaborating taxonomies of DRs and/or DRDs
    - However, discourse annotation guidelines provided by various theories (e.g. PDTB, RST, and SDRT) differ in terms of the features of a relation that are analyzed and the types of relations that are distinguished (from 4 to more than 70).
  - Accounts on D-related phenomena are either
    - **relation**-oriented: RST, CCR, SDRT
    - or **connective**-oriented: PDTB

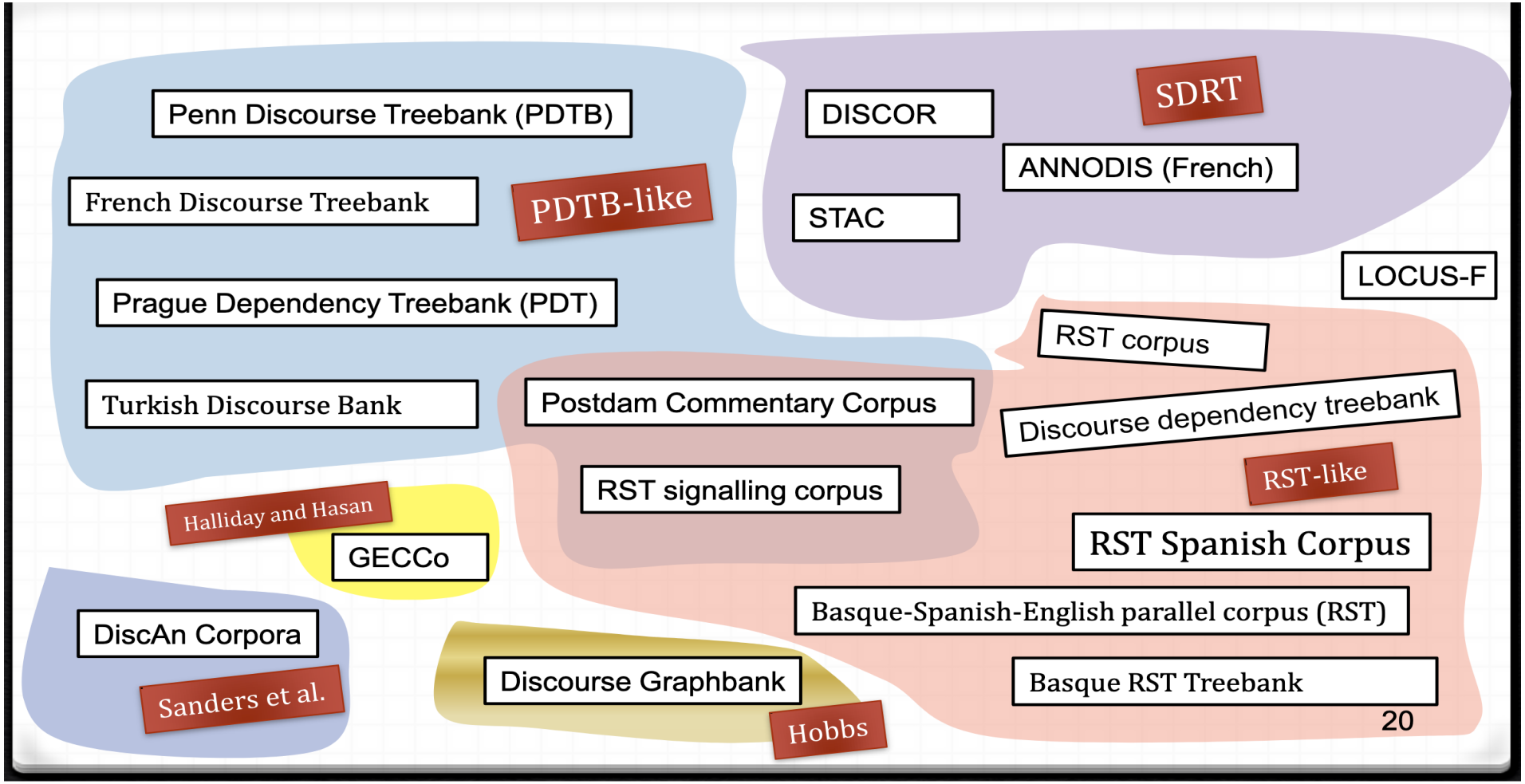
A selection of models of discourse structure

Four leading models for discourse annotation (Theories and annotation guidelines):

- **RST**: Rhetorical Structure Theory (Mann and Thompson 1988; and its annotation guidelines: Carlson and Marcu 2001)
- **SDRT**: Segmented Discourse Representation Theory
  - These two models share the goal of providing a global representation of discourse structure encompassing every segment of a text, thus going beyond the level of local discourse relations
- **PDTB**: Penn Discourse Treebank (Miltsakaki et al., 2004, annotation guidelines (Prasad et al., 2007))
  - lexically grounded approach to discourse structure that anchor the study of discourse relations in the use of connectives
- **CCR**: Cognitive Approach to Coherence Relations (Sanders, Spooren & Noordman 1992)
  - cognitively plausible account of discourse relations,
  - decomposing DRs into a set of cognitively motivated primitives

Discourse structure frameworks (Nedoluzko 2016)

- These models have been used to annotate large corpora with discourse relations



B1. RST
(Rhetorical structure theory)

Mann, W. C. and S. A. Thompson (1988). **Rhetorical structure theory. Toward a functional theory of text organization**. Text 8(3), 243–281.

Taboada, Maite and William C. Mann. (2006). **Rhetorical Structure Theory: Looking back and moving ahead**. Discourse Studies, 8 (3), 423-459.

1. RST: Background

- http://www.sfu.ca/rst/ (RST web site)
- Language-independent, descriptive theory for textual organization describing coherence relations between text fragments
- The initial goal was to provide a tool that could be used in computer-based text generation.
- RST analysis wants to answer the question of how coherence in **text** is achieved
- Central claim: a text is coherent in virtue of the relations between its parts

RST: Background

- RST provides a way to analyze the structure of texts by decomposing them into discourse relations
- relations are hierarchical, depending on the lengths of the text spans that they unite:
  - local relations can be embedded into more global ones within a text
- Main goal: Descriptive adequacy - to capture the full variety of structures of natural texts
  - descriptive adequacy as the sole principle for defining a set of RR has been the object of a lot of criticism (in CCR)

What are the relational arguments?

- When performing an RST analysis of a text, the first step consists of segmenting the text into **spans**, and then determining the relations between them
  - Exactly what a span is, is a well-debated topic.
  - RST proposes that the minimal units of discourse (**Elementary Discourse Units** (Marcu 2000a) are clauses, but that other definitions are possible.
  - **Adjunct** clauses stand in clear rhetorical relations (cause, condition, concession, etc.).
  - Complement clauses, however, have a syntactic, but not discourse, relation to their host clause *(see slide 42, span 2)*.
    - Complement clauses include subject and object clauses, and restrictive relative clauses, but also embedded report complements. (Mann and Thompson 1988)
    - Carlson et al. (2003) propose a much more fine-grained segmentation, where report complements, relative clauses and appositive elements constitute their own EDUs. (Iruskieta & al 2013)

How many and what type of relations?

- There are several classifications of RST relations (Iruskieta & al 2013):
  - the classic one of **24** relations (Mann and Thompson 1988)
  - The extended one of **30** relations (Mann and Taboada 2010)
  - Marcu's classification of **78** relations (Carlson et al. 2003), among others
- different relations are needed for different languages or text types (spoken vs. written)

Relation names (Mann-Thompson 1988)

Circumstance
Solutionhood
Elaboration
Background
Enablement and Motivation
- **Enablement**
- **Motivation**

Evidence and Justify
- **Evidence**
- **Justify**

Relations of Cause
- **Volitional Cause**
- **Non-Volitional Cause**
- **Volitional Result**
- **Non-Volitional Result**
- **Purpose**

Antithesis and Concession
- **Antithesis**
- **Concession**

Condition and Otherwise
- **Condition**
- **Otherwise**

Interpretation and Evaluation
- **Interpretation**
- **Evaluation**

Restatement and Summary
- **Restatement**
- **Summary**

Other Relations
- **Sequence**
- **Contrast**

Later on, other relations such as **list**, **means**, **preparation**, **unconditional** and **unless** are added to the list (Mann, 2005).

Examples of relations (Iruskieta 2016)

NON-VOLITIONAL CAUSE: The ground is wet **because** it has rained

EVIDENCE, N-S: It must have rained, **because** the ground is wet

PURPOSE, S-N: Once all this is correctly organised in a single text we can mould the "legal discourse" of Basque. **->** **To** attain this goal we have been translating doctrinal texts in law at the University of Deusto since 1994.

CONCESSION, N-S: In recent years work has begun to develop instruments in several languages for automatic terminology extraction in technical texts, **<-** **though** human intervention is still required to make the final selection from the terms automatically chosen.

INTERPRETATION, N-S: Secondly, we must make it clear that the prefix-core / base-complement of the romance languages and English has a corresponding feature in Basque in base-complement / suffix-core. <- This is an important contribution to modern lexicography.

SEQUENCE, N-N: Key words are extracted from parsing such definitions so that literal translation of English key words into Chinese can be achieved. <-> **Then** the Chinese key word translations are processed in the coiner making use of Chinese morpheme database and Chinese word formation rules.

Relational argument types

- Identification of two different parts for most relations:
  - **Nucleus**: the most important part of the relation, important individual fragment from within the discourse, essential to the speaker's purpose
    - If all nuclei are removed from a text, its content is not interpretable anymore
  - **Satellite**: more secondary, provides some rhetorical information about the nucleus
    - If satellites are removed, the text, even though incomplete and agrammatical, can still be understood.

➢ the reader's comprehension of the satellite will increase their belief in the nucleus.

Preferential patterns for some relations

- Elaboration, Restatement, Enablement:
  - Nucleus + Satellite
  - **Elaboration:** Paul had a great holiday$_{\mathbf{N}}$. He went swimming$_{\mathbf{S}}$, ate good food$_{\mathbf{S}}$, and partied every night$_{\mathbf{S}}$
- Concession, Condition, Background, Evidence
  - Satellite+Nucleus
  - **Evidence+Claim:** The lights are out$_{\mathbf{S}}$, so nobody is at home$_{\mathbf{N}}$.
  - Good as it may look$_{\mathbf{S}}$, I won't eat dessert$_{\mathbf{N}}$.
- Contrast, List, Sequence: Multinuclear relations
  - Nucleus + Nucleus (+Nucleus)
  - **Contrast:** Helen is blond$_{\mathbf{N}}$ but Sandra is a brunette
  - Peel the carrots, and slice them into thin slices. Cook them briefly in the pan, and serve hot.

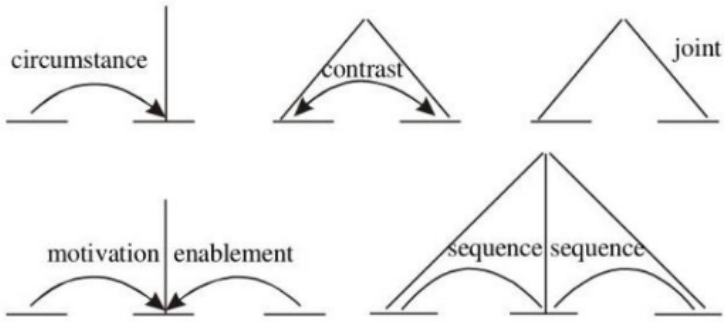
Relational types

- Respectively, the relations are of two types:
  - **Paratactic**/multinuclear, N-N (symmetric):
    - relations between fragments that are equally important to the author
    - LIST, CONTRAST, DISJUNCTION, SEQUENCE
  - **Hypotactic**/nuclear, S-N/N-S (asymmetric):
    - connect a less-important unit with a more important unit
    - ELABORATION, MEANS, PREPARATION, CONCESSION, CAUSE, RESULT, ANTITHESIS, CIRCUMSTANCE, CONDITION, EVIDENCE, JUSTIFICATION, MOTIVATION, PURPOSE

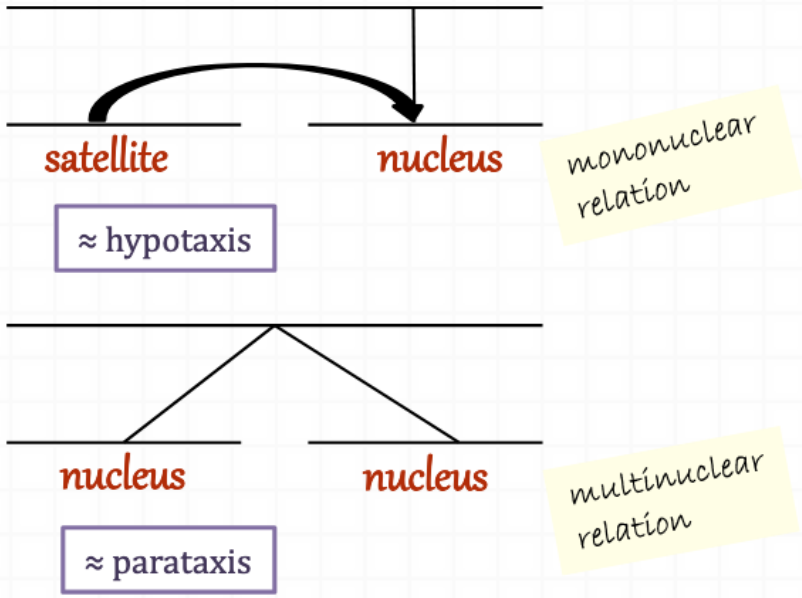
Relations in RST - nuclearity

Coherence relations between discourse segments

- asymmetric ("mononuclear")
  - one nucleus, one satellite
- symmetric ("multinuclear")
  - multiple nuclei



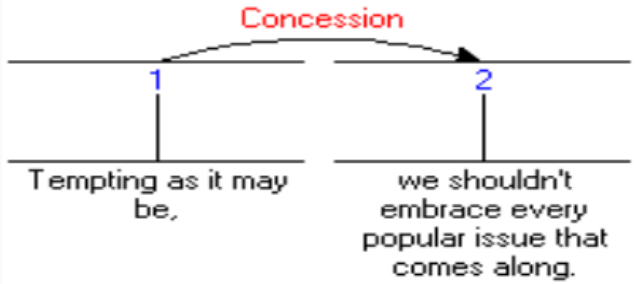
other schemas



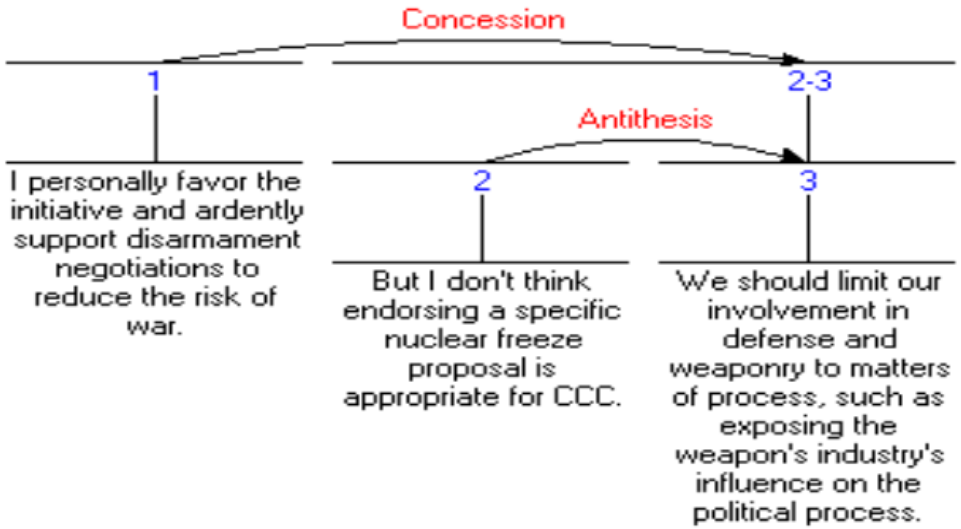
(source: Iruskieta 2016)

Hypotactic (subordinate)

- Sub-sentential Concession relation



- Concession across sentences
  - Nucleus (spans 2-3) made up of two spans in an Antithesis relation

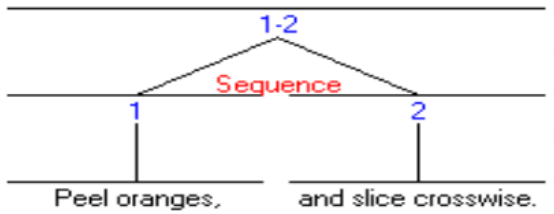


(source: Iruskieta 2016)

Paratactic (coordinate)

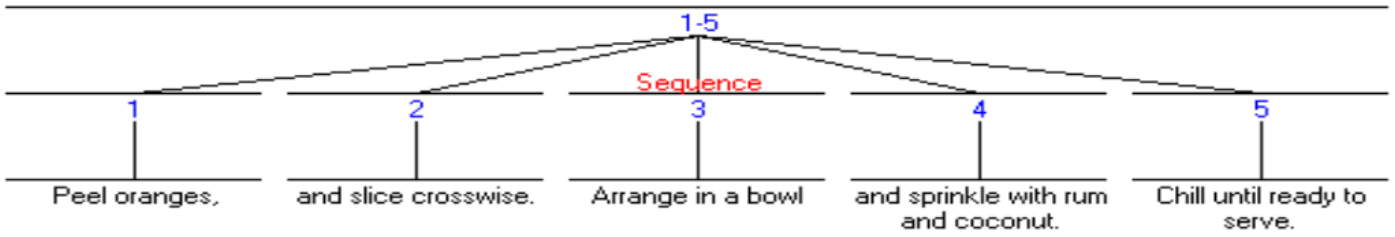
- At the sub-sentential level (traditional coordinated clauses)

  Peel oranges, and slice crosswise.



- But also across sentences

  1. Peel oranges, 2. and slice crosswise. 3. Arrange in a bowl 4. and sprinkle with rum and coconut. 5. Chill until ready to serve.

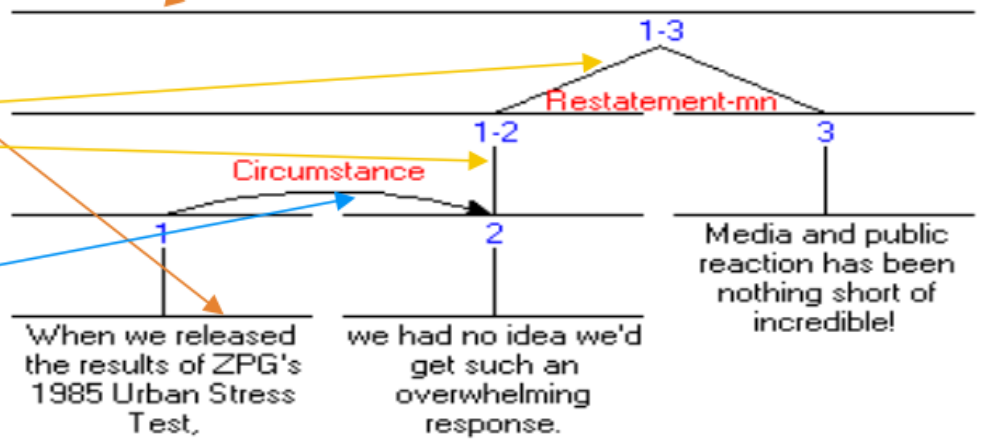


(source: Iruskieta 2016)

Recursive Rhetorical Relations

RST: Graphical Representation

- A horizontal line covers a span of text (possibly made up of further spans)
- A vertical line signals the nucleus or nuclei
- A curve represents a relation, and the direction of the arrow, the direction of satellite towards nucleus

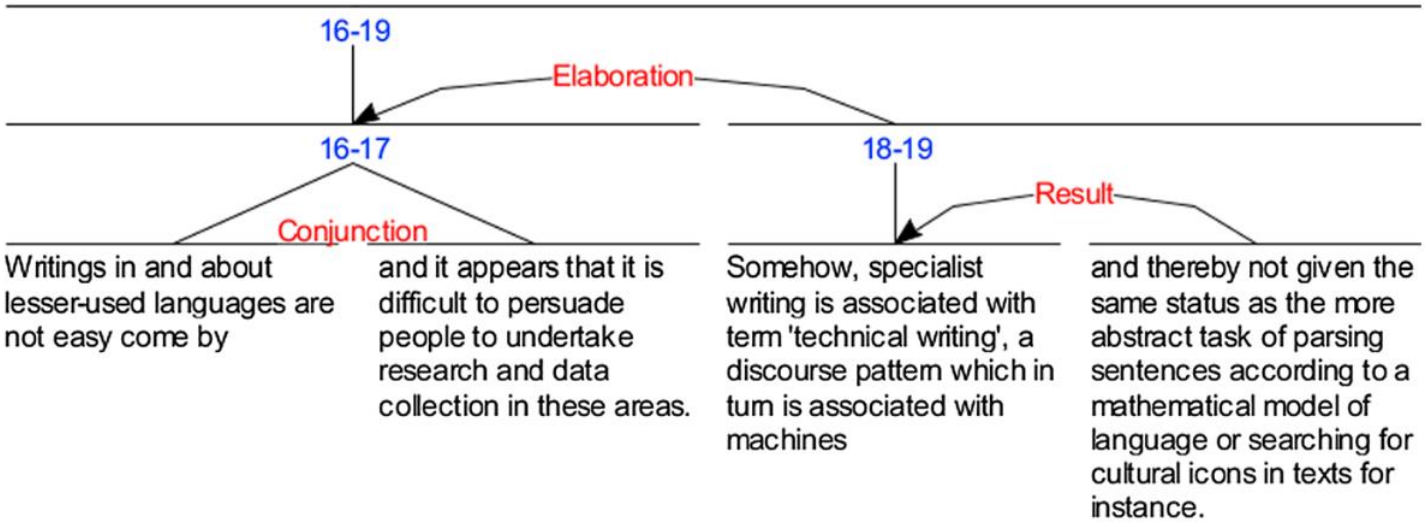


(source: Iruskieta 2016)

RST recursive trees (Iruskieta & al 2013)

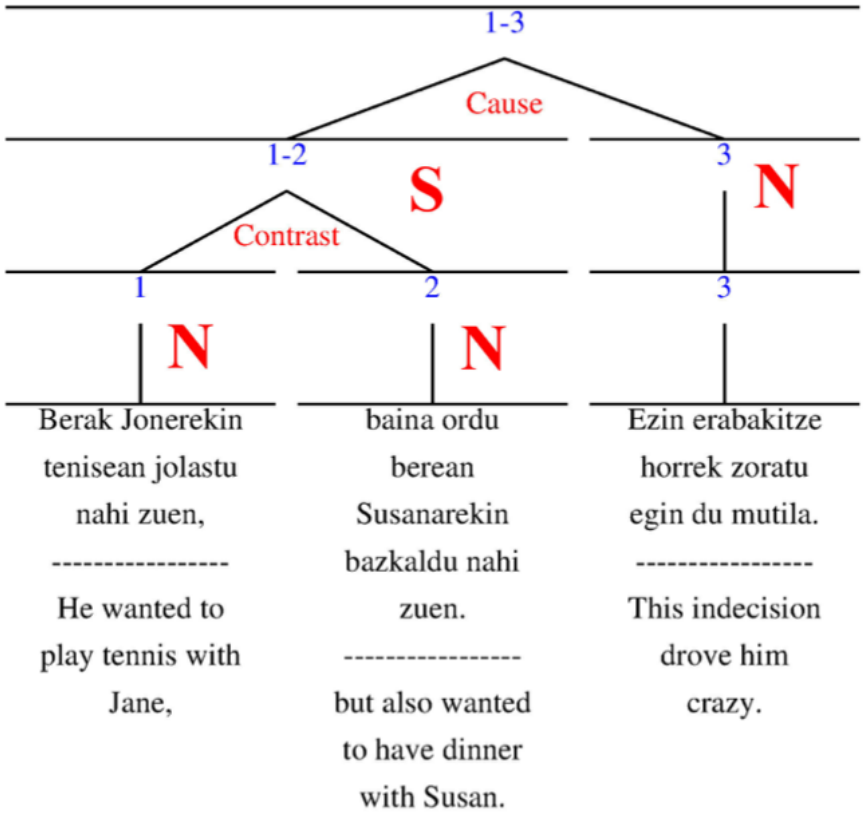
- RST relations are typically represented as trees. Figure 1 shows a fragment of an RST tree, with one multinuclear relation (CONJUNCTION) and two mononuclear relations (RESULT and ELABORATION).
- rhetorical relations are applied recursively, i.e., spans that stand in a relation: 18 and 19 form a new span (18–19) that can enter into new relations, such as the ELABORATION relation. In this case, the annotator labelled this relation as such because the span made up of units 18–19 (satellite) provides additional information about the previous span (16– 17), which constitutes the nucleus of the relation. Following Marcu's (2000b) strong compositionality criteria, the most important units for the 16–19 span are 16 and 17. For the span 18–19 the most important unit is 18.

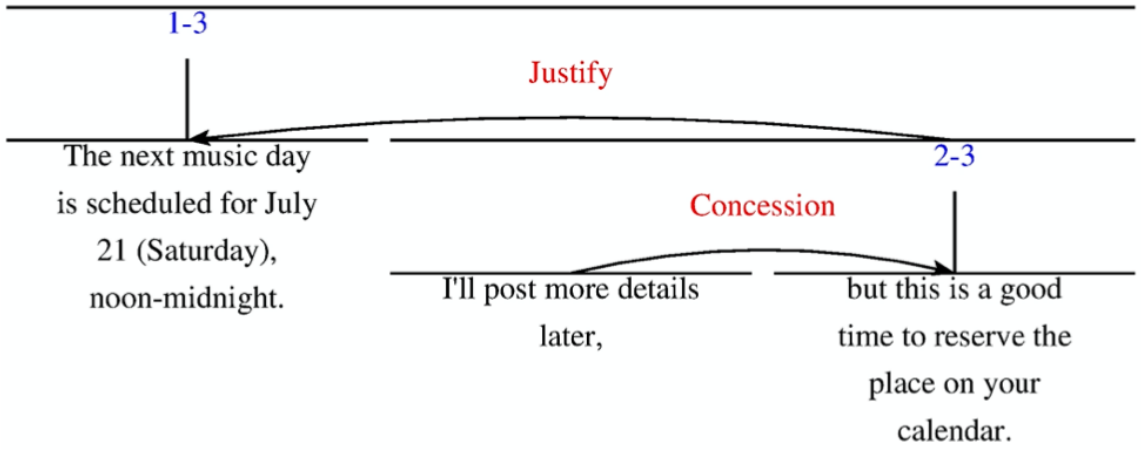
(source: Iruskieta 2016)



Rhetorical relations in RST

S-N relations (nuclear) are represented with arrows in RST





	Const. on *S* or *N*	Constraints on *S* + *N*	Intention of W
Conc.	on N: W has positive regard for N on S: W is not claiming that S does not hold;	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	R's positive regard for N is increased
Just.	none	R's comprehending S increases R's readiness to accept W's right to present N	R's readiness to accept W's right to present N is increased

(source: Iruskieta 2016)

Cross-linguistic similarities

- Some studies have focused on one specific relation and observed the various ways in which it can be signalled across languages
  - Taboada and de los Ángeles Gómez-González (2012) focused on the relation of **concession** in English and Spanish, using the RST framework
  - The relation of concession functions in a very similar manner in English and Spanish, as most of the differences found are linked to the different genres compared in the study (Zufferey & Degand 2024, ch.7, p. 147).

RST corpora

In the RST framework, there are several discourse-annotated corpora available in different languages, such as: English, Spanish, Brazilian Portuguese, German, and Basque, among others. Some of them can be consulted and several tools have been developed for corpus exploration. There is also a small multilingual aligned RST corpus, which can be explored for getting information

- English: https://catalog.ldc.upenn.edu/LDC2002T07
- Multilingual aligned RST corpus: http://ixa2.si.ehu.eus/rst/
- Methods and tools developed to consult the multilingual RST TreeBank
- Applications in NLP (Taboada and Mann, 2006)

RST TB, SFU Corpus (Taboada and Renkema 2011),
RST Spanish TB (da Cunha et al. 2011),
Potsdam Corpus (Stede 2004),
TCC (Pardo and Nunes 2006),
Rhetalho corpus (Pardo and Seno 2005),
spoken corpus (Antonio and Cassim 2012),
Basque RST Treebank (Iruskieta et al. 2013)

(source: Iruskieta 2016)

RST corpora

- RST Discourse Treebank (Carlson et al. 2003)
- RST Signalling Corpus (Das and Taboada 2015)
- Potsdam Commentary Corpus (Stede and Neumann 2014)
  - 220 German newspaper commentaries annotated with different types of linguistic information, including RST
- Discourse Relations Reference Corpus
  - http://www.sfu.ca/rst/06tools/discourse_relations_corpus.html
  - texts from RST web site +annotated Wall Street Journal articles from the RST Discourse Treebank +review texts from the SFU Review Corpus
- GUM - The Georgetown University Multilayer Corpus
  - POS, lemmas, syntax, constituent and dependency syntax, Information status (given, accessible, new)
  - Entity and coreference annotation
- Spanish RST Discourse Treebank (da Cunha, Iria, Juan Manuel Torres-Moreno and Gerardo Sierra 2011)): http://corpus.iingen.unam.mx/rst/
- Basque RST Discourse Treebank (Iruskieta et al.): http://ixa2.si.ehu.es/diskurtsoa/en/
- Multiling RST Treebank (English, Spanish and Basque): http://ixa2.si.ehu.es/rst

NLP applications based on RST

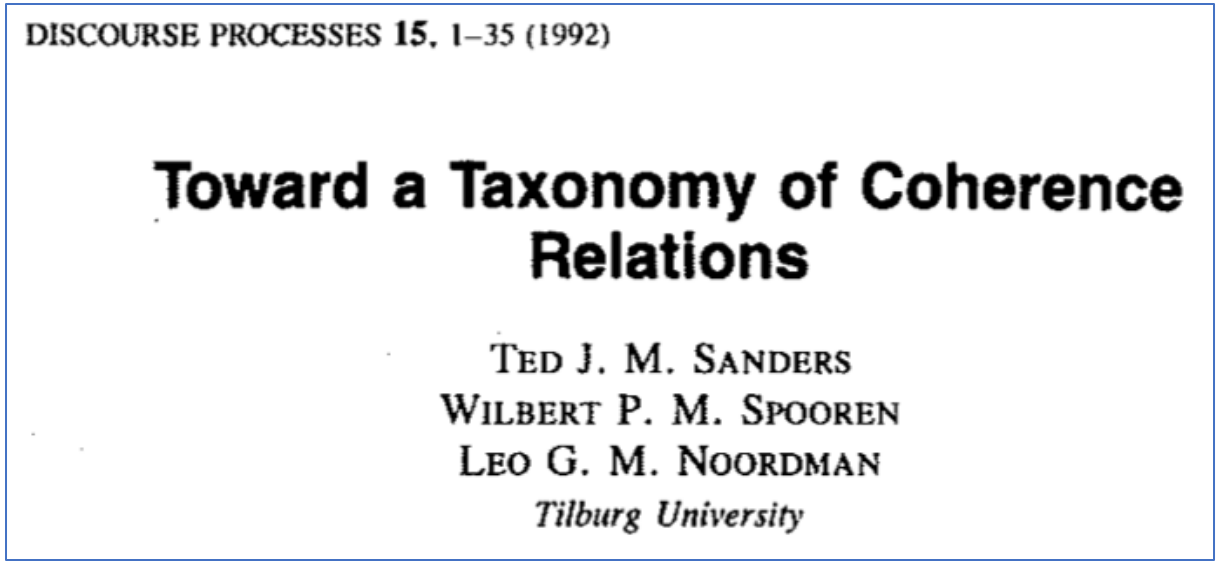
- − Automatic text creation (Bouayad-Agha, 2000; Agirrezabal et al., 2015),
- − Automatic text summarization (Marcu, 2000b; Zipitria et al., 2013),
- − Machine translation (Ghorbel et al., 2001),
- − Assessment of written texts (Burstein et al., 2003),
- − Information retrieval (Haouam and Marir, 2003),
- − Automatic Discourse Analyzer (Pardo and Nunes 2008; Soricut and Marcu 2003)
- − Question answering (Bosma, 2005)
- − Polarity extractor (Alkorta et al., 2015)

RST done!

B2. CCR

Cognitive approach to Coherence Relations

(Sanders & Spooren 2001, 2009, Original proposal: Sanders, Spooren & Noordman 1992, 1993)



DISCOURSE PROCESSES 15, 1–35 (1992)

Toward a Taxonomy of Coherence Relations

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CCR (Cognitive approach to coherence relations)

Sanders, T. J. M., W. P. M. Spooren, and L. G. M. Noordman (1992). **Toward a taxonomy of coherence relations**. Discourse Processes 15, 1–35.

coherence relations are considered as cognitive entities (coherence relations and their linguistic marking affect the cognitive representation of discourse, e.g. text understanding, they are psychological entities rather than merely an analytic tool)

Proved by series of psycholinguistic experiments (Spooren, 1989; Haberlandt, 1982; Sanders 1986, e.g. linguistic marking appears to lead to faster processing of the following discourse segment).

Requirements to a theory of discourse structure

Ted Sanders (1992)

A satisfying theory of discourse structure should meet

DESCRIPTIVE ADEQUACY

A theory discourse structure makes it possible to describe the structure of all kinds of natural texts.

PSYCHOLOGICAL PLAUSIBILITY

A theory of discourse structure should at least generate plausible hypotheses on the role of discourse structure in the construction of the cognitive representation.

(it should make sense) ☺

2. CCR: A cognitive approach to coherence

- CCR: psychologically plausible theory of d-structure
- Relations are not merely an analytical tool for a discourse analyst but are motivated for cognitive processes and representations (Sanders, Spooren & Noordman 1992)
- The goal is to describe the link between:
  - the discourse as a linguistic object and its cognitive representations
  - the cognitive processes of production and understanding
- The essential property of coherence relations is that they establish coherence in the cognitive representation people have or make of a discourse
- Underlying assumption: coherence relations are cognitive, psychological constructs that language users make use of when interpreting text and not just descriptive constructs created by linguists.
- Understanding discourse means constructing a coherent representation of that discourse.

Cognitive implausibility of CR taxonomies

- From a psychological point of view, Mann & Thompson's ideas are not convincing, because they assume that all relations are cognitively basic:
- it is cognitively implausible that speakers have knowledge of all the relations that have been proposed,
  - If, e.g, a relation like EVIDENCE occurs in a discourse, people interpret the discourse by referring to the cognitively basic notion of the evidence relation

CCR: Background

- A major aim of CCR is not to develop a complete and descriptively adequate taxonomy to annotate corpus data, as in RST,
- but to provide a framework of coherence relations explaining differences and similarities between them in cognitive terms
- **informational surplus:** observation that a discourse relation provides more information than the two related segments in isolation.
- This supplementary information can be categorized into four dimensions
  - when put together, they constitute the meaning conveyed by each discourse relation

Set of primitives vs. Set of relations

- The idea was to go beyond a simple list of discourse relations, and to decompose each of them into a set of primitives.
  - This decomposition was meant to account for all possible cases in terms of basic cognitive principles such as causality. (Zufferey & Degand 2024:ch2)
- It is more attractive to assume that speakers generate the set of coherence relations by combining the members of a set of four primitive cognitive categories:
  - (i) basic operation (causal or additive);
  - (ii) source of coherence (semantic or pragmatic);
  - (iii) polarity (negative or positive);
  - (iv) order of segments (basic or non-basic).

Four primitives in CCR

- Sanders et al. (1992, 1993) distinguish four cognitive primitives that they claim to be relevant for every coherence relation:

1. **Basic Operation:** additive (a) or causal (b)
   - (a) John is ill. Pete does not feel well either.
   - (b) John is ill. He had bad beef for dinner.
2. **Source of Coherence:** semantic/objective (c, d) or pragmatic/subjective (e)
   - (c) John is ill. His mother called this morning.
   - (d) Theo was exhausted because he had run to the university.
   - (e) Theo was exhausted because he was gasping for breath.
3. **Polarity:** Positive (f) – negative (g)
   - (f) Jan is ill. He looks unhealthy.
   - (g) Although Greta Garbo was called the yardstick of beauty, she never married.
4. **Order of the segments:** Basic (h) – non-basic order (b)
   - (h) John is ill. So he won't be at work.

Advantages of CCR framework

- the set of coherence relations is ordered and the readers use their knowledge of a few cognitively basic concepts to infer the coherence relations
  - A relation like *evidence* (Claim-Argument) is regarded as composite, analyzed as a set of more elementary notions
  - ➢ More economic theory of the role of coherence relations in discourse understanding
- meant to account for the polyfunctionality of some connectives, and showing that their various senses shared some elements in their primitives
  - **AND** can be used to convey additive or causal relations but never concessive ones can be accounted for by the basic difference of polarity between positive and negative relations

CCR (Sanders et al.)

Four cognitive primitives

1

0 basic operation (Additive – Temporal – Causal / Conditional)

There was a lot of rain. Later, storms came in.

P **Q**

P, later Q

temporal

originally (Sanders et al. 1992) only additive (weakly connected) vs. causal (strongly connected) were distinguished

She got wet and her friend got wet too.

P **Q**

P & Q

additive

She got wet because it rained.

Q **P**

P → Q

causal

Basic operation

- Basic operation separates causal from additive relations.
  (a) Ann is happy because she won the competition
  (b) Elsa is very good at math and she won a swimming competition.
  - On the one hand, **causal** relations have an implicational order between the segments, as in (a) where the fact of winning the competition implies the state of happiness.
  - **conditional** relations also have an implicational order, but the difference between them is the status of the cause (hypothetical or real).
  - On the other hand, **additive** relations do not have an implicational order, but are simply linked by a logical conjunction, as in (b).
- In addition to additive relations, **temporal** relations of sequence (conveyed by connectives like **and then**) or temporal overlaps (conveyed by connectives like **meanwhile**) are also linked by a conjunction rather than an implication. But contrary to additive relations, they are also temporally ordered.

CCR (Sanders et al.)

Four cognitive primitives

2

- 0 basic operation (Additive – Temporal – Causal / Conditional)
- 0 **source of coherence (semantic/ pragmatic)**

semantic (objective)

She got wet because it rained.

Q locutions P

A relation is objective (semantic) when both segments happen in the real world and are thus facts. The speaker's opinion is not reflected in the relation.

She is not at home, because her car is not there

Q illocutions P

pragmatic (subjective)

A relation is subjective (pragmatic) if one or both segments express an opinion, argument, claim or conclusion of the speaker.

Source of coherence

- The source of coherence separates the objective from subjective relations (originally called “semantic” and “pragmatic” relations in Sanders, Spooren and Noordman (1992)
- This dimension separates subjective relations such as EVIDENCE and JUSTIFICATION from objective ones such as TEMPORAL SEQUENCE or CAUSE-CONSEQUENCE.
  - Objective relations are connected at the level of their propositional content, or in other words they concern real-world events not constructed by the speaker:

  (a) The door slammed because there was strong wind outside.

  - In subjective relations, the speaker is actively involved, as it presents a reasoning or speech act that they perform in one or both segments,

  (b) The neighbours must be on holiday, because their lights are always out.

Source of coherence: subjective vs. objective (Langacker 2000; Pander Maat & Sanders 2000)

Objective

a. Jan turned on the lights. It was getting dark.
b. It was getting dark. The sun was setting.
• Speaker just reports the causal relation

Subjective

c. Could you turn on the lights? It is dark in here.
d. The neighbors are not at home. Their lights are out.
• Subject's "mind" constructs causal relation
• Subject of consciousness=Speaker-here-and-now or actor

CCR (Sanders et al.)

Four cognitive primitives

3

- 0 basic operation (Additive – Temporal – Causal / Conditional)
- 0 source of coherence (semantic/ pragmatic)
- 0 **order of segments (basic/non-basic)**

Although he worked hard, he failed the exam.

P Q

A relation with a basic order has an antecedent, followed by a consequent. The antecedent is the cause of the argument, the consequent is the consequence or the claim.

basic

She got wet because it rained.

Q P

non-basic

A relation with a non-basic order has a consequent which precedes the antecedent. The cause or the claim thus precedes the cause of the argument.

Temporality and order of segments

- When there is a temporal order,
  - it can either be chronological when the first event chronologically is presented before the second one:

  (a) Sam had his breakfast and then he left for work.

  - or anti-chronological when the second event is presented before the first one:

  (b) Sam left for work after taking his breakfast.

CCR (Sanders et al.)

Four cognitive primitives

4

- basic operation (Additive – Temporal – Causal / Conditional)
- source of coherence (semantic/ pragmatic)
- order of segments (basic/non-basic)
- **polarity (positive/negative)**

She got wet because it rained.

S_1=Q S_2=P

positive

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.

Although he worked hard, he failed the exam.

not-S_1=P not-S_2=Q

negative

A relation is negative if not S_1 and S_2, but their negative counterparts, not-S_1 and not-S_2, function in the basic operation.

Polarity

- **Polarity** separates positive from negative relations.
- A positive relation functions between the content of the two related segments.

  (a) Ann is happy because she won the competition.

  link between the fact of winning the competition and the state of happiness.

  Typically, such relations are conveyed by connectives like **and** or **because**.
- A relation is negative if it holds between a negated version of one segment

  (b) Ann is happy but she lost the competition.

  in (a), Ann's happiness leads to an expectation that something positive happened to her, but this expectation is denied in the second segment.
- The dimension of polarity separates negative relations as ADVERSATIVE, CONCESSIVE and CONTRASTIVE from those with a positive polarity.

Causality, polarity, order

- The criterion of causal vs. additive link also applies to negative relations. For example, the relation of concession in (a) implies the negation of a causal link, whereas the relation of contrast in (b) does not.

  (a) Ann is happy but she lost the competition.

  (b) Elsa is very good at math but her sister is not.

- In relations that involve an implicational link between the segments, this link can be conveyed in basic order as in (c) or in non-basic order as in (d).

  (c) Peter was tired so he went home early.

  (d) Peter went home early because he was tired.

  - Relations with a basic order present the information in the text following the order of the implication, for example, with the antecedent in the first segment and the consequent in the second segment, as in (c).
  - The order is reversed in non-basic relations like (d), where the consequent is presented first and the antecedent second in the text.

Basic operation	Source of coherence	order	polarity	Type of relation
causal	semantic	Basic	positive	1. Cause-consequence
				2. Condition-consequence
	semantic	basic	negative	3. Contrastive cause-consequence
	semantic	Non-basic	positive	4. Consequence-cause
				5. Consequence-condition
	semantic	Non-basic	negative	6. Contrastive consequence-cause
	pragmatic		positive	7. Argument-claim
				8. Condition-claim
	pragmatic		negative	9. Contrastive argument-claim
	pragmatic	Non-basic	positive	10. Claim-argument
				11. Claim-condition
	pragmatic	Non-basic	negative	12. Contrastive claim-argument
additive	semantic		positive	13. List
	semantic		negative	14. Opposition
				15. Exception
	semantic		positive	16. Enumeration
	semantic		negative	17. Concession

CCR vs. RST

	CCR (Sanders & al 1992)	RST (Mann & Thompson 1988)
Coherence relations	Composite (set of elementary features)	Basic, elementary
	ordered	arbitrary
	Generated via cognitive primitives	Tools for annotators
Theoretical model's goals	Cognitive plausibility	Descriptive adequacy
	Cognitive representation of discourse	Annotation of discourse/text
	economy	exhaustiveness
Discourse connectives	polyfunctional	Monofunctional (no focus on DCs)
End result for CRs	17	78

Cognitive plausibility

- the CCR framework places a lot of weight on **cognitive validity**
- The validation of these 4 primitives as cognitively basic notions, is shown on the basis of **converging evidence** from psycholinguistic studies, which have found evidence in favor of this model
- For each dimension, one of the two possible values is deemed to be cognitively more complex than the other :
- hence, the primitives affect language **processing** (how readers process discourse relations) and **acquisition** (order in which children acquire them), (a.o. Bloom et al., 1980, Sanders 1997; Noordman & Vonk 1998; Sanders & Noordman 2000, Sanders & Spooren 2009; Evers-Vermeul & Sanders 2009, 2011; Canestrelli, Mak & Sanders 2013; Li, Mak, Evers-Vermeul & Sanders, to appear):

Cognitive plausibility

- Constructing a **causal** relation is a more complex cognitive procedure than merely **conjoining** segments,
  - it implies constructing an implicational order, often based on world knowledge.
- Inferring a **subjective** relation is more complex than an **objective** one
  - it requires the ability to infer the mental states of the speaker (Zufferey, 2010), an ability known in cognitive psychology as having a theory of mind.
- having to infer a **non-basic order** relation is more complex than a **basic-order** one, and a non-chronological temporal relation is more complex than a chronological one,
  - because in such cases, the chronological or implicational order of the relation reverses the order of presentation in the text.

Psycholinguistic validity

- In the domain of **language processing**, cognitively simpler relations are processed more quickly compared to more complex ones.
  - **causal** relations are processed more quickly compared to **concessive** relations (Köhne & Demberg, 2013),
  - **objective** causal relations are processed more quickly than **subjective** ones (Canestrelli, Mak & Sanders, 2013),
  - causal relations with a **basic order** are processed more quickly than those with a **nonbasic** order (Noordman & de Blijzer, 2000).
- In the field of **language acquisition**, children start producing cognitively simpler relations before more complex ones:
  - Produce **additive and causal** relations before **concessive and adversative** relations (Evers-Vermeul & Sanders, 2009),
  - master **objective** relations before **subjective** ones (Zufferey, 2010; Evers-Vermeul & Sanders 2011),
  - understand temporal relations in **chronological** order better than in **antichronological** order (Pyykkönen and Järvikivi 2012)

Flowchart of CCR (Scholamn, Evers-Vermeuil & Sanders 2010)

- CCR has been used successfully to help nontrained and nonexpert annotators annotate coherence relations using a stepwise approach corresponding to the different dimensions of this model (Scholman, Evers-Vermeul & Sanders, 2016).
- The four primitives can be represented in a flowchart, which can be used for annotating discourse and allows for a systematical, step-wise decision-making process (Figure 1)
- Starting with a discourse relation, the first step in the annotation process is determining the **polarity**. The category of negatives differs greatly from that of positives; therefore this step is the first one in the flowchart.
- Second, the **basic operation** has to be decided upon. For positive relations, this can be causal, causal-conditional, additive or temporal. For negative relations, this basic operation can be divided into the categories causal and non-causal (any negative relation that is not causal). This step is taken as the second step because the remaining two steps are not applicable to every relation.
- The third step is determining the **source of coherence**, which consists of the same two categories for all relations (objective and subjective), except for temporal and non-causal relations. Because temporal relations are made up of a description of two events that are ordered in time, this type of relation is always objective.
- The final step concerns the **order**, which can be basic or non-basic. The order is not applicable for additive and non-causal relations, since the two segments in such relations are logically symmetric, and for temporal relations in which the segments describe events that occur simultaneously.

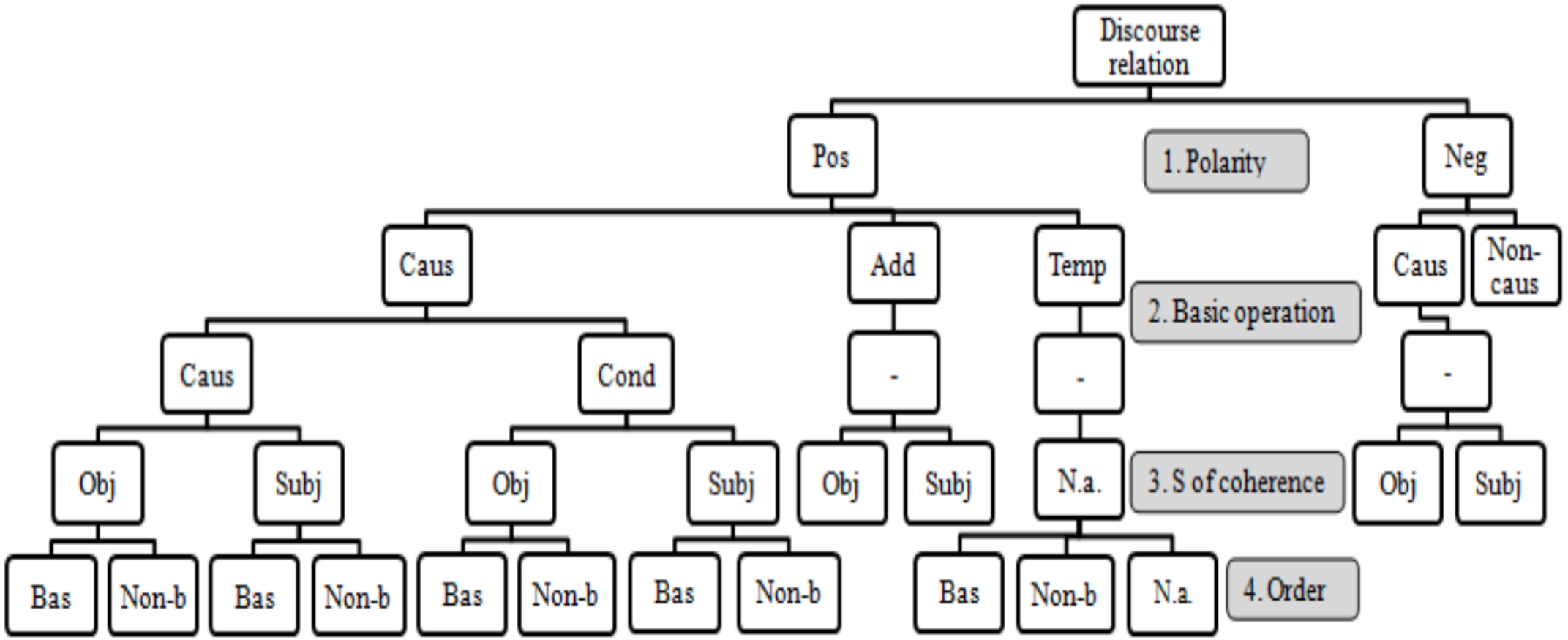


Figure 1. Flowchart of the step-wise annotation instruction.

Advantages of CCR instead of label classification (Scholman & al 2010)

- The four primitives make the discourse annotation less complex because they allow for a step-wise annotation:
  - coherence relations are broken up into several characteristics vs. defining the relations in terms of end labels.

    Although the legality of these sales is still an open question, the disclosure couldn't be better timed to support the position of export-control hawks in the Pentagon and the intelligence community.

    - **ANTI-THESIS** relation (RST manual): specific kind of contrast in which one cannot have a positive regard for both of the situations described (Carlson & Marcu, 2001: 45).
    - The coherence relation is **causal** (rather than temporal or additive), it is **negative** (rather than positive), and it involves the speaker's reasoning and is therefore **subjective** (rather than objective).

Advantages of CCR instead of label classification (Scholman & al 2010)

- shows links between conceptually related relations, using their similarities as well as differences, as for contrastive (a) and (b), both negative and contrastive:
  - End labels divide these related relations into separate classes, without acknowledging their conceptual relatedness, as (a) and (b) are assigned different labels in PDTB model
  - (a) Operating revenue rose 69% to $8.48 billion from $5.01 billion. **But** the net interest has jumped 85% to $687.7 million from $371.1 million. COMPARISON
  - (b) (The biotechnology concern said) Spanish authorities must still clear the price for the treatment **but** that it expects to receive such approval by year-end. EXPANSION

CCR done!

B3. SDRT

SDRT

- Segmented Discourse Representation Theory (SDRT), developed in the 1990s (Asher, 1993; Lascarides & Asher, 1993) based on two different trends of research from the 1980s:
  - Discourse Representation Theory (Kamp & Reyle, 1993)
    - formal semantics model accounting for discourse phenomena such as anaphoric relations
  - Theories of discourse structure with applications to computational linguistics
    - Rhetorical Structure Theory
    - Centering Theory (Grosz & Sidner, 1986)
- Attempts to keep the formal rigor of DRT while using the notion of discourse relation
  - developed to provide means to incorporate discourse relations into a logical representation of discourse
  - link the occurrence of discourse relations with other discourse phenomena such as the use of pronouns

Temporal interpretation of discourse

- Max opened the door. The room was pitch dark.
- Max switched off the light. The room was pitch dark.
- similar grammatical structure: past tense, punctual event+stable state of affairs
  - But difference in processing
- How to differentiate between these two situations?
  - No means in DRT

Temporal interpretation of discourse

- Need of information on the type of discourse relation between the two sentences

  Max opened the door. The room was pitch dark.

  - S2 covers the whole event of S1
  - Relation of **Background**

  Max switched off the light. The room was pitch dark.

  - S2 happens only after S1
  - Relation of **Result**

Two types of analyses of discourse structures

- **Bottom-up**: local relations
  - from minimal discourse units – linking them with discourse relations in a recursive fashion – embedding relations in one another
  - A bottom-up annotation of elementary and complex discourse units linked by discourse relations can be found in ANNODIS corpus
- **Top-down**: global structures
  - look for global textual coherence before assigning local links between sentences,
  - focus first on global structures such as thematic continuity or discontinuity rather than more local discourse relations
  - starting from full discourse structure and identifying signals of global text organization
  - a top-down annotation of high-level structures such as enumerative structures and topical chains, in line with the two types of discourse structures identified in SDRT can be found in ANNODIS corpus

Discourse relations: 2 parameters

- **Grammatical criterion**
  - horizontal relations between coordinated segments
  - hierarchic relation with a subordinate clause
- **Veridicality:**
  - veridical relations that entail the content of their arguments
  - nonveridical relations that do not entail the content of at least one of the arguments.

14 relations for written texts

Coordinating relations		Subordinating relations	
Veridical	Nonveridical	Veridical	Nonveridical
Continuation	Consequence	Background	Attribution
Narration	Alternation	Elaboration	
Result		Explanation	
Contrast		Commentary	
Parallel		Source	
Precondition			

Semantic characterization of relations

- Relations are described in relation to one another
  - it can be verified whether two relations are the same, if one of them entails the other, or if they are incompatible.
    - Entailment of TEMPORALITY from EXPLANATION.
- Explanation(α, β) holds when the main eventuality of β is understood as the cause of the eventuality in α.
- Explanation has temporal consequences, viz. that the eventuality described in β precedes (or overlaps) the eventuality described by α

Relations and connectives in SDRT

- Relations are defined independently of discourse connectives and other markers
  - Which can be ambiguous, but are still potential indicators of a relation,
  - The strength of each signal is also indicated
    - "**Because** is a monotonic cue for Explanation. '**After**', '**when**' sometimes signal Explanation"
- Several relations can be presented simultaneously between two discourse segments (contra RST),
  - contrast and narration: John gave Mary a book, **but then** he took it back.

Structure of discourse

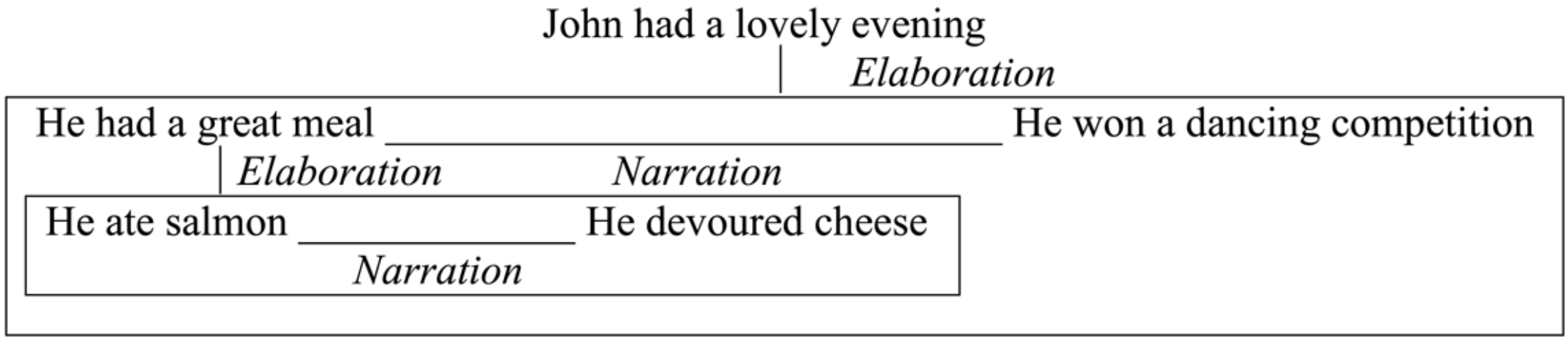
- the structure of discourse takes the form of graphs rather than trees
  - => Possibility of having attachments between parts of texts that are not contiguous
- Contra RST or PDTB, where implicit relations are annotated only between adjacent segments
  - part of the existing relations within a text are missed

Contrast (1, 3)

- [In 1988, Kidder eked out a $ 46 million profit,]$_1$ [mainly because of severe cost cutting.]$_2$ [Its 1,400-member brokerage operation reported an estimated $5 million loss last year,]$_3$ [although Kidder expects to turn a profit this year]$_4$.

Graph structure

1. John had a lovely evening. 2. He had a great meal. 3. He ate salmon. 4. He devoured cheese. 5. He won a dancing competition.



Applications

- SDRT analyses have been implemented in a large corpus of French written texts: the ANNODIS corpus (Reese et al., 2007; Afantenos et al., 2012).
  - multi-genre: news, encyclopedia articles, linguistics research papers, and international relations reports.
- ANNODIS is a useful resource
  - to compare the frequency of different relations across genres,
  - to link the occurrence of discourse relations with other discourse phenomena such as the use of pronouns.
  - To show how relations are realized in discourse and identify all the different linguistic forms that can be used to signal each relation
    - contrary to models that start from markers as a way to identify relations
  - For NLP applications: To be used as training for systems dealing with discourse structure prediction, discourse parsing, relation labeling and sentiment analysis.

SDRT done

B4. PDTB
(Penn Discourse TreeBank)

PDTB – Authors

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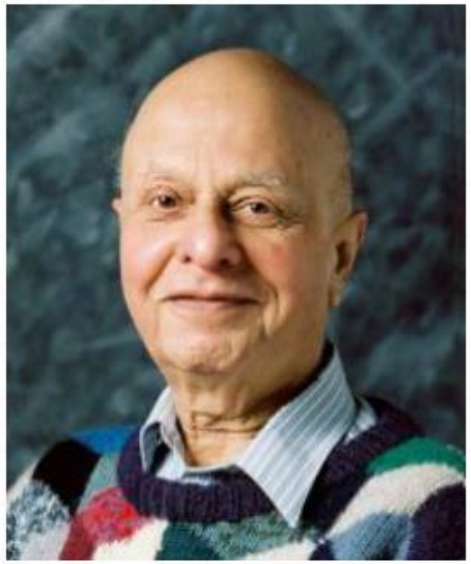

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Penn Discourse Tree Bank (PDTB)

- History
  - PDTB 1.0 – 2004 (Miltsakaki et al., 2004, LREC Portugal)
  - PDTB 2.0 – 2008 (Prasad et al., 2008, LREC Morocco)
  - PDTB 3.0 – 2019 (UPenn, University Wisconsin-Milwaukee)
- Important literature:
  - The PDTB research group: The PDTB 2.0 Annotation manual, 2007.
  - Prasad et al. 2008: The Penn Discourse Treebank 2.0, LREC, Morocco.
  - R. Prasad, B. Webber and A. Joshi. 2014. Reflections on the Penn Discourse TreeBank, Comparable Corpora and Complementary Annotation. In: Computational Linguistics 40:921–950

PDTB background

- Provides a discourse-layer annotation over the million words Wall Street Journal Corpus (Webber et al., 2006).
- PDTB provides the most extensive resource of annotated connectives available.
  - manually annotated senses for about 100 types of (explicit) connectives
  - 2.0 version (Prasad et al. 2008), 18 000 explicitly and 16 000 implicitly signaled relations.
  - PDTB-3 version (2019), + 17000 new relations added.
- Goals: To annotate a large-scale corpus of discourse relations to:
  - Extend the scope of discourse-level NLP research and resulting applications;
  - Facilitate cross-linguistic empirical research on discourse relations

PDTB background

- Lexically grounded: relations anchored by lexical items
  - Premise: The meaning and coherence of a discourse results partly from how its constituents relate to each other.
  - Relations are intrinsically linked to connectives (explicit or implicit) and other signals that can be used to express them.
  - PDTB annotation does not cover the relations conveyed by other means than connectives, contrary to RST- and SDRT- annotations, which include all relations, independently of its marking
- Low-level: “Shallow” or “local” discourse analysis: does not aim at building global discourse structures beyond the linking of arguments by connectives
  - Lack of agreement on high-level discourse representation structures (trees, graphs…)
- Theory-neutral: A major specificity of PDTB framework is that it is not tied to any theory
  - Allows corpus to be usable with different frameworks and easily merged with other annotations;
  - allows for data-driven “emergent” theory of discourse structure.

Lexically grounded approach to discourse

- Given the importance of discourse connectives in this framework, a crucial aspect of the project was to define them in such a way as to label as many different relations as possible, while separating them clearly from neighboring classes.
  - The same two discourse segments could be annotated with more than one discourse relation,
    - for example, when the connective had multiple senses
    - or when the relation was implicit and the annotators inferred more than one relation between them.
- This enabled the authors to identify the most recurrent cases of double relations.

What is annotated in PDTB?

- Discourse connectives "but, then, for example, although…"
  - A discourse connective is a discourse-level predicate taking two (and only two) text units (abstract objects) as its arguments:
    - subordinating conjunctions (e.g. *since*, *although*, *because*),
    - coordinating conjunctions when they are used to relate two clauses (e.g. *and*, *or*, *nor*) vs. (4)
    - prepositional phrases/adverbials (as a result, in comparison, *however, for example,* etc.);
    - adverbs (then, instead, yet, etc.).

1. The federal government suspended sales of U.S. savings bonds ***because*** Congress hasn't lifted the ceiling on government debt.
2. The House has voted to raise the ceiling to $3.1 trillion, ***but*** the Senate isn't expected to act until next week at the earliest.
3. Working Woman, with circulation near one million, and Working Mother, with 625,000 circulation, are legitimate magazine success stories. The magazine Success, ***however,*** was for years lackluster and unfocused.

What else is annotated in PDTB?

- In the PDTB-3 version, the list of connectives has been enlarged to include **prepositional subordinators** like *for*, *with*, *instead of*, etc. that can also complementize for clauses.
- **Implicit connectives**: cases where no connective was used in the text, but the annotator judged that there was still a discourse relation that could be inferred between two adjoining text segments, and that this link could be adequately expressed by a connective.
  - In such cases, they insert this connective, counted as an implicit connective.

Some have raised their cash positions to record levels. [Implicit = **because**] High cash positions help buffer a fund when the market falls.

What else is annotated in PDTB?

- Annotation of alternative lexicalizations or AltLex
  - But a strong level of investor withdrawal is much more unlikely this time around, fund managers said. **A major reason** ~~(+ BECAUSE)~~ is that investors have already sharply scaled back their purchases of stock funds since Black Monday.
  - A few years ago, the company offered two round-trip tickets on Trans World Airlines to buyers of its Riviera luxury car. The promotion helped Riviera sales exceed the division's forecast by more than 10%, Buick said at the time
- Annotation of entity-based coherence: S2 extends the information about the entity in S1
  - **Hale Milgrim, 41 years old**, senior vice president, marketing at Elecktra Entertainment Inc., was named president of …

What is not annotated in PDTB?

- Coordinating conjunction relating two noun phrases instead of two clauses :
  a. Dr. Talcott led a team of researchers from the National Cancer Institute ***and*** the medical schools of Harvard University and Boston University.
- Clausal adverbials such as *strangely* and *probably* with non-connective function which only take one abstract object as argument instead of two (b):
  b. John is very clever. He will *however/probably* not get the job.
  vs. Connective function of adverbial: concession relation between two distinct abstract objects.
  c. John is very clever. He will get the job.
- Cue phrases like *well* and *so* in the sentence initial position that are used for functions like topic shifts rather than for the communication of discourse relations,
- Discourse markers like *actually* and *you know* have not been annotated either, as their role is not to relate two abstract objects but to "signal the organizational or focus structure of the discourse.

The PDTB-2 hierarchy of discourse relations

1. **Temporal**
   - synchronous
   - asynchronous
     - precedence
     - succession
2. **Contingency**
   - cause
     - reason
     - result
   - pragmatic cause
     - justification
   - condition
     - hypothetical
     - general
     - unreal past
     - unreal present
     - factual past
     - factual present
   - pragmatic condition
     - relevance
     - implicit assertion
3. **Comparison**
   - contrast
     - opposition
     - juxtaposition
   - pragmatic contrast
   - concession
     - expectation
     - contra-expectation
   - pragmatic concession
4. **Expansion**
   - conjunction
   - instantiation
   - restatement
     - specification
     - equivalence
     - generalization
   - alternative
     - conjunctive
     - disjunctive
     - chosen alternative
   - exception
     - list

The list of senses from the PDTB-2 version is described in the annotation manual (PDTB Research Group, 2008) and early experiments with sense annotation are reported in Miltsakaki et al. (2008).

Taxonomies in Version 2 vs. 3

- The list of discourse relations included in the PDTB takes the form of a hierarchy encompassing three different levels.
  - This list has evolved between the PDTB-2 and PDTB-3 releases.
- In PDTB-3, Level-3 is used only for relations that can have a different directionality.
  - In other words, one or the other argument linked by the connective can take on a specific role, for example, conveying the goal or the cause segment.
  - Version 2 used this level to make more fine-grained distinctions between sub-types of relations.
- In the current version, all relation types can be found at Level-2, whereas Level-1 merely categorizes these relations into four main families.

The PDTB-3 hierarchy of discourse relations

Temporal	Synchronous	–
	Asynchronous	Precedence
		Succession
Contingency	Cause	Reason
		Result
		Neg-Result
	Cause+Belief	Reason+Belief
		Result+Belief
	Cause+SpeechAct	Reason+SpeechAct
		Result+SpeechAct
	Condition	Arg-1-as-Cond
		Arg-2-as-Cond
	Condition+SpeechAct	–
	Negative Condition	Arg-1-as-NegCond
		Arg-2-as-NegCond
	Negative Condition+SpeechAct	–
	Purpose	Arg-1-as-Goal
		Arg-2-as-Goal
Comparison	Concession	Arg-1-as-Denier
		Arg-2-as-Denier
	Concession+SpeechAct	Arg-2-as-Denier +SpeechAct
	Contrast	–
	Similarity	–
Expansion	Conjunction	–
	Disjunction	–
	Equivalence	–
	Exception	Arg-1-as-Excpt
		Arg-2-as-Excpt
	Instantiation	Arg-1-as-Instance
		Arg-2-as-Instance
	Level-of-detail	Arg-1-as-Detail
		Arg-2-as-Detail
	Manner	Arg-1-as-Manner
		Arg-2-as-Manner
	Substitution	Arg-1-as-Subst
		Arg-2-as-Subst

Corpora inspired by the PDTB annotation (Nedoluzko 2016)

- The BioDiscourse Relation Bank (BioDRB, Prasad et al., 2011) – **English**
- **Hindi** Discourse Relation Bank (HDRB, Kolachina et al., 2012, Oza et al. 2009)
- The Leeds **Arabic** Discourse Treebank (Al-Saif and Markert, 2010)
- PDTB-style annotation of **Chinese** (Zhou and Xue, 2012)
- **Turkish** Discourse Bank (Zeyrek et al., 2010)
- Prague Dependency Treebank 3.0 (Bejček et al., 2013) – **Czech**
- LUNA: PDTB-style annotation of **Italian** spoken dialogs (Tonelli et al., 2010)
- Potsdam Commentary Corpus (Stede 2004, Stede and Neumann 2014) – **German**
- **French** Discourse Treebank (Danlos et al. 2012)
- Tüba-D/Z Treebank (Gastel et al 2011, Versley and Gastel 2012) – **German**

Cross-linguistic similarities

- The relations from PDTB-3 have also been used in an ongoing effort to put together lexicons of connectives from different languages (Stede, Scheffler & Mendes, 2019)
  - A multilingual annotation experiment conducted by Zufferey and Degand (2017) indicates that similar discourse relations hold across languages
    - Dutch, English, French, German, and Italian
    - They found that the framework could be used in all of them with only minimal changes (Zufferey & Degand 2024, ch.7:146).
      - For instance, they added a relation of **parallelism** to the **comparison** section, but this is not only due to the existence of specific connectives in some languages, but rather to a relation that appears to be missing in English as well
  - This lexical view of discourse relations has enabled researchers to apply a similar method to typologically diverse languages, and to compare their results (Prasad, Webber & Joshi, 2014)
    - In the same vein, Kolachina et al. (2012) also suggested the addition of a "similarity" tag in the comparison section in the revised version used to annotate Hindi.

Other applications

- PDTB corpus has been used for various language technology applications
  - automatic annotation of discourse relations (Pitler et al., 2008)
  - prelabeling of connectives to improve the output of machine translation systems (Meyer & Popescu-Belis, 2012).
- The PDTB has also been used to assess cognitive theories about discourse
  - **continuity hypothesis** according to which some discourse relations should be conveyed implicitly more often than others.

PDTB done!

PRE-CONCLUSION

- There is some evidence that different languages use a similar set of relations (Zufferey & Degand, ch.7: 146).
  - most major models of discourse have been used to annotate corpus data in several languages.
    - PDTB is used to annotate relations in Arabic, Chinese, Czech, Danish, Dutch, Hindi and Turkish.
    - RST has been used to annotate data in Basque, Dutch, German, English, Portuguese and Spanish,
    - SDRT-annotated corpora exist in Arabic, French and English (Benamara Zitoune & Taboada, 2015).
  - In some cases, the taxonomies of relations had to be modifed, with the addition or elimination of some relations, or even an elimination of the hierarchical nature of some models like the PDTB (Prasad, Webber & Joshi, 2014).

Pre-conclusion

- The role played by connectives is quite different across models.
  - it is central in the PDTB model.
  - it is quite peripheral in RST, SDRT and CCR, which aim most of all at representing the coherence created by discourse relations,
    - The advantage of models like RST and SDRT is that they provide a very comprehensive view of **all the other linguistic means** that are used to convey discourse relations in addition to connectives.
    - The main advantage of the PDTB is that it provides **thousands of occurrences of connectives** annotated with a sense tag.
      - It is therefore the most comprehensive resource available to date to study this class of lexical items.
    - The main advantage of CCR is its psychological grounding that makes it particularly well suited in psycholinguistic studies.

Pre-Conclusion

- A major difference between them lies also in their scope.
  - RST and SDRT models aim at providing a full-edged representation of text structures,
  - PDTB framework is lexically grounded and theory-neutral.
  - CCR takes yet another perspective, as it does not aim at listing all the possible relations, but rather at characterizing them by using a set of basic dimensions that are cognitively motivated.
    - Contrary to the other frameworks, it thus favors cognitive plausibility over descriptive adequacy.
- Each model has its own advantages and limitations, the choice of one model over another therefore depends on the goals of the annotation, and more generally on the research questions addressed in a project.
- An important step ahead in future years will be to find ways to make data annotated with discourse relations more comparable across corpora, either by agreeing on a standardized set of discourse relations, or by finding ways to make different frameworks communicate, for example, by comparing the different dimensions involved in each relation, as proposed by the CCR framework.

B5. Kehler (2002)

Kehler 2002

- Coherence relations reflect cognitive principles that we apply when we try to make sense of the real world (Hobbs)
  - Theoretical linguists approaching coherence **categorize** the different types of coherence relations that can serve to connect clauses,
- Developing Hobbs' idea, Kehler proposes that there are three such cognitive principles of connection between ideas (and respectively, three types of coherence relations): **resemblance**, **contiguity** in time and space, and **causal** relations:
  - =? Sanders & al's 3 basic operations: causal, temporal, additive

From fine-grained taxonomies to major categories

- Many traditional works classify relations into **four main categories** and the resulting classifications bear a strong similarity to one another.
  - **Halliday and Hasan (1976)**: **Additive**, **Temporal**, **Causal**, and Adversative
  - **Longacre (1983)** **Conjoining**, **Temporal**, **Implication**, and Alternation,
  - **Martin (1992)**: **Addition**, **Temporal**, **Consequential**, and Comparison.

  ➢ The first three categories in each analysis are quite similar, so the main difference lies with respect to the fourth category.

  - **Kehler (2004)** all of these are actually special cases of the **Resemblance** category
    - Which also includes **Additive/Conjoining** relations

A. Contiguity relations (Kehler 2002)

A. Contiguity relations are based on knowledge gained from human experience about how eventualities can enable, or set the stage for, other eventualities in the world. This class contains one relation—*Narration*, or *Occasion:*

- OCCASION/NARRATION: Infer a change of state for a system of entities from the assertion of *S*2, establishing the initial state for this system from the final state of the assertion of *S*1

A huge storm hit Scranton this weekend. Many children were seen out playing in the snow.

B. Resemblance relations (Kehler 2002)

- **Resemblance relations** hold in virtue of recognisable similarities and differences between the corresponding elements (entities, relations) of the content of two sentences (or larger discourse units).
  - For example, we establish a *Contrast* relation because we are able to recognise that both clauses talk about the snow-made figurines (the similarities), and state that the form/size is *not* the same (the differences).

PARALLEL: Jill built a snowman, and Sue made snow angels.

EXEMPLIFICATION: Children love to play in the snow after the storm. Today, Jill built a snowman.

GENERALIZATION: Today, Jill built a snowman. Children love to play in the snow after the storm.

ELABORATION: Today, Jill built a snowman. She piled three snowballs on top of one another, and decorated it with button eyes, a carrot nose, a pipe, and a scarf.

CONTRAST: Jill likes building snowmen, but Sue prefers making snow angels.

EXCEPTION: Children love to play in the snow after the storm. But today, Jill stayed inside.

Resemblance

- The definitions for Resemblance relations make use of the predicate/argument configuration.
  - What makes a discourse relation one of *resemblance* is that the inferred **predicates** must be the same, whereas the **arguments** must have some property in common.
- Resemblance relations require a COMMON TOPIC.
  - Clauses participating in a Parallel relation can be seen as providing partial answers to a (usually implicit) questions-under-discussion, e.g. *What did the girls do in the snow today?*"

C. Causal relations (Kehler 2002)

- **Cause-effect relations** depend on the possibility to establish an inferential link between the contents of two discourse units.
  - The "inferential link" is understood in a broad sense, ranging from causal relations between the events described to defeasible consequence relations as that between an expectation trigger in the first conjunct of *but* and the expectation denied by the second conjunct of *but* .
- The causal relations are defined in terms the connectives, → and ¬; this allows us to explore the logical link between them.
  - **EXPLANATION**: I hope it snows this weekend. I love building snowmen.
  - **RESULT**: I love building snowmen. I hope it snows this weekend.
  - **VIOLATED EXPECTATION**: I love building snowmen, but I hope it does not snow this weekend.
  - **DENIAL OF PREVENTER:** I hope it does not snow this weekend, even though I love building snowmen.

Against RST's descriptive adequacy

- Descriptive adequacy as the sole principle for defining a set of Rhetorical Relations (as in RST) has been the object of a lot of criticism.
  - A major problem is that the central claim of RST that text is coherent in virtue of the relations between its parts becomes unfalsifiable if one can add RR at will. For instance, what would stop one from adding relations that describe incoherent texts? To adequately describe (a) one could, for example, introduce a relation *inform-accident-and-mention-fruit*.
  - (a) # John broke his leg. I like plums. (Knott and Dale 1994)
  - Clearly, we do not want to include such arbitrary relations in any principled set of RR.
    - Therefore **there must be more contentful constraints on what counts as a good relation.**

Advantages of Kehler's taxonomy

- **Kehler's account provides the answer**: a sequence of discourse units is coherent *only if* the relationship between the units can be established by one of these three principles.
  - A relation can be included in "the list of RR" *only if* it can be shown to satisfy the conditions for one of these three types.
  - This keeps arbitrary relations like *inform-accident-and-mention-fruit* out and lays the foundations of a falsifiable theory of discourse coherence

Kehler (2002) done!

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