Optimal Interpretation for Rhetorical Relations

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Abstract
This paper explores the use of a simple and computational optimality theoretic pragmatics (OT pragmatics, OTP) to the analysis of the rhetorical structure of texts. It introduces this variant of OTP briefly and then shows that it can be applied to explain coherence, rhetorical relations, discourse trees and context dependence using the occasional extra premiss. It thereby improves on existing accounts by reducing rhetorical structure to general pragmatics. It also contributes to the computational problem of inferring rhetorical structure by giving more structure to the inference processes involved, though it is as dependent on better ways of estimating semantic plausibility as any other system.

1 Optimality Theoretic Pragmatics

Optimality theory (OT) is a natural environment to formalise pragmatics. It gives an account of defaults that is simpler than competing ones and defaults are the bread and butter of pragmatics. While other formal accounts of pragmatics can likewise exploit the use of defaults in simplifying axioms, the OT framework forces their expression as a small set of very general principles which are applicable throughout pragmatics and thus prevents the development of accounts which only work for isolated phenomena. In this way, whatever one states about e.g. rhetorical structure will have its repercussions on presupposition projection or the derivation of implicatures. In fact, the proposal of this paper on rhetorical structure developed in an organic way by progressive abstraction from the influential account of presupposition projection of Heim (1983) and van der Sandt (1992). It was also heavily influenced by other work on OT pragmatics like Blutner (2001), Beaver (2004), Jäger (2003) and Mattausch (2001a) as well as by the pioneering approach of Hendriks and de Hoop (2001).

Calling the system OT pragmatics merely means that it is conceived as a system of strictly ordered soft constraints. Both the constraints and their ordering should be universal. It will be argued below that it is identical to a constraint system that would give explanations for communicative behaviour of other subjects, itself a special case of the notion of explanation of natural events. This means that the constraint system as such is not part of the development of human languages and may operate just as well in other species, provided joint attention to common goals and common questions can be assumed. It can even be argued that it is not OT at all,
but merely another case where a cognitive problem can be described by a system of strictly ordered soft constraints.

The version of OTP used in this paper is purely interpretational (it selects an optimal interpretation for an utterance) and is thereby comparable to relevance theory Sperber and Wilson (1984). It derives from an unpublished attempt by Blutner and Jäger (1999) to reconstruct the DRT-based presupposition theory of van der Sandt (1992) within optimality theory. *NEW is a generalised version of *ACCOMMODATE and of Hendriks and de Hoop (2001)’s DOAP principle. PLAUSIBLE comes from Matthausch (2001b)’s attempt to reconstruct the temporal reasoning in Lascarides (1993). The replacement of Blutner’s STRONG by RELEVANCE is influenced by Van Rooy (2003)\(^1\).

In this way, it is different from the various bidirectional accounts of OT that have been offered (Smolensky (1996) and Blutner (2001) are the original versions). These accounts assume a single constraint system that can be used to select the best forms for an interpretation and the best interpretations for a form by running a match between possible forms and possible interpretations respectively. A normal phenomenon in a system of this kind is that \(F\) can be the best form for interpretation \(I\) without \(I\) being the best interpretation for \(F\). In such situations, it seems absurd to use \(F\) for \(I\): one is guaranteed to be misunderstood. Or inversely, \(I\) can be the best interpretation for form \(F\), but \(F\) is not the best interpretation for \(I\). Here, the interpretation is spoiled by the thought that one would never have said it that way oneself and consequently by not having a proper explanation for why the other speaker said what she said. Strict bidirectionality (strict BIOT) outlaws these situations: if \(X\) wins for \(Y\), \(Y\) must also win for \(X\). Real winners for an input are the ones for which the input is also a winner.

Strict BIOT can be weakened to weak bidirectionality (weak BIOT). The reason for wanting to do so is that strict BIOT rules out any pair \(<X', Y'>\) where \(X'\) is more marked than \(X\) and \(Y'\) is more marked than \(Y\). Such a pair is \(<cause to die, kill in an unusual way>\), which is eliminated by the pairs \(<cause to die, kill in an unusual way>\) and \(<kill, kill in a normal way>\).

In strict bidirectionality a pair \(<X, Y>\) is out if there exists an \(X'\) or \(Y'\) such that \(X'\) is better for \(Y\) or \(Y'\) is better for \(X\). Let’s call pairs \(<X, Y'>\) or \(<X', Y>\) improvements. A weakly bidirectional pair merely has no weakly bidirectional improvements. This sounds like a complex definition\(^2\), but all strict bidirectional pairs are weakly bidirectional and OT well-orders the pairs, so that a recursion can be set up.

Weak bidirectionality approximates the Horn-Levinson concept of pragmatics and crucially is able to formalise the M-principle, i.e. iconicity.

Unfortunately, there are very serious problems with both notions of bidirectionality.\(^3\)

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\(^1\)The formalisation of Van Rooy by means of decision problems is interesting and consistent with what I do here. It is however not easy to see how Van Rooy’s approach can be made dynamic, i.e. how the influence of the ongoing discourse on the decision problem can be modelled. The current approach is more in line with Rooth (1992) and Zeevat (2006a).

\(^2\)As shown in Jäger (2000), which also shows that weak BIOT loses the property of simple monodirectional OT with a boundary on the number of errors that if the system is made up from regular constraints, the resulting system is also regular.
rectionality. First of all, there is the Rat-Rad problem (in a bidirectional system, the pronunciation /rat/ in German would always be interpreted as the abstract form Rat, while it is ambiguous between Rat and Rad. This problem is not specific for phonology but also crops up in syntax, as shown in Zeevat (2006b) and is a problem for any notion of bidirectionality in which production and generation use the same constraint system, as in the strict and weak bidirectionality introduced above. Beaver and Lee (2003) discuss more problems with bidirectional systems but crucially show that a reasonable system of constraints for Korean syntax, under a weakly bidirectional interpretation predicts a completely unattestable unbounded series of weakly bidirectional equilibria. This argument is lethal for a synchronic version of weak BIOT since it is (again) a direct consequence from the well-ordering on pairs imposed by an OT constraint system.

A third problem is the prediction of fully bidirectional systems that synonymy and ambiguity would occur with the same low frequency: there is considerable and identical evolutionary pressure against both of them. Weak bidirectionality would even seem to rule out both phenomena altogether. Full synonymy however seems a minor phenomenon while the ambiguity of natural languages is overwhelming and is considered by many to be the main obstacle to constructing machines with human-like language capabilities.

The reasoning behind the bidirectional systems is however hard to dismiss. There is considerable evidence that production and interpretation are interconnected and the null hypothesis for explaining the interconnection is that the abstract description of the processes, the grammar, is the same. Second, it would not seem to be the case that one ever interprets an utterance in such a way that the result of the interpretation cannot be seen as a suitable input for generating the utterance oneself (allowing for performance errors and differences in perspective and competence between the speaker and the hearer). And to use a form for a meaning knowing full well that it will be interpreted in the wrong way seems to border on insanity.

Something has to go. For the pragmatic theory of this paper (see also Zeevat (2007b)), the point of departure is precisely the argument for bidirectionality which forbids interpretations that would not explain the use of the utterance by the speaker. This is a corollary of Grice’s definition of meaning_{NN} in Grice (1957): unless the hearer thinks the putative intention behind the utterance explains why it was made, she cannot think she has recognised the intention behind it. But the relevant notion of explanation is just that the form must be optimal—at least in the speaker’s grammar— for the intention, i.e. the interpretation. It seems this principle cannot fail, since it is constitutive of the notion of interpretation as such. Given that for standard constraint systems, selecting the best interpretation does not give the same connections between form and meaning as selecting the form for a given meaning, it follows that a competition using the generating system of constraints cannot be the right model of interpretation.

It is more plausible to think of interpretation as a different process (e.g. one that locally connects the lexically evoked concepts in a plausible way with each other and the context) which is filtered by the generating system.
This could be called the mirror neuron model of interpretation: speech
behaviour like other observed behaviour by other creatures brings about
the same excitations of the mirror neuron system as would occur when the
same behaviour would be carried out by the motor system and includes
representations of the goals of that behaviour V. (2003). A model of
interpretation of this kind predicts the amazing possibilities of syntactic
repair that we seem to have and which allows us to engage in dialogue
even when a common language is largely missing or when the channel is
quite noisy. And also why language understanding is much more extensive
than the language that can be produced. It would also give a model in
which interpretation is guaranteed to be in harmony with generation.

Pragmatics proper is about the further filters on interpretation. This
paper assumes three more filters: a constraint that maximises plausibility,
a constraint that maximises coherence and a constraint that maximises
relevance, applying in that order.

Does this mean that bidirection has completely gone overboard? The an-
swer is yes, if bidirection is a formal condition on generation. But it still
comes back in three forms, as a condition on interpretation, as a driv-
ing force in learning and language evolution and in the form of expressive
constraints in OT syntax. The first was introduced above: interpretation
is dependent on generation by being the strongest constraint on possible
interpretations of an utterance. But there is also an important reflex of in-
terpretation in generation. Pragmatics prefers certain readings and speak-
ers will be misunderstood if they want to express the less plausible, less
coherent or less relevant reading in a context. This has led to lexical, into-
national and syntactic modes of expression whose primary purpose seems
to be to mark against these tendencies. The existence of vast inventories
of nouns, verbs and adjectives in natural languages should be attributed
to the tendency to go for the stereotypical and the contextually expected
(the tendency enforced by plausibility). Adversative and mirative markers
seem to serve the same purpose of allowing implausible interpretations:
they do not force implausible interpretations but prevent repair of im-
plausible interpretations, since the marker needs to be justified by a less
than normally plausible interpretation. Marking new information by in-
tonation, articles and additive particles serves as a counteragent against
overly coherent interpretation. Twiddly intonation, particles like "well"
and modals mark against unwanted relevance. In fact, most properties of
natural languages can be seen as an answer to unwanted interpretations
due to pragmatics. And pragmatics itself is nothing more than the theory
of explanation applied to communicative events, where a purpose can be
assumed in the sender.

Pragmatics helps in selecting the right interpretation, but as such is also
the mechanism behind misunderstandings. Linguistic expression used for a
meaning A but understood as B will not replicate well in language history
and other expressions for A will invade. Pragmatics accounts for why an
expression for A will be interpreted as B and thereby is the account of one
of the two driving forces behind language change: the need for functioning
expressive power. The other is phonetic, phonological, morphological and
syntactic erosion which finds its explanation in the difficulties of upholding
norms of speaking in societies of speakers, in the absence of clear and
conscious criteria.
The same driving force of expressive power can be seen in synchronic syn-
tax in expressive constraints forcing the expression of certain features of
the input. Why is an occurrence of "too" normally obligatory? Because
otherwise, the utterance would be interpreted too coherently, by identi-
fying the earlier and current state of affairs. Why does the reference to
John come out as "he"? Because otherwise the interpreter may think that
it is not the same person as in last sentence and may misunderstand the
name. These expression constraints are bidirectional: they assign errors to
a candidate if it is also optimal for the input where the feature is toggled.
They are constraints that are freely ranked with the others, though the
order is not completely arbitrary since the features have an inherent com-
municational importance. They can have grammaticised to a particular
morphological, lexical or syntactic device for their expression (e.g. tense,
plural, imperfective), but can also employ a number of expressive devices
(e.g. subject in Dutch or Russian which can be marked by case, agreement
or word order). Expressive constraints are visible expressions of bidirec-
tion in syntax. They make the speaker's task easier of guaranteeing that
she will be properly understood. But the fact that such constraints did
emerge and grammaticise makes it questionable that speakers are really
able to guarantee that they will be understood. The problem to which ex-
pressive constraints seem to contribute would not have existed if speakers
would be able to avoid misunderstanding altogether. At the same time,
the emergence of expressive constraints also shows that speakers try to
avoid unwanted interpretations. It is clearly a hard task. The importance
of feedback mechanisms in natural dialogue seems to be evidence that
speakers and hearers can and do not count on perfect understanding.

2 Optimality Theoretic Pragmatics

Faithfulness in optimality theory refers to the relation between the input
and the output. The concept does not come out in the clearest possible
way in phonology where it is customary to use the Latin alphabet both
for the abstract input phonemes (defined in the lexicon) and the concrete
phonemes that form the basis for pronunciation: faithfulness then seems
to be identity, though it really is not. In syntax, there can be no identity.
While useful versions of OT syntax can be given where the input is rather
linguistic, for pragmatics, it is necessary to take actual speaker intentions
as input. These intentions have internal structure and various complex or
primitive constituents of the intentions can have features, in virtue of what
they are or in virtue of a relation they bear to the context. If a feature
of the input or a feature of a constituent is expressed by a candidate
realisation, the candidate is faithful with respect to the feature, otherwise
it is not. If one could list the relevant features and characterise speaker
intentions by sets of them, this would be an easy issue.

But there are good reasons for doubting that there is a universal inventory
of features that get expressed in language and even more reason to doubt
that intentions can be characterised as sets of such features. To start with
the last problem, intentions should contain the content of what the user
wants to express and this can be arbitrarily complex. It follows that in-
tentions can only be finite if a limitation is adopted, e.g. to intentions
corresponding to simple clauses. It may then be possible to pack the lexi-
con, semantic and contextual properties into a single set of features. But a limitation of this kind is not plausible if intention recognition should also allow the interpreter to reconstruct the reason of the speaker for producing the speech act in the first place, something which seems unavoidable in pragmatics.

The second problem is that the content of lexica of different languages can be full of idiosyncrasies. Assuming a universal language of thought does not really help here, since the lexicon of the language may well be unable to express aspects of the universal thoughts. And it is not clear at all that linguistically important semantic features (e.g. the feature that should control negative polarity items, or animacy) allows of a universal definition.

The view of this paper is that the input of the speaker is the speaker’s intention. It is given by the speaker’s goal in the conversation, together with what the speaker knows about the language, the worlds and the context. The intention as a representable entity comes into being as the sum of the decisions that make up the production process. These are forced by the constraint system governing the production of natural language utterances and may partially depend on properties of the inventory of the language. It follows that understanding is not so much that the hearer obtains the same intention, but that the hearer forms a picture of the intention that would allow her to make all the decisions in the same way, if she would have been the speaker and allowing for differences in competence and error.

On this view, correctness of understanding is dependent on the language used as given by the inventory and the constraint system. Intention recognition can be limited to understanding those aspects of the goal of the utterance and the information that the speaker had at her disposal that played a role in shaping the utterance.

FAITH is the strongest constraint in the constraint system of this paper. It tells the hearer to select those interpretations that for the speaker could constitute a reason for making precisely that utterance. It involves the reason why the speaker is speaking and everything connected with making decisions that determine the form of the utterance. The speaker may repair the utterance in view of performance errors or incomplete competence of the speaker. FAITH however minimises the number of such repairs. A selected interpretation should not have competitors which would require less error correction.

Interpretive accounts of natural language semantics like Montague Grammar, Discourse Representation Theory, Head Driven Phrase Structure Grammar or other grammar formalisms that integrate a treatment of semantics are approximations to FAITH. The same holds for versions of OT syntax that take as input a semantic representation of some kind.

They are approximations only, because they do not attribute to the speaker a reason for speaking and because they do not contain an account of non-literal use of language, such as irony or metaphor. An OT syntax which would start from intentions as input and which would incorporate the use of non-literal language use would be a better approximation, but treatments have not been formulated yet.

For natural events, actions by humans and other organisms and non-linguistic communicative acts, the corresponding demand on interpreta-
tions would be that the interpretation explains them.

PLAUSIBLE is concerned with consistency and likelyhood of the interpretation. It rules out an interpretation that has a more consistent or more likely interpretation as a competitor. It can be related to the use of consistency and likelyhood in various linguistic processes, like e.g. in the pragmatics proposed by Gazdar (1979) or in ambiguity resolution as practiced in many current lines of work in natural language processing.

Outside language, it compares explanations for consistency and likelyhood. An explanation is more likely to the degree the cause it proposes is itself likely and to the degree the cause is known to bring about the effect that has to be explained.

*NEW minimises the number of new objects by the interpretation, but also militates against new unanchored objects and changes of syntactic role of the object. Plausible proper interpretations that have more new objects or less anchored objects or that retain fewer objects in their syntactic role are rejected in favour of equally plausible and proper interpretations which do better.

Outside language, in scientific explanation, the principle is just Ockham’s razor. It is not significantly different in everyday explanation. The simpler the explanation, the better.

RELEVANCE is closest to the Gricean maxim. The interpreter has the right to expect that the speaker addresses issues and questions of which it is common ground between her and the speaker that they are of interest to the subjects of the conversations. An issue or question can start out as such, but dialogue can add new questions and answer others. Most overtly this can be done by asking questions and stating goals and so raising the question how the goal can be achieved. But another important other mechanism is by activating propositions that are not yet decided, stating surprising facts, mentioning new objects etc. In all these cases, questions are added: is the activated proposition true, how did the surprising fact come about and how did the speaker know about it, who or what is the new object? RELEVANCE maximises the number of activated questions that are answered by the utterance, by matching the utterance with the activated question whenever that is possible and then adding the assumption that the information provided in the utterance is all there is to know about the question.

There is no corresponding principle in the explanation of natural events since there is no justification for the idea that natural events occur in answer to a goal the interpreter shares with nature. But there is the same principle for non-linguistic communicative behaviour. If you show me a photograph in a common ground where we want to know what happened at the departmental party, I will take you to imply that the picture is about that party. If we are skating over the lake and you shout “aargh”, I will draw the conclusion that you want to warn me for a natural peril in the situation.

The ordering has to be exactly this way. Without minimisation of new objects, it would be easy to have too much relevance. Without plausibility to constrain the interpreter, she would identify everything. Without FAITH in overall control, plausibility would limit the hearer to trivial messages only.
What should a theory of rhetorical structure achieve?

In the first place, it should be able to support models of text generation. The text planning and accumulation modules distinguished in Reiter and Dale (2000) should be guided by the ideas of what is possible structure according to the account of rhetorical relations. There is a strong case for developing suprasentential OT syntax but this has not been done yet.

Second, it should similarly support models of comprehension. An important role of rhetorical structure theory in combination with theories of information structure is to give criteria for comprehension. Information theory should give an account of the purpose of a move in a dialogue. Current theories seem to contribute the requirement of a maximally strong discourse relation between the current DCU\(^3\) and the pivot DCU and constraints on the identification of the pivot.

The literature on rhetorical structure contains several proposals: the abduction model of Hobbs et al. (1990), the glue logic of Asher and Lascarides (2003), the "greedy parser" of Prüst et al. (1994) and others. The theory given in this paper has one contribution to make here. It distinguishes three kinds of defaults (those coming from PLAUSIBLE, *NEW and RELEVANCE) and adjudicates on the resolution of conflicts between these 3 kinds of defaults. In this way, it is more structured than Hobbs or Lascarides and Asher where all the defaults are in direct competition and where weighting or specificity is the single adjudicator\(^4\).

Second, rhetorical structure theories have powerful predictions to make on the interpretation of anaphoric elements such as pronouns, ellipsed constituents, proper names, descriptions, nouns, tense, particles, (implicit) (temporal) locatives, factives, (pseudo-)clefts, predicates with sortal restrictions, intonationally marked topics, contrastive stress, additive marking etc. These predictions come from the identification of the pivot and the relation the DCU bears to it.

The strongest claims are made by Prüst et al. (1994) where pronominal resolution and VP anaphora are reduced to a mechanism that bears a certain resemblance to mechanisms that have been proposed for the computation of "discourse topic". The mechanism enforces a maximal parallelism between two DCUs. The most specific common denominator of a semantic representation (or perhaps more properly a hybrid representation between syntax and semantics) of the pivot and the representation of the DCU is computed. \(mscd(A, B)\) is the most specific generalisation of \(A\) that still unifies with \(B\). If \(A\) is instantiated where \(B\) has variables (i.e. pronouns or pro-VPs) \(mscd(A, B)\) has the values of \(A\). If \(A\) and \(B\) have conflicting instantiations, the corresponding place in \(mscd(A, B)\) will have a variable which will be instantiated by the value that \(B\) has there. The unification

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\(^3\)DCU (discourse constituency unit) is terminology introduced by Polyani (1985). It refers to the constituents that enter into rhetorical relations and covers subsentential as well suprasentential units.

\(^4\)It may be that there is mileage in the proposals of Zeevat (2005) which proposes a cascade of procedures (one for each constraint) that try to further instantiate an underspecified representation. In that case, default processing can be limited to a mechanism like default unification. But it is really too early to tell: a crucial ingredient is a formal treatment of non-literal language use and better ways of estimating plausibility.
\( msd(A, B) \land B \) gives the result of the interpretation process for \( B \).

The mechanism is important, but limited to a subset of the phenomena. While it can be extended to N- and VP-ellipsis, some particles, implicit locatives tense and contrastive stress, it does not seem to be applicable to proper names, nouns, descriptions, additive marking, other particles, factives and sortal restrictions, because these cannot be described as parallelism effects and do not necessarily have an antecedent in the pivot. The mechanism also does not give the right result in discourse relations that do not require parallelism: parallelism is only required in the case of Contrastive Pairs, Lists and Question Answer Pairs and optional with other relations. But—also in the absence of parallelism—rhetorical structure has an important contribution to make to cross-sentential resolution by identifying the pivot which binds pronouns, tense and ellipsis in the new DCU.

### 4 Pragmatic constraints in rhetorical structure

It is particularly easy to see that PLAUSIBLE has an important role in rhetorical structure. In fact, this can be seen as the dominant view among the theorists: enough competing default rules of various strength or specificity should do the job as in Hobbs et al. (1990) or Asher and Lascarides (2003).

In (1), a pivot sentence \textit{John fell} is combined with three new DCUs: \textit{Mary pushed him}, \textit{Mary smiled at him} and \textit{Mary hit him}. All three DCUs can be marked for their connection to the pivot by explicit markers, here: \textit{but} (Concession or Formal Contrast), \textit{then} (Narrative), \textit{so} (Result) and \textit{because} (Cause). Typically, the absence of a marker leads to the most plausible connection given the predicates. In (a) Cause, in (f) Narration and (k) nothing is chosen because it could be anything: Cause, Narration, Concession or Result. It seems clear in (k) that normally a choice will be based on the particular context where e.g. John is doing a balancing act so that being hit is a plausible cause of falling, John and Mary are in a fight where it is plausible that Mary seizes her chance of hitting John when he falls, or sporting expectations are set up that would normally prevent Mary from hitting John when he falls, or the reverse, where Mary has threatened John to hit him if he would be so clumsy as to fall.

The markers override any of the defaults and may effect reinterpretations of the context to make it possible to have concessive or causal interpretations. This is only possible with explicit markers that are interpreted by FAITH. If the context cannot be reinterpreted to allow the concessive, causal or result interpretation, pragmatic incorrectness results. The markers seem clumsy if they do nothing more than confirm the most plausible relation anyway. They should be left out in that case. At the same time, their occurrence is not optional if the speaker intends a particular relation while PLAUSIBLE would give a different relation (though a different means of expression may be chosen). The force behind the need to mark can be expressed by an expressive constraint (that would also be satisfied if the connection is clear by plausibility).
   c. John fell. Then Mary pushed him.
   d. John fell. So Mary pushed him.
   e. John fell. But Mary pushed him.
   f. John fell. Mary smiled at him.
   g. John fell. Because Mary smiled at him.
   h. ? John fell. Then Mary smiled at him.
   i. John fell. So Mary smiled at him.
   l. John fell. Because Mary hit him.
   m. John fell. Then Mary hit him.
   n. John fell. So Mary hit him.

*NEW applies to all discourse markers in the new DCU. This is a rather large class if one takes the criterion for being a discourse referent that of being a possible antecedent for some kind of anaphora or ellipsis. This is not necessary. One could let the criterion be the existence of overt anaphoric elements, but that would not be a universal criterion since elliptical anaphora is a typological option. On the other hand, for relations or topics (arbitrary abstracts) overt and specific devices seem to be rare.

This gives a list like (2) for *NEW to apply to.

(2)  objects
     kinds
     moments of time
     sets
     events
     states
     facts
     thoughts
     spatio-temporal regions
     relations or topics

Relations or topics require some argument. Consider (3). (3a.) requires takes an antecedent \( X \) gave Mary flowers, (3b.) \( X \) gave \( Y \) flowers, (3c.) \( X \) gave \( Y \) \( Z \) and (3d.) \( John \) gave \( X \) flowers.

(3)  a. John gave Mary flowers. Bill did too.
     b. John gave Mary flowers. Bill Sue.
     c. John gave Mary flowers. Bill Sue chocolates.
     d. John gave Mary flowers. And Sue.

It is not necessary to think of elements of the last category as being created by some construction algorithm. It is enough that they are available for binding ellipses and that they can have levels of activation. But both of these properties can be derived from the antecedent utterance itself: it may have a level of activation which makes an abstract contained in it suitable as the antecedent of a certain ellipsis or overt element and the abstract itself can be derived from the utterance when needed. The description of the abstract as the topic should be underpinned on intonational grounds.
In fact, Rooth (1992) notices that contrastive intonation on Mary and Sue or on John and Sue leads to quite different interpretations. In the corresponding *John gave SUE flowers too, John gave X flowers* is destressed and thereby marked as given, something the interpreter needs to check.

Let’s try to reformulate *NEW appropriately. It should generally always prefer old over new, highly activated over lower activated, parts over merely related. If in addition preservation of certain linguistic features (e.g. AGENT, THEME) is preferred over changing them from the antecedent, maximal parallelism becomes the interpretational norm. The additional demand makes sense under the interpretation of *NEW as a perceptual principle of conservatism: when there is no new information assume everything stays the same. Adding this principle recreates the MSCD-based mechanism of Prüst et al. (1994) while avoiding the limitations because *NEW is a soft constraint.

RELEVANCE would be mainly responsible in rhetorical structure for the strengthening of discourse relations. If \(e_2\) is contingent on \(e_1\) as in Narration, \(e_1\) addresses the question *what caused \(e_2?*_. RELEVANCE instructs the interpreter (if \(e_1\) is a plausible cause of \(e_2\)) to take \(e_1\) as the answer which changes the discourse relation into Result. Other strengthenings of this kind are Background to Cause, Background to Justification, Reformulation to Conclusion.

This leaves FAITH. FAITH is first of all responsible for marking devices which can suspend the workings of PLAUSIBLE, *NEW and RELEVANCE. But if its proper formulation involves reconstructing the speaker intention as is assumed in this paper and not just the projection of lexically and syntactically expressed meanings into a semantic representation, it is responsible also for the motivational aspect of the utterance: the hearer must find a reconstruction of the intention that makes it clear not just why the speaker decided on these words and constructions but also why it is worthwhile to make the utterance in the first place. And —where the utterance is complex— also why the speaker thinks the subutterances are worth making.

5 Coherence

While it is necessary to allow for errors and lapses, it is rational to assume that a speaker has a reason for speaking and that there is a reason behind any part of her utterance. Some of the parts find their reason in an overarching reason for producing a larger part: the reason is just that they contribute to the larger enterprise. Thus the occurrence of a word like "he" in a larger part of speech like "he ran away" can be explained by whatever the reason is for the larger utterance: without the "he" the speaker would not identify the event to the necessary degree which presumably would defeat the intention behind mentioning the fact that "he ran away".

But this changes in those cases where the degree of freedom is greater: for optional modifiers, participials, and for extra separate sentences. Now it could well be countered that for such extra material the hearer can find an independent intention behind its utterance. But this does not work: the hearer faces the double task in this case of explaining not just the extra
material but also of explaining why it is syntactically integrated with the other sentence or appears adjacent to it -in the absence of a sign that makes it clear that the speaker intends to shift or interrupt the current course of the conversation, as in (4).

(4) John is away. Now for something entirely different. Somebody took my cup. Do you know anything about it?
   A: What time is it? B: 4.30 and why did you not show up yesterday?

The fact of the matter is that the best explanations of the extra material connect the extra material by a discourse relation to the other sentence. It is only if the speaker rules out such a connection or if it is not possible to fit in the new material with the drift of the conversation until the current point, that shift can be assumed.

The proper explanation of the connectedness of a new utterance or an optional part of an utterance starts by denying that it needs to be. Not every utterance/optional material is connected to a pivot (it is not necessary here to assume pseudo-relations like interruption or topic change). Then FAITH demands an explanation for optional material and in particular for extra sentences. *NEW finally brings about a preference for given topics, given objects, times etc. This connects the explanation for the unaccounted material with the current drift of the conversation.

A quite tempting direction that has been taken here but still has not been exploited to the full extent is the perspective of generation systems. In systemic grammar (the framework to which the first work on rhetorical relations (Mann and Thompson (1985)) belongs) the generation process is conceptualised as a series of connected choices the speaker has to make and provides decision procedures in some cases (e.g. obligatory marking of tense, choice of article for NPs). This gives a large range of explanations for the choices of a speaker. But the pragmatically most interesting choice points are the ones where choices are not forced. FAITH seems to force finding a reason for any choice that is not arbitrary. As has been noted by Dale and Reiter (1996) for some particular cases, some of these choice points are connected with a range of pragmatical implicatures. In this view, unexpressed rhetorical relations are implicatures of the choice points that involve the insertion of optional material and of choices at the text level.

(5) The angry farmers blocked the road.
   The farmers -angry because of falling prices for their products- blocked the road.
   The farmers blocked the road. They were angry.
   possible implicature: the farmers blocked the road because they were angry.

The implicature may be the joint effect of FAITH, *NEW and RELEVANCE, where FAITH demands that there be a reason for the extra material, *NEW that it is strongly connected to the pivot, and RELEVANCE determines whether the cause of the blocking is at issue (it might also be Background).
6 Rhetorical Relations

In the following, it is attempted to answer the question why there are the rhetorical relations that researchers like Mann and Thompson (1985), Hobbs (1979), Grosz and Sidner (1986), Polyani (1985) and others have found. It does not do to explain these as cultural artefacts that have proved useful in conducting conversation and writing texts. This would predict substantial variation among cultures in the inventory of relations and nothing really spectacular has been found in this respect.

More promising is to see DCUs bearing a rhetorical relation to a pivot as specialised speech acts that follow up on other speech acts. Turn changing speech acts like answering, accepting, rejecting have a relation to the other turn and cannot be understood without knowing the content of the other turn. In rhetorical relations, the turn does not change and the relation is to an earlier element of the same turn, the pivot, without which it cannot be fully understood.

While it is right to see the DCU as a special kind of assertion and the relation it has to the pivot as part of what makes it a special kind of assertion, it does not seem this perspective throws light on the question where the inventory of relations comes from. The major speech acts themselves seem to arise naturally out of the sort of things one can do with language: give information, ask questions, enter into commitments etc. Specialised speech acts seem to come from the defaults associated with their superclass and lead to marking devices for indicating the special case. E.g. a default assertion expresses knowledge of the speaker and addresses an unsettled issue in the strong sense that there is no bias for or against any particular way of settling it. This guarantees that the interlocutor can just accept the content of the assertion, unless she has conflicting information. Special cases need to be marked (as illustrated in (6)): if the speaker has merely inferred it, if it is only a suggestion the speaker is making, if negative or positive evidence is present or if the speaker needs confirmation from the interlocutor.

(6) John has left.
John must have left.
John may have left.
John has indeed left.
John has left after all.
John has left, hasn’t he?

The situation with rhetorical relations is not different. There is a default with respect to what is the pivot (the last simple DCU) and a default with respect to what the DCU does (the same thing as the pivot). All other things are marked and need to be protected from misunderstanding by connectors, particles, lexical material and intonation.

This section tries to argue that rhetorical relations can be explained from *NEW. By default, the pivot and the current DCU are completely the

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5There are different strategies in telling stories, explaining complicated states of affairs, different politeness norms, but not clearly different rhetorical relations. If the treatment of these strategies can be achieved in an extended OT syntax, this would predict the existence of a typology of rhetorical strategies. If the relations are explained —as in this paper— from the theory of interpretation, this predicts the same inventory of relations.
same. Rhetorical relations classify the transgression of *NEW. Strengthened relations are obtained by RELEVANCE.

To make the point, it is helpful to assume that DCUs can be represented by four parameters: a list of participants, a spatio-temporal location, a relation and a segment topic (the last parameter is not defined in an opening DCU).

The segment topic is part of information structure, but is distinct from the DCU’s own topic. When the DCU’s topic can be seen as part of the segment topic, one obtains the tripartite view of information structure proposed by Vallduvi (1992). The segment topic is a proposition (it can be seen as an issue to be decided) for the settling of which the current DCU is relevant.

Given *NEW, the most unmarked next DCU is a full Repeat: everything is preserved, participants, relation, location and segment topic. But a repeat is only useful, if it is likely that the hearer has somehow failed to recognise the utterance well enough. A full Repeat would normally lead to a conflict with FAITH: if the DCU is made and accepted, any of the goals for which it was produced in the first place should now have been reached and, if they are not, it cannot be expected that merely repeating will achieve them. So the speaker cannot reach any goal by a mere repeat and the hearer is consequently not able to reconstruct an intention behind it.

For a non-repeat, the interpretation best meeting *NEW is one where the parameters shift as little as possible. Here the strongest similarity is given by retaining the main participant(s) and the location. This forces a closely related sentence topic and a compatible predication. The rhetorical relation is known as Reformulation. Jasinskaja (2007) shows that with default intonation and without explicit markers, Reformulation is the most preferred interpretation: it redescribes what happened to the participants at that time and place.

A new sentence without an explicit marker is however not guaranteed to meet FAITH and PLAUSIBLE. FAITH can change participants (by full NPs) or change location by temporal modifier and locatives, PLAUSIBLE can force change of location and participants if the identities are hard to swallow. The second clause of (8) redescribes what befell Alena (from Jasinskaja (2007)).

6 Or for getting attention back to an earlier part of the exchange: Reminders, another purpose of later repeats can be to remind the interlocutor of an earlier commitment, which she now seems to give up (Reconfirmation). Yet another purpose can be to use old information to explain or motivate the pivot (Justification). These Repeats are often marked for their new function and in all these cases the pivot is not the repeated DCU which would occur much earlier.

7 A precise definition is difficult. The examples in (7) are covered by making it a demand that one discourse referent of the pivot is maintained in addition to the location.

(7) Alena broke her skis.
   a. It was a sad thing.
   b. She lost her only means of transport.
   c. She lost her mobility.
   d. She hurt herself.
   e. They snapped in two.
Alena broke her skis. She lost her only means of transport.

Time, place and participants are the same. The only change is the predication and the point is the entailment: Alena no longer has a means of transport and stuck to her location. In (9), there are problems with assuming that Alena and the location are maintained: is Alena John? Are the skis a car? The implausibility forces the interpreter out of the Reformulation assumption.

Alena broke her skis. John smashed his car.

Change of location (change of time or place) can be divided into proper change to a disconnected spatio-temporal region and change to a subregion or overlapping region. Change to a subregion is typical of elaborations. Overlapping regions are typical of causal connections. Disconnected regions lead to distinct sentence topics.

A similar division can be made with respect to participants. A participant can be continued or its role can be occupied by a subparticipant (a single individual or proper subset of the group that was the original participant, a part of the participant or a subquantity of a quantity participant) or can change to a distinct object. Change to a subparticipant indicates an elaboration. Change to a distinct participant a distinct sentence topic.

Changes to subregions and subparticipants indicate elaborations and this is the default if Reformulation cannot be assumed. In this case, the pivot becomes the segment topic. It now functions as the topic for the whole elaboration. The typical elaboration strategy for dealing with a topic is to break it up in distinct parts by breaking up its location or one of its complex participants and treating the parts in turn.

Making the pivot the segment topic does not mean that the current DCU has the pivot as its sentence topic. It merely means that the pivot is not abandoned and is still necessary for further semantic processing, e.g. for exhaustification effects. The same is also going on in discourse relations like Explanation, Background, and Justification. But this needs some explanation.

The explanation in fact takes care of some other questions as well. If our model of addressing topics is question answering, i.e. addressing the topic is giving an answer that settles the topic, it would not be understandable why there are relations like Elaboration and Restatement in which an already settled question is readdressed. What could be the point of that? But the model of question-answering seems to be misconceived. An assertion is not offering a proposition for belief, it offers a proposition that appears to the speaker as knowledge, something she has grounds for accepting as reliable. The purpose of communication of facts is not to let it be known what the speaker knows, but to construct the knowledge in the interlocutor so that she knows these facts as is necessary for her purposes. That is why the details given in an Elaboration and in a Background matter: they tell the interlocutor how the knowledge presented itself. In a causal Explanation, the speaker also underpins the proposition, the explanation makes the truth of the proposition understandable. In a Justification, the speaker states the grounds for accepting the proposition as true, grounds which may be sufficient for the interlocutor as well. In elaborating Lists and Reformulations, the segment topic helps to de-
termine the sentence topic and consequently the exhaustivity effects. In Explanation, Background and Justification, the segment topic gives the issue that the DCU helps to settle. The segment topic is necessary in order to state the causal and inferential connections.

So far, the pivot is kept. Quite literally in a Repeat or by keeping it as a segment topic as in Reformulation, Elaboration, Background, Explanation and Justification.

In the other cases, the pivot is discarded, a violation of *NEW. In these cases, the location or the main participant(s) is distinct from the location or participant(s) of the pivot. If there is a segment topic, this is maintained in List and in Narration relations. In a List relation, the sentence topics are distinct subtopics of the segment topic, where the subtopics are typically given by splitting up a participant or the spatial location. In Narration, the division is by temporal location. There are however two properties of a Narration that makes Narration different: the fact that time moves forward in a Narration and the fact that successive events have to be contingent on each other. This mirrors the stream of experience (or the structure of plans) and cannot be reduced to abstract pragmatics. Event descriptions themselves seem to move the attention from the start of the event to the point where it happens. Again this seems iconic with the experience of an event. From these considerations, it is perhaps not surprising that Narrations can have formal properties that set them apart from other relations, like specialised tense forms (past tense on non-stative verbs in Dutch) or zero subjects as in Chinese (which are limited to subordinate sentences otherwise). Nonetheless, Narrative sequences are still a special kind of List given by division of a segment topic by splitting up the temporal location.

The most marked cases from the perspective of *NEW are Contrastive Pairs and Concession. In both cases, the sentence topic of the first DCU (the concession) is a subtopic of the sentence topic and affirms it. The second DCU denies the remainder of the topic, often by entailing or implicating the falsity of the remainder.

Concession is the special case. The truth of the concession in a Concession is a reason for thinking that the whole segment topic is true. The second clause corrects this. In a Contrastive Pair, the causal connection between the first clause and the falsity of the second is not given. For contrast, it is sufficient that the segment topic contains both a part that is affirmed and a part that is denied, as is argued in Umbach (2001).

Contrastive Pair is always marked by two intonationally prominent constituents in each clause, if not by a contrastive marker. It is even harder to make Concessions without an overt marker of concession.

While it is possible to have explicit antecedents for the segment topic of Contrastive Pairs and Concessions (normally a question), this is rare. It is also not necessary, since the pairs give enough information to reconstruct them. In a formal version of this material, one should decide between

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8 Movement of time is intimately connected with the aspectual systems one finds in many languages. Perfective marking can be described as locating the event at a given point to reach another later point in time. If another perfectly marked event is located there, the contingency relation that for Hobbs (1979) is definitional of Narration is nearby, since the resulting state of the first event should hold when the second event occurs, thus making it part of the circumstances that allow the second event to occur.
representing such Contrastive Pairs and Concessions by inserting a zero pivot, that creates the segment topic or by assigning an extra superordinate segment topic to the pair.

This section tried to show that *NEW structures the inventory of discourse relations. While the pivot itself may deal with a wider topic, the default is to go on with communicating the experience reported in the pivot. Within this default, there is a further default of preserving the location and main participant, followed by parts of that and followed in turn by Cause and Justification. If the pivot is abandoned, the default is to retain the segment topic, i.e. keep on doing what the pivot was doing. This default is broken in contrasts and concessions.

So-called discourse popping is not a rhetorical relation. It is a breach of the default that the pivot is the last simple DCU. Discourse popping results if the last simple DCU cannot be the pivot, i.e. if the utterance cannot be constructed to be on the issue of the last simple DCU or contributing to the segment topic of the last simple DCU. In that case, the next candidate for the pivot is the segment topic.

The contingency that is typical of Narration can be strengthened into causality (Result). In the set-up of this paper this is a question of addressing the question what caused the second event, a question that would be activated by any event report. RELEVANCE then lets the interpreter assume that the first event is the cause of the second. All that is needed is that the first event is a plausible cause of the second. This reconstructs Result. It is natural to assume that pragmatic strengthening by RELEVANCE is responsible for other discourse relations. Narration is a strengthened form of List (is the DCU contingent on the pivot?), Explanation or even Justification are strengthened forms of Background, Conclusion is a strengthened form of Reformulation (taking a List as its pivot), Concession a strengthened version of Contrastive Pair.

This section tried to argue that *NEW is the only default in inferring discourse relations and that the basic classification of the rhetorical relation a DCU bears to its pivot is a classification of the ways *NEW is transgressed and obeyed. The full classification of rhetorical relations involves RELEVANCE which is responsible for inferring the strongest relationship, if this is allowed by PLAUSIBILITY. At the same time, overt marking, obligatorily resolved elements (all part of FAITH), contingency estimates, estimates about possible causes and reasons, and estimates about what can address which topic (PLAUSIBILITY) have an important role to play in the actual processing. While most of these allow of a computational treatment, PLAUSIBLE is an exception as long as good empirical approaches to plausibility estimation are not available. These seem to be within reach however.

7 Discourse Trees

The hierarchical structure normally assumed in accounts of rhetorical structure comes out in the current approach. A DCU dominates all DCUs of which it is the segment topic. A complex DCU is a maximal sequence whose members share a segment topic or a Contrastive Pair. Interruptions are not in the tree, though they may have a tree structure themselves.
The tree structure can also be broken by full shifts of topic. This seems an improvement on various approaches in which everything needs to be integrated in a tree, even if they are incoherent by definition. The approach is also not committed to see the tree as the object computed in discourse processing; it just computes the relation between a new DCU, finds the pivot and computes the integration of the new DCU with its pivot. The outcome determines the tree, but the tree is not itself important for interpretation or processing.

The right frontier constraint is a constraint on what the pivot can be. By default, it is the last simple DCU. If that does not work, the more complex DCU terminating at the new DCU can be considered to be pivot. Moving to the segment topic of an unsuitable candidate is the next step and these moves can be iterated. It follows the activation patterns. Segment topics of segment topics are less activated. The last element processed is more activated than the sequence or pair to which it belongs.

8 Context Dependency

The theory of Montague (1974) and Kaplan (1989) makes model-theoretic interpretation of an utterance dependent on a set of context parameters. The ambition of current dynamic semantics is to improve on that by including an account of how the utterance changes those parameters. Concentration has been here on one parameter in particular, the information that is available, it being taken for granted that somehow the value of the other parameters can be recovered from that. There are ways of doing that.

It is not sufficiently realised that accounts of rhetorical structure have an important role to play here. They make the interpretation of the current utterance dependent on the pivot as the major source of the context parameters and constrain the choice of the pivot. Moreover, the dependency varies with the relation of the utterance to the pivot, and it is the task of an account of rhetorical structure to explain how it works in particular cases.

The system described in this paper has no pretence at being a mechanistic account that fully determines how the contextual parameters influence the interpretation of the utterance. From an abstract perspective, the opposite appears to be true. It is quite easy to construct situations in which formally correct language use does not allow the context to fully determine the interpretation of the utterance.

But one can hope that in actual language use this only happens by mistake and that full determination of content is not a question of luck but the aim of language users, using syntax as well as plausibility, *NEW and relevance. Language users can aim for that situation because they are interpreters themselves and so can estimate the degree to which the process will result in the recognition of their intention. In fact, they would use a bidirectional filter. It would be far-fetched to call the proposals of this paper a logic of pragmatics, but it is a way to extend the Montague-Kaplan proposals to the full range of context dependency and to incorporate the task of determining the context for the next utterance.
9 Conclusion

Apart from providing another application area for OTP (Zeevat (2007a) (presupposition), Zeevat (2007b) (implicatures and pronouns)) and thereby giving an account of rhetorical structure in general pragmatics rather than treating it as an area of its own, this paper makes a number of points particular to rhetorical structure. This is the list.

1. Both Hobbs et al. (1990) and Lascarides (1993) and Asher and Lascarides (2003) are approaches to rhetorical structure in which a general theory of common sense reasoning is extended with axioms for rhetorical structure. The approach in this paper largely vindicates that strategy by giving a central place to plausibility. The nature of the rhetorical structure processing is however conceived in a different way by strictly ordering the application of the four constraints. This makes PLAUSIBLE, *NEW and RELEVANCE produce defaults and makes it impossible that the defaults produced by the higher constraints can be overridden by the lower ones. This is computationally simpler.

The approaches of Hobbs and Asher & Lascarides can also be described as “plausibility reigns supreme”. Or better, since these authors assume prior semantic processing, “plausibility reigns supreme after FAITH”. In this paper, it was shown that a whole range of rhetorical structure defaults follow from *NEW and RELEVANCE and that plausibility is merely a filter. This seems an improvement.

2. An important innovation is concerned with pronouns and other items that are obligatorily resolved. Pronoun resolution is rightly regarded as pragmatic core business: it cannot be done in syntax or in the semantic composition rules and it is governed by defaults and heuristics. In the OTP of this paper, the actual resolution is separated from the necessity of resolution. It is easy to think that *NEW has something to do with pronoun resolution (its precursor DOAP stands for “do not miss anaphoric possibilities”), but it would be quite unable to make the resolution of pronouns obligatory. In fact, it would be better not to resolve if the resolution would result in implausibility, as e.g. in corrections that are maximally implausible in the contexts that warrant them. This means that the need to resolve a pronoun is due to a syntactic rule that can and therefore must realise a highly activated discourse referent with a personal pronoun. The recognition of a pronoun is therefore incomplete without assigning it a highly activated discourse referent as its referent. The fact that pronouns need to be resolved is therefore part of FAITH. If there is more than one highly activated discourse referent, the decision between them is constrained by PLAUSIBLE. The need to resolve pronouns and other anaphoric items is a powerful factor in recognising rhetorical structure.

3. Rhetorical relations are not given by heaven but classify different transgressions of *NEW and can be strengthened by RELEVANCE. The exceptions are debatably Narration and —much less debatably— Concession. This points to a universal grammaticalisation process for possibly Narration and for Concession.

4. The implementation strategy for OTP is more straightforward than for either abduction or SDRT. One needs a model for FAITH which assigns

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9 Asher and Lascarides (2003) reject their earlier assumption of default discourse relations.
10 I owe this point to David Beaver p.c. commenting on a draft of Zeevat (2001)
semantic representations to utterances. Any model is in principle fine, in particular all the existing models in natural language semantics, such as Montague grammar, DRT, or GB inspired approaches. Then one requires a model for estimating plausibility. Good empirical methods are still missing, but it is reasonable to expect progress here. Counting discourse referents and investigating their status is trivial. The current proposal for relevance is not difficult to implement if one formulates rules for activating questions. Part of these rules are given in the literature on natural language generation and others can be added (e.g. the questions that presupposition triggers activate and that cause accommodation in Zeevat (2007a). Others may be connected to plausibility: low plausibility information naturally raises questions of cause and justification. The algorithm would eliminate successively candidates supplied by FAITH by means of plausibility, *NEW and RELEVANCE.

Alternatively, the algorithm could operate from an underspecified representation coming out of the model for FAITH, to which PLAUSIBLE, *NEW and RELEVANCE try to add extra information.

References


