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Integrating informational and intentional theories of discourse coherence

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This paper explores the ways in which insights from the two influential formal pragmatic theories of discourse coherence, namely, Question Under Discussion (QUD) and Rhetorical Relation (RR) models, can be integrated to build a more inclusive theory of discourse coherence. It proposes a simple and concrete procedure to derive the hierarchical structure of discourse from the subquestion relations between implicit QUDs reconstructed using informational structural principles (Riester 2019; Reyle & Riester 2017) and contextual entailment relations (Roberts 2012). It applies the procedure to discourse examples involving various RRs to determine subordinating and coordinating relations and to create a parsimonious feature-based inventory of RRs with formal definitions. The resulting theory shows that establishing the QUD-RR correspondence is possible, contrary to what has been claimed (Hunter & Abrusán 2017; Onea 2019; Riester 2019).

1 Introduction

The meaning of a discourse is not equal to the mere sum of all the sentences occurring in it. A discourse is meaningful because it is coherent—that is, the sentences in a discourse must hang together for the discourse to be well-formed and convey meaning. Consider an often-cited example (1) from Hobbs (1979). (1a) is not understood as merely a list of two separate facts about John, but rather as related statements: The second sentence is thematically connected to the first, providing a reason for him to go to Istanbul. In contrast, (1b) is awkward because it is not easy to see how the second sentence is possibly connected, and thus relevant, to the first.

(1) a. John took the train from Paris to Istanbul. He has family there.
 b. #John took the train from Paris to Istanbul. He likes spinach.

Even in those cases where coherence relations are not explicitly marked with a conjunction or an adverbial, as in (1a) above, they are nonetheless effortlessly inferred, organizing the discourse into a systematic structure and establishing the most natural inter-clausal dependencies. Theoretically fleshing out this intuitive idea, however, turns out to be a nontrivial task. Rhetorical Relations, such as *Narration*, *Explanation*, *Elaboration*, etc., have been proposed as a way to explain coherence (Hobbs 1979; 1990; Mann & Thompson 1986; 1988; Kehler 2002; Asher & Lascarides 2003). In (1a), an *Explanation* relation can be established between the two sentences, but no apparent Rhetorical Relation can intervene between the two sentences in (1b), rendering it incoherent. It has also been argued that a coherent discourse must address a discourse topic (Question Under Discussion, or the speaker's intention) and should not digress from it (Carlson 1983; Grosz & Sidner 1986; van Kuppevelt 1995; Ginzburg 1996; 2012; Roberts 2012). (1) is about John's trip, and the discourse participants are committed to resolving the question "What was John's trip like?". Whereas "Why was he going to Istanbul?" is a legitimate question in this regard, "What vegetable does he like?" obviously does not help answer the intended question at hand, explaining why (1b) sounds incoherent.

These two influential formal pragmatic theories of discourse coherence, namely, the **Question Under Discussion** (**QUD**) model and the **Rhetorical Relation** (**RR**) theories, highlight different aspects of discourse and thus have been developing largely independently from each other. RR-based theories focus on the informational aspect of discourse and are supposed to represent its interpretation, which has to be incrementally processed bottom-up (unless the discourse begins with a summary statement or the discourse goal is laid out at the outset). Strategies for resolving the QUD, on the other hand, focus on the intentional aspect and the production of discourse, mostly relying on a top-down processing. The domain/discourse goal must be set before strategies to achieve it can be devised. As a result, despite their common objective of explicating discourse coherence, only a few studies have examined a possible connection between them. Roberts (2004; 2012) informally discusses the correspondence between RRs and QUDs (e.g., *Explanation* relation and "why?" QUD). Hunter & Abrusán (2017) reach a negative conclusion, namely, the impossibility of direct modeling of rhetorical structures in terms of QUDs. Following a suggestion by Hunter & Abrusán (2017), Riester (2019) abandons the subquestion requirement between implicit QUDs reconstructed from RRs, which significantly weakens the predictive power of the QUD theory. Similarly, Onea (2019) expands the notion of a subquestion by treating it as a special case of dependent or 'potential' questions, which are not taken to be constraints/filters on discourse coherence.

Although the intentional and informational approaches of discourse interpretation can be quite different, there seems in principle no reason why the goal-oriented perspective of QUD theories cannot be reconciled with the representational framework of RR theories. This paper proposes an account that establishes a direct correspondence between QUD and RR, which will help develop a more inclusive theory of discourse coherence that captures the inherent connection between the informational and intentional tropes of discourse. This paper proposes three simple steps to establish a correspondence between QUD and RR. First, implicit QUDs are reconstructed from a text following the Maximize Q-Anaphoricity principle (Reyle & Riester 2018; Riester 2019), assigning the narrowest focus possible to the constituent sentences. Second, a subquestion relation, if one is present, between the implicit QUDs obtained from the first step is identified using Roberts' (2012) contextual entailment relations, incorporating information in the common ground. Third, coordinating vs. subordinating RRs are determined based on the subquestion relation established in the second step. In a nutshell, if there is a subquestion relation between the implicit QUDs, then the RR connecting the constituent sentences is subordinating; if not, then the RR is coordinating. This test will classify most RRs (*Result*, *Explanation*, *Exemplification*, etc.) as subordinating and *Occasion*, *Parallel*, and *Contrast* as coordinating. Following these steps will establish the desired mapping between QUD and RR. That is, the relations between constituent sentences connected via an RR in a text will match the subquestion relations between QUDs that are congruent with them, highlighting the strategic nature of coherence discourse and thus maintaining the theory's predictive/explanatory power. A systematic feature-based taxonomy of RRs will emerge in the process and will be given formal definitions.

Coherence relations are linguistically interesting because they do not solely derive from extralinguistic performance factors and/or rational behaviors. Instead, they are semantic relations contributing to the logical form of a discourse and have (non-monotonic) truth-conditional semantics. As such, they are not easily defeasible or reinforceable (Mann & Thompson 1986).[1] Recent years have seen an outpouring of experimental studies proving the effect of

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[1] Adding the denial of the inference in (ib) makes the discourse incoherent.

(i) a. I'll give you a free tour of the development. My phone number is 555–9876.
    b. #But calling that phone number won't help you to get the tour.

QUD and RR on grammatical processing and interpretation. Both off-line and on-line tasks (truth value judgment, sentence completion, self-paced reading, eye tracking, etc.) demonstrate the influence of QUD on a wide range of syntactic and semantic phenomena, such as scope ambiguity resolution, scalar implication calculation, relative clause attachment, verb semantics, exhaustivity inference in clefts, and pronoun resolution, to name a few (Clifton & Frazier 2012; Kehler & Rohde 2017; Rohde et al. 2011; Ronai & Xiang 2020; Zondervan et al. 2008; a.o.). Similarly, the semantic features involved in RRs like causality, polarity, and textual order have shown through experimental studies to be psychologically real. A large body of psycholinguistic literature (employing visual world, self-paced reading, ERP, etc.) has shown that participants differ in their acquisition, representation and processing of additive vs. causal relations (Bloom et al. 1980; Knott & Dale 1994; Knott & Sanders 1998; Sanders et al. 1992) and positive vs. adversative relations (Crible 2021; Evers-Vermeul & Sanders 2009; Köhne-Fuetterer et al. 2021; Knoepke et al. 2017). The empirical interests of discourse coherence and the significant role that QUD and RR play in meaning and grammar processing, as evidenced by these recent experimental studies, make the construction of a unified theory of discourse coherence an urgent task.

This paper is organized as follows. Section 2 briefly introduces the QUD and RR theories of discourse coherence to provide background. Section 3 discusses previous attempts to combine the QUD and RR approaches to set the stage for the current analysis, which is presented in Section 4. Section 5 concludes the paper with a summary and directions for future research.

2 Question Under Discussion and Rhetorical Relations

2.1 Question Under Discussion

The QUD model (Carlson 1983; Beaver & Clark 2008; Ginzburg 1996; Roberts 2012) has arisen as an influential framework for formal pragmatic analyses, offering a concrete and interesting (i.e., falsifiable) theory to analyze the elusive notions of discourse coherence and relevance. According to this theory, conversational goals and the strategies to achieve them are at the center of discourse organization. Goals of discourse can be viewed as questions that the interlocutors are committed to answering. The accepted question becomes the immediate topic of discussion, dubbed QUD. QUDs and their answers are partially ordered in terms of the strategic relations, with an ultimate goal of answering the big question “What is the way things are?”

Roberts (2012) develops a QUD-based theory in detail, arguing that the context includes a set of questions or issues under discussion partially ordered by contextual entailment, as illustrated by her small fragment discourse example in (2). This discourse assumes only two people, Hillary

Making the inference explicit as in (iib) is redundant, destroying the coherence of the narrative.

(ii) a. I went hitchhiking in Norway. Nobody would pick me up.
b. #It was in Norway that nobody would pick me up.

and Robin, and two food items, bagels and tofu. The interlocutors' goal is to find out who ate what.

(2) Who ate what?

a. What did Hilary eat?

i. Did Hilary eat bagels? Ans(ai) = no

ii. Did Hilary eat tofu? Ans(aii) = yes

b. What did Robin eat?

i. Did Robin eat bagels? Ans(bi) = yes

ii. Did Robin eat tofu? Ans(bii) = no

The QUDs form a stack in which questions higher on the stack are subquestions of the lower, previously accepted questions on it. As the subquestions are answered, they pop out of the stack, revealing a bigger question. For example, when ($2a_i$) and ($2a_{ii}$) are answered, (2a) will be removed from the current QUD stack, but the larger QUD "Who ate what?" will remain on the stack until (2b) is fully answered. The meaning of a QUD like "What did Hillary eat?" is formalized as a set of relevant alternatives that the interlocutors are considering, called '*q*-alternatives' (e.g., {Hilary ate u: $u \in D$} where D is the domain of discourse). Coherent discourse requires that the focus structure of an utterance be congruent with the *q*-alternatives for QUDs (Büring 2003; von Stechow 1991). For example, "Hillary ate [$_F$ tofu]" is a relevant utterance in this context since the focal alternatives for "tofu" are the *q*-alternatives for the question "What did Hillary eat?". An utterance is **relevant** as long as it introduces a partial answer to the question, in the case of assertions (e.g., "Hillary ate tofu"), or is part of a strategy to answer it, in the case of questions (e.g., "What did Hillary eat?"). The notion of a **strategy of inquiry** relative to a QUD is defined in (3). The ordered pair which Strat yields for a given question q, $\langle q, S\rangle$ reads "the strategy to answer q by conducting the set of subinquiries in S" (ibid.: 18). *Acc* stands for 'accepted questions'.

(3) The strategy of inquiry which aims at answering q, Strat(q):
For any question $q \in Q \cap Acc$, Strat(q) is the ordered pair $\langle q, S\rangle$, where S is the set such that:
If there are no $q' \in Q$ such that QUD(q') = $\langle \ldots q\rangle$, then $S = \varnothing$.
Otherwise, for all $q' \in Q$, QUD(q') = $\langle \ldots q\rangle$ iff Strat(q') $\in S$.

For (2) above, Strat yields (4):

(4)

a. $\text{Strat}(a_i) = \langle a_i, \varnothing\rangle$

b. $\text{Strat}(a_i) = \langle a_{ii}, \varnothing\rangle$

c. $\text{Strat}(a) = \langle a, \{\langle a_i, \varnothing\rangle\}, \{\langle a_{ii}, \varnothing\rangle\}\rangle$

d. $\text{Strat}(b_i) = \langle b_i, \varnothing\rangle$

e. Strat(b_i) = ⟨b_{ii}, ∅⟩
f. Strat(b) = ⟨b, {⟨b_i, ∅⟩}, {⟨b_{ii}, ∅⟩}⟩
g. Strat(2) = ⟨2, {⟨a, {⟨a_i, ∅⟩}, {⟨a_{ii}, ∅⟩}⟩, ⟨b, {⟨b_i, ∅⟩}, {⟨b_{ii}, ∅⟩}⟩}⟩

(4a), (4b), (4d), and (4e) indicate that QUDs a_i, a_{ii}, b_i, and b_{ii} have no subinquiries (i.e., there are no questions higher on the QUD stack). (4c) and (4f) show that QUDs a and b are answered by conducting the subinquiries (4a), (4b), (4d), and (4e). According to (4g), the strategy to answer (2) includes two subinquiries of answering a and b. Given these relations, any question q is part of a strategy to answer q' only if a complete answer to q contextually entails a partial answer to q'. The QUD stack is formally defined in (5).

(5) The QUD stack is a function from M (the moves in the discourse) to ordered subsets of $Q \cap Acc$ (the set of accepted questions) such that for all $m \in M$:
  a. For all $q \in Q \cap Acc$, $q \in$ QUD(m) iff
    i. $q < m$ (i.e., neither m nor any subsequent questions are included) and
    ii. CG(m) fails to entail an answer to q and q has not been determined to be practically unanswerable. (CG stands for common ground)
  b. QUD(m) is (totally) ordered by $<$.
  c. For all $q, q' \in$ QUD(m), if $q < q'$, then the complete answer to q' contextually entails a partial answer to q.

Contextual entailment is defined in (6):

(6) A question q_1 contextually entails another q_2 iff answering q_1 in a discourse context with common ground CG is such that CG ∪ Ans(q_1) entails a complete answer to q_2.

Note that (4c) does not require that all questions on a QUD stack entail those higher on the stack. Roberts (2012) uses the subquestion relations in (7) to explain why.

(7) a. What kinds of seafood will John eat?
  b. Isn’t John allergic to clams?

If the answer to (7b) is negative, then it does not entail John will eat clams because he might have other reasons for not eating them, e.g., he keeps kosher. Hence, (7a) does not entail (7b), i.e., the answer to (7b) does not give a partial answer to (7a). She argues that (7b), however, implicitly assumes a **bridging question** “What reasons would John have for not eating clams?”, whose answer contextually entails a complete answer to (7b). Since an answer to the bridging question provides a partial answer to (7a), (7b) can count as a subquestion of (7a) via this question, assuming that the CG includes the proposition “One eats whatever one has no reason not to”.

The theoretical utility of QUD is that it not only helps precisely define the vague notions of discourse topic and relevance, but it can also predict how the discourse will proceed based on the strategy of inquiry. Moreover, an important semantic distinction that was obscured in traditional semantic theories, namely, that between 'at-issue' content, which directly answers a QUD, and 'not-at-issue' content (e.g., expressive, appositive), which does not, has been made prominent in this model, generating rich literature on layers of meaning (Potts 2005; Tonhauser et al. 2013; a.o.).

2.2 Rhetorical Relations

The RR-based theories of coherence maintain that sentences in a coherent discourse must stand in some type of meaningful relations, such as *Narration*, *Explanation*, *Elaboration*, *Parallel*, and *Contrast*, to name a few. A simple list of open-ended and unordered relations with some intuitive taxonomy, however, falls short of being a theory (Hobbs 1979). To properly constrain the list of RRs, rather than adding them whenever a new relation is needed to describe texts (e.g., Mann & Thompson's (1986; 1988) Rhetorical Structure Theory), Hobbs (1985; 1990; 2006), Sanders et al. (1992), and Kehler (2002; 2022) propose systematic ways to organize and characterize them. For instance, Kehler's (2002) categorization is inspired by the philosopher Hume, who suggested three basic cognitive mechanisms for connecting ideas, namely, *Resemblance*, *Cause-Effect*, and *Contiguity*. The ***Resemblance*** relations are based on categorization and subsumptive reasoning within a semantic hierarchy (analogical reasoning). The ***Cause-Effect*** relations are based on inferential axioms within a knowledge base (implicational reasoning). The ***Contiguity*** (in space and time) relations depend on some scriptal knowledge about sequences of intermediate states that make up a coherent event. Kehler's (2002) *Resemblance* class subsumes the RRs *Parallel*, *Contrast*, *Exemplification*, *Generalization*, *Exception*, and *Elaboration*, defined in (8), in which *P* and *Q* are predicates and a_i and b_i are arguments.

(8)
a. *Parallel*: Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $P(b_1, b_2,...)$ from the assertion of S_1 where for some property vector Q, $Q_i(a_i)$ and $Q_i(b_i)$ for all i.
b. *Contrast* (i): Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $\neg P(b_1, b_2,...)$ from the assertion of S_1 in which for some property vector Q, $Q_i(a_i)$ and $Q_i(b_i)$ for all i.
c. *Contrast* (ii): Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $P(b_1, b_2,...)$ from the assertion of S_1 where for some property vector Q, $Q_i(a_i)$ and $\neg Q_i(b_i)$ for some i.
d. *Exemplification*: Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $P(b_1, b_2,...)$ from the assertion of S_1 where b_i is a member or subset of a_i for some i.
e. *Generalization*: Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $P(b_1, b_2,...)$ from the assertion of S_1 where a_i is a member or subset of b_i for some i.
f. *Exception* (i): Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $\neg P(b_1, b_2,...)$ from the assertion of S_1 where b_i is a member or subset of a_i for some i.
g. *Exception* (ii): Infer $P(a_1, a_2,...)$ from the assertion of S_0 and $\neg P(b_1, b_2,...)$ from the assertion of S_1 where a_i is a member or subset of b_i for some i.
h. *Elaboration*: Infer $P(a_1, a_2,...)$ from the assertions of S_0 and S_1.

His *Cause-Effect* class includes *Result, Explanation*, *Violated Expectation*, and *Denial of Preventer*, defined in (9).

(9) a. *Result*: Infer *p* from the assertion of S_0 and *q* from the assertion of S_1 where normally $p \rightarrow q$.
b. *Explanation*: Infer *p* from the assertion of S_0 and *q* from the assertion of S_1 where normally $q \rightarrow p$.
c. *Violated Expectation*: Infer *p* from the assertion of S_0 and *q* from the assertion of S_1 where normally $p \rightarrow \neg q$.
d. *Denial of Preventer*: Infer *p* from the assertion of S_0 and *q* from the assertion of S_1 where normally $q \rightarrow \neg p$.

Kehler's (2002) *Contiguity* only contains one relation, *Occasion*, defined in (10).

(10) a. *Occasion* (i): Infer a change of state for a system of entities from S_0, inferring the final state for this system from S_1.
b. *Occasion* (ii): Infer a change of state for a system of entities from S_1, inferring the initial state for this system from S_0.

RR also figures prominently in Asher & Lascarides' (2003) Segmented Discourse Representation Theory (SDRT). SDRT requires that new information be attached to the speech act discourse referent of the last clause in the preceding discourse with a particular RR. To illustrate, in the Segmented Discourse Representation Structure (SDRS) in (11), the speech act discourse referent associated with the event of John pushing Max, π_2, is connected to the speech act discourse referent for the event of Max falling, π_1, with the RR *Explanation*.

(11) Max fell. John pushed him.

$x, y, e_{\pi 1}, e_{\pi 2}$
Max(x) fall($e_{\pi 1}$, x) $e_{\pi 1} < \mathrm{n}$ John(y) push($e_{\pi 2}$, y, x) $e_{\pi 2} < \mathrm{n}$ *Explanation*(π_1, π_2)

The operating RR is inferred via commonsense reasoning with domain knowledge, which is calculated in a separate pragmatic system called 'the glue logic'. These are based on Gricean-style pragmatic maxims and world knowledge, i.e., they are defeasible laws which are assumed to form part of the hearer's knowledge basis. For example, *Explanation*(π_1, π_2) is inferred when there is evidence in the discourse that the event described by π_2 caused the event of π_1, i.e., $Cause_D(\pi_2, \pi_1)$.

SDRT is attractive in that its empirical coverage is not confined to individual utterances or a simple question-answer adjacency pair but extends to longer stretches of discourse. As a result, long-distance dependencies, such as pronoun resolution, which is often affected by RR, find a natural explanation in this theory. Consider Asher & Lascarides' (2003) favorite example in (12), in which the anaphoric link between "salmon" in (12c) and "it" in (12f) is impossible despite the fact that no blocking expressions such as "every" or "not" intervene between (12c) and (12f).

(12) a. John had a lovely evening.
  b. He had a great meal.
  c. He ate salmon.
  d. He devoured lots of cheese.
  e. He won a dancing competition.
  f. #It was a beautiful pink.

Figure 1 shows the discourse structure of (12) in a graphic form. *Elaboration* connects two clauses in a subordination relation, whereas *Narration* builds a coordination structure, with the resulting structure affecting anaphora resolutions.

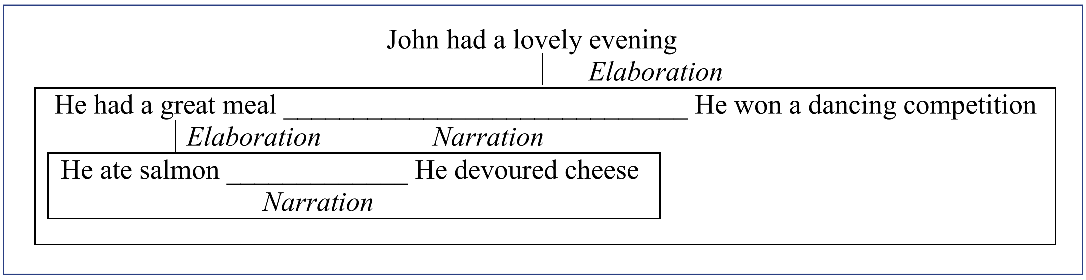

Figure 1: The discourse graph of (12).

Many scholars postulate the **right frontier constraint** (Asher & Lascarides 2003; Hobbs 1990; Grosz & Sidner 1986; Polanyi 1985; 2001; a.o.), which requires a new clause to attach either to the last node entered to the graph or one of the nodes that dominate the last node. Since the last node is usually located on the right of the structure, the nodes to which a new clause can attach are on the right frontier of the discourse graph or SDRS. In **Figure 1**, (12a) and (12e) are in the right frontier. This constraint blocks the pronoun in (12f) from binding to its antecedent in (12c) since (12c) is not on the right frontier when (12f) is introduced. The possible ways of continuing the discourse in (12) are thus constrained by the overall discourse structure: The possibilities are limited to elaborating on the dancing competition or to introducing a new event parallel to either John having a lovely evening or him winning the dancing competition. As such, like the QUD model, RR theories like SDRT offer a logical method of not only describing coherent discourse but also predicting possible continuations of it.

3 Theories on the relationship between RR and QUD in the literature

3.1 Roberts (2004)

Assuming that all discourses address implicit questions, Roberts (2004) points out that RR-based theories of discourse coherence such as SDRT do not make connections between intentions and questions, nor between RRs and strategies of inquiry. She informally sketches a possible connection between them using examples from Mann & Thompson (1986), who assign the *Solution-hood* relation between the two utterances in (13). According to Roberts (2004), (13a) triggers a domain goal, which in this case is satisfying the speaker's hunger. Therefore, the implicit QUD would be "How can the speaker's hunger be satisfied?". (13b) suggests an answer to that question, namely, going to eat at a specific restaurant.

(13) a. I'm hungry.
b. Let's go to the Fuji Gardens.

Mann & Thompson (1986) use *Contrast* to establish coherence between (14a) and (14b). Roberts (2004) points out that this RR by itself is an insufficient characterization of (14) since it cannot predict the types of context that allows utterances like it. Here, the QUD is "What do the interlocutors want?" and the answers to this question in (14a) and (14b) not only participate in a *Contrast* relation but are predicted to be felicitous in this context by the QUD account, given relevance.

(14) a. We don't want orange juice.
b. We want apple juice.

Mann & Thompson (1986) call the RR connecting (15a) and (15b) *Elaboration*. Roberts' (2004) QUD is "What are your hobbies?" The elaboration in (15b) is felicitous because it is part of a larger strategy to find out about the speaker, including her general likes and dislikes. According to Roberts (2004: 213), (15b) is relevant in the sense that it helps answer this big question, which is "what the query is really after," rather than minimally answering the immediate question.

(15) a. I love to collect classic automobiles.
b. My favorite car is my 1899 Duryea.

In sum, Roberts (2004) suggests that RRs can be seen as strategies for accomplishing (domain) goals in discourse. In a separate article, Roberts (2012: 62) also briefly discusses the connection between her QUD model and RRs, where she contends that the goal of discourse is not limited to offering more information but also includes deriving a consensus regarding the "value" of the information offered. A primary function of some RRs, she argues, is to convince the addressee that the information contributed is worth adding to the CG. One way of achieving this is by demonstrating how the new information explains or follows from already existing information in the CG.

3.2 Hunter & Abrusán (2017)

Hunter & Abrusán (2017) test two hypotheses regarding possible connections between RRs and QUDs. They reject the first obvious hypothesis that RRs directly correspond to QUDs (the R-QUD hypothesis). The main reason why a simple one-to-one correspondence between RRs and QUDs cannot be maintained, they argue, is that individual discourse units, not RRs, are ordered by constraints such as the right frontier in SDRT, while a QUD stack orders questions, not answers. As a result, the stack derived from the right frontier of a discourse would not necessarily be ordered by the subquestion relation. (16) illustrates their point.

(16) a. We had so much fun in London! (π_1) We got to see the Lion King! (π_2) I've been wanting to go for a really long time (π_3) and my mom finally gave me tickets for my birthday! (π_4) We also got to ride on the big Ferris wheel (π_5) ...

b. *Elaboration*(π_1, π_2), *Background*(π_2, [π_3, π_4]), *Continuation*(π_3, π_4), *Elaboration*(π_1, π_5), *Continuation*(π_2, π_5).

c. (q_1) What did you do? (q_2) What makes that so exciting?

(16c) lists two QUDs corresponding to the first two RRs, *Elaboration* and *Background*. They are stacked in such a way that q_2, the more recent question, is on top of q_1. *Elaboration*(π_1, π_5) and *Continuation*(π_2, π_5) in subsequent discourse indicate that q_1 has not completely resolved and thus is still on the stack of open questions when π_3 and π_4 are introduced. The problem is that q_2 is not a subquestion of q_1, leaving unanswered why π_3 and π_4 are still coherent and relevant.

As an alternative, Hunter & Abrusán (2017) suggest that QUDs may be associated with **Complex Discourse Units (CDUs)** since a CDU and the RR connecting its members have the potential to yield the desired planning structure (the CDU-QUD hypothesis). That is, the content CDUs, which reveal a topical cohesion, can be analyzed as complex answers to implicit QUDs, since the set of CDUs in a discourse will naturally give rise to a partial order based on a subset relation. If a CDU π_1 includes a CDU π_2, the set of members of π_2 will be a proper subset of the set of members of π_1. From these premises, they explore the possibility that if a CDU π_2 is a member of another CDU π_1 then QUD(π_2) is a subquestion of QUD(π_1). To illustrate this, they analyze the SDRT's classic example in (12) above, repeated in (17a).

(17) a. John had a lovely evening (π_1). He had a great meal (π_2). He ate salmon (π_3). He devoured lots of cheese (π_4). Then he won a dancing competition (π_5).

b. *Elaboration*(π_1, $\pi_{2\text{–}5}$), *Narration*(π_2, π_5), *Elaboration*(π_2, $\pi_{3\text{–}4}$), *Narration*(π_3, π_4)

c. (q_1) What was John's evening like? (q_2) What did he do? (q_3) What did he eat?

In (17), π_{1-5} is associated with q_1, π_{2-5} is associated with q_2, and π_{3-4} is associated with q_3. Note that π_{2-5} is included in π_1 and π_{3-4} is included in π_{2-5} because the former is related to the latter in terms of an *Elaboration* relation. These RRs naturally generate a set of questions ordered by the subquestion relation, i.e., $q_3 < q_2 < q_1$.

Hunter & Abrusán (2017) point out that this neat subquestion relation, however, breaks down for CDUs related in terms of other subordinating RRs, citing the example in (18).

(18) a. Yesterday John and his wife went to the fanciest restaurant in Paris (π_1). It was John's birthday (π_2), and his wife wanted to spoil him (π_3).
b. *Explanation*(π_1, π_{2-3}), *Result*(π_2, π_3)
c. (q_1) What did John do yesterday*?* (q_2) Why did he do this?

Two CDUs are built out of (18): π_{1-3} and π_{2-3}. Although π_{2-3} is a subset of π_{1-3}, the question associated with the latter, q_2, is not a subquestion of the question associated with the former, q_1. Therefore, CDU-QUD correspondence is only applicable when the CDU π_2 attaches to the top node of the prior CDU π_1 with a relation that entails sub-eventhood, like *Elaboration*. This means that CDUs are no longer able to form a plan or strategy to achieve a discourse goal. Hunter & Abrusán (2017) suggest that one way to salvage the idea of a CDU-QUD correspondence is to relax the requirement that QUDs be ordered by the subquestion relation, instead allowing strategies for achieving discourse goals that are more multifaceted and complex.

3.3 Riester (2019)

The suggestion by Hunter & Abrusán (2017) is taken up by Riester (2019), who abandons the subquestion requirement between implicit QUDs reconstructed from RRs, thus deviating significantly from Roberts (2012). Such constraint, he asserts, is neither necessary to maintain coherence nor realistic when actual discourse is considered. In (19), which is a slight modification of (12) above, the "what-about" question is not a sub-question of the "what" question, but the discourse is still coherent. As previously discussed, this point has been driven home by Hunter & Abrusán (2017), as well.

(19) (What did John do?) John had a lovely evening. He had a great meal. (What about the meal?) It was cooked by a famous chef and it was rather expensive. He won a dancing competition.

As long as a new utterance has some topical connection to an immediately preceding utterance, Riester (2019) contends, it needs not address a question that is already in the QUD stack. To theoretically flesh out this idea, he proposes the 'compact QUD-tree format' in **Figure 2**, in which topically connected (or anaphorically dependent) questions appear to the right of their antecedents and thus need not be entailed. This format also has the advantage of separating questions and assertions by restricting the former to the non-terminal nodes, and the latter to the terminal nodes.

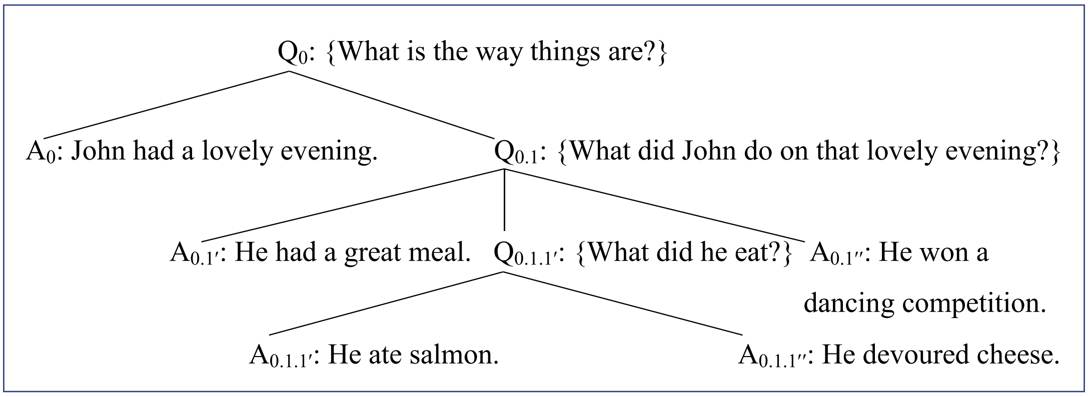

Figure 2: The compact QUD-tree for (12).

Assuming this more flexible tree structure, Riester (2019) argues that subordinating discourse relations can be directly replaced by questions (e.g., *Explanation* by a "why" question and *Elaboration* by a "what-about" question), contra Hunter & Abrusán (2017). The coordinating discourse relations, e.g., *Narration*, are replaced by a series of parallel questions about different times "What happened at t_i?", à la von Stutterheim & Klein (1989).

To constrain the implicit QUDs, whose number can be as many as the number of constituents in a sentence taken out of context, Riester (2019) suggests the pragmatic principle in (20). This general principle corresponds to 'Avoid-F' (Schwarzschild 1999) or 'Maximize-Anaphoricity' (Büring 2008) in the previous literature on focus.

(20) **Maximize-Q-Anaphoricity**: Implicit QUDs should contain as much given (or salient) material as possible.

He illustrates how (20) prevents overgeneration and offers a deterministic procedure of the QUD reconstruction. He cites the example in (21), which can be an answer to any of the questions in (22).

(21) He literally suffocated.

(22) a. What happened?
b. What about him?
c. Who literally suffocated?

Only when (21) is embedded in a discourse context, as in (23), can we rule out some potential QUDs, namely, (22c).

(23) And all I can say is that his condition was extremely bad during his last years (π_1). He literally suffocated (π_2).

Maximize-Q-Anaphoricity further eliminates (22a), selecting (22b) as the QUD for (21).

3.4 Onea (2019)

Onea's (2019) theory is inspired by Wisniewski's (1995) erotetic inference system, in which questions can serve the role of conclusions. An erotetic inference is a process where one arrives at a question on the basis of some previously accepted declaratives and/or a previously raised question. The criteria of validity for the inferences between questions are precisely defined in this system. A question is sound if at least one possible answer to it is true. For example, the question in (24c) is a conclusion following from the assertions in (24a) and (24b).

(24) a. The theory of ideas is presented in the writings of Plato.
b. If the theory of ideas is presented in the writings of Plato, then it was invented by either Plato or Socrates.
c. Who invented the theory of ideas: Plato or Socrates?

A question can follow from another question, as illustrated in (25).

(25) a. Was Plato a pupil of Socrates and a teacher of Aristotle?
b. Was Plato a pupil of Socrates?

Wisniewski's (1995) definitions of erotetic implication explicate the relevant notions of question raising/evocation.

Onea (2016; 2019) refers to questions that are evoked based on valid erotetic inference as 'potential questions'. He observes that in the process of addressing a question, an auxiliary question is often raised which is not a subquestion in a strict sense but still is necessary for answering the original question. That is, assertions are not only answers to QUDs, but also lead to potential questions or PQs, defined in (26).[2]

(26) Potential questions (Onea 2019: 158)
If a question q has a supposition p and some assertion π in discourse makes p significantly more probable, then π licenses q as a potential question.

A supposition is defined as a kind of general, weak pragmatic presupposition. For example, in (27), the supposition that someone might be in the house is made more probable by A's assertion that the lights are on. Therefore, A's utterance licenses B's question as a PQ.

(27) A: Look, the lights are on.
B: I wonder who might be in the house?

He treats the erotetic structure (Wisniewski 1995) and rhetorical structure of discourse as two levels of analysis of the same phenomenon, albeit with the latter being deemed a higher level of

[2] Onea's (2016; 2019) PQs can be seen as a more formalized version of van Kuppevelt's (1995) subquestion-hood (or sub-topic), which applies when an answer to a question is not fully satisfactory, leading to another question to resolve the same issue.

abstraction than the former. He derives subordinating and coordinating RRs from his PQs, as his definitions in (28) show.

(28) a. If the question q answered by π_2 is licensed by π_1 as a PQ, the relation between π_1 and π_2 is subordinating.
b. If, π_1 answers q_1 and π_2 answers q_2 and both q_1 and q_2 are licensed by a node π_0 as PQs, the relation between π_1 and π_2 is coordinating.

Onea (2019), however, emphasizes that PQs are by no means a filter for valid/coherent discourse moves. For instance, B's question in (29) is not a licit PQ but still constitutes a perfectly acceptable discourse continuation.

(29) A: Mary kissed John.
B: Who else kissed John?

According to Onea (2016; 2019), the notion of subquestion is only a very special case of dependent questions where the speaker knows the answer but addresses all subquestions in order not to miss any alternative. A more common situation, he argues, is when there is lack of complete information. He asserts that discourse is only partially strategic, as it is also driven by reactions to new information introduced by the interlocutors. The idea of 'loosely strategic discourse', he assumes, complements the idea of Roberts (2012): PQs are basically discourse devices for deviating from strictly strategic discourse while preserving Roberts' basic idea that discourse is goal-oriented, and that discourse goals can be best understood as questions.[3]

4 A new integrated analysis

Removing or even relaxing the requirement that QUDs be ordered by the subquestion relation, which was suggested by Hunter & Abrusán (2017) and executed in Riester (2019) and Onea (2019), sacrifices much of the explanatory and predictive power of the original QUD model. Riester (2019: 174) states,

> "It is sometimes suggested that QUDs 'arise' or 'follow' from the previous context and then 'guide' the way how the subsequent discourse is going to evolve. Nothing could be more wrong than that. In fact, the only rule that speakers or writers must observe when formulating

[3] Other notable proposals to amend QUD include Rojas-Esponda (2013; 2014), who incorporate presuppositions to Roberts' QUD. She points out that the presupposition in a superquestion may be lacking in subquestions (e.g., "Who ate what?" presupposes that each person in a contextually relevant set ate something, while "What did Hillary eat?" only has a weaker presupposition that Hillary ate something and "Did Hillary eat tofu?" has no presupposition). To be able to track presuppositions, she relaxes the definition of questions so that they can be a partition on a subset of the world set (rather than the entire set of worlds, cf. Groenendijk & Stokhof 1984). Her main concern is restricted to tracking presuppositions, which differs from our goal of integrating QUD and RR theories and therefore her ideas are not discussed in detail.

their next move is to think about some topical connection to whatever was said before, but in all other respects they are free to formulate their own continuation of the plot."

It is unclear, however, how "some topical connection" can be clarified. As observed in (1b) above ("John took the train from Paris to Istanbul. He likes spinach."), sharing the same topic entity is not sufficient for discourse coherence. Onea's (2019) PQs are more constrained, but they too are not taken to serve as filters on discourse coherence. This section will develop a theory that maintains the QUD-RR correspondence meeting both descriptive and explanatory adequacy. To keep this correspondence, a mapping must be established between the subquestion relation among implicit QUDs and the hierarchical discourse structure comprised of coordinating and subordinating RRs. The mapping will be achieved in the following steps.

(30) Step 1. Derive an implicit QUD from each sentence π_i in discourse observing Maximize-Q-Anaphoricity in (20) above, favoring the narrowest scope possible.
Step 2. Establish a subquestion relation between the reconstructed QUDs using the definition of contextual entailment in (6) above.
Step 3. Determine the hierarchical structure of discourse using the subquestion relation.
Case 1: If QUD(π_1) is a subquestion of QUD(π_2) or vice versa, then Subord(π_1, π_2).
Case 2: If there is no subquestion relation between QUD(π_1) and QUD(π_2), and QUD(π_1) and QUD(π_2) are subquestions of QUD(π_0), where π_0 is a summary and abstraction of π_1 and π_2, then Coord(π_1, π_2).
(Subord = subordinating; Coord = coordinating).

Before using examples to illustrate how taking these steps will solve our problem, let us first elaborate a bit more on each of them. Step 1 offers a systematic method for reconstructing implicit QUDs from a discourse. As pointed out by Riester (2019), the number of implicit QUDs can be as limitless as the number of constituents in isolated sentences taken out of context, leading to a problem of overgeneration of QUDs. Following Riester (2019) and Reyle & Riester (2016), we assume that the QUD reconstruction procedure obeys the pragmatic principle Maximize Q-anaphoricity! defined in (20) above, repeated here. This principle favors the narrowest focus possible.

(20) **Maximize-Q-Anaphoricity**: Implicit QUDs should contain as much given (or salient) material as possible.

In the case of Step 2, we will not attempt to reconstruct the main QUD from the entire CDUs first (cf. Hunter & Abrusán 2017) because there seems to be no objective method for doing so. Instead, a QUD will be reconstructed from each **elementary discourse unit** (**EDU**) using the Maximize Q-anaphoricity! principle, and then a subquestion relation between them, if any, will be calculated using Roberts' (2012) definition of contextual entailment defined in (6) above, repeated here.

(6) A question q_1 **contextually entails** another q_2 iff answering q_1 in a discourse context with common ground CG is such that CG ∪ Ans(q_1) entails a complete answer to q_2.

The higher/at-issue QUD and its congruent main assertion of a CDU will be identified as a result of this procedure. Regarding Step 3, although a consensus exists that discourse is not merely a linear sequence of sentences but has a hierarchical structure, there is no agreement on the actual classifications of RRs into **coordinating** and **subordinating** relations (Asher & Lascarides 2003; Hobbs 1985; 1990; Polanyi 1985; 2001; a.o.) and some have even given up the idea that the division is categorical (e.g., Asher & Vieu 2005).[4] The lack of consensus is mostly due to the absence of agreed-upon operational tests that consistently distinguish between the two classes of relations. Although most previous studies derive QUDs from RRs, e.g., a "why" question from *Explanation*, we argue that the direction of derivation should be reversed.[5] The QUD model with its subquestion relations can help determine the two classes of RRs, following Step 3.

We are now ready to apply the steps introduced in (30) to actual examples in order to demonstrate that following this procedure yields the desired QUD-RR mapping. [6] Causality-based RRs are subdivided into four relations, as illustrated by the minimal quadruple in (31).

(31) a. Donald Trump is by far the least experienced in government of all the presidential candidates (π_2). <u>He will probably not win the election</u> (π_1). [*Result*]
b. <u>Donald Trump will probably not win the election</u> (π_1). He is by far the least experienced in government of all the presidential candidates (π_2). [*Explanation*]
c. Donald Trump is by far the least experienced in government of all the presidential candidates (π_2), but <u>he will probably win the election</u> (π_1). [*Violated Expectation*]
d. <u>Donald Trump will probably win the election</u> (π_1), even though he is by far the least experienced in government of all the presidential candidates (π_2). [*Denial of Preventer*]

Following Step 1, two QUDs are reconstructed from the discourses in (31) (because Trump and the election are given information, ruling out questions like "Who will lose the election?" or "What will Trump lose?"):

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[4] Asher & Vieu (2005) argue that, besides the prototypical coordinating relation (*Occasion/Narration*) and the prototypical subordinating relation (*Elaboration*), other relations like *Result* can be coordinating or subordinating as an effect of a minor difference in punctuation and cue words, advocating a more gradient notion of coherence relations.

[5] Onea (2019) also derives subordinating and coordinating RRs from the hierarchical relation between questions ((28) above), although his questions are PQs.

[6] The examples in this section come from Kehler (2002; 2022) with modifications to reflect the contemporary politics. An anonymous reviewer pointed out that in sentences like "John danced because the music was good", the two clauses do not have the same subject and thus the hidden occurrence of John in the second variable needs to be teased out (e.g. "good" = "liked-by-John"). Since this paper is not concerned with providing a compositional analysis of EDUs, we assume that the property applied to the same individual can be inferred or calculated (e.g., music was good to John) from the surface syntax and used in the semantic/logical definitions.

(32) a. QUD_1 (from π_1): Will Trump win the election?
b. QUD_2 (from π_2): How much experience does Trump have in government?

In executing Step 2, inferential axioms presupposed by RRs play an important role. For example, discourses in (31) make salient the following **(defeasible) inferential axiom**:

(33) If x is a presidential candidate and has the least experience in government, x will not win the election.[7]

Assuming that this proposition is part of the CG, answering QUD_2 will provide a partial answer to QUD_1. If the answer to QUD_2 is "the least experience", as in these examples, then the answer to QUD_1 will be negative, assuming that (33) is upheld. However, if the answer to QUD_2 were "a lot of experience", it would not guarantee a positive answer to QUD_1 because Trump may be lacking in other important qualifications. Following Roberts' reasoning in (7) above, QUD_1, even in this case, can contextually entail QUD_2 via a bridging QUD in (34b), which is a superquestion of QUD_2 and also provides a partial answer to QUD_1.

(34) a. QUD_1 (from π_1): Will Trump win the election?
b. $QUD_{bridging}$: What factors determine Trump's chances of winning the election?
c. QUD_2 (from π_2): How much experience does Trump have in government?

Finally, Step 3 allows us to identify QUD_1 as a higher/at-issue question and the congruent EDU π_1 (underlined in (31)) as the main assertion of the CDU. This in turn makes QUD_2 as a subquestion or strategy and the congruent EDU π_2 as the subordinating assertion of the CDU.

Since a subquestion relation has been established between the implicit QUDs reconstructed from the EDUs (Case 1 in (30)), the causality-based RRs, namely, *Result*, *Explanation*, *Violated Expectation*, and *Denial of Preventor*, are subordinating RRs.[8]

The differences among the examples in (30) derive from the differences in textual order and (in)consistency of the presupposed implication. (30a) and (30c) presents the answer to the

[7] This kind of inference is based on Aristotelian notions of enthymemes and topoi, which have been incorporated in dialogue model by Breitholtz (2021). She focuses on a much narrower range of RRs (mainly *Explanation*) since her goal is to incorporate arguments/rhetorical reasoning-based contextual knowledge into conversation. Her QUD, on the one hand, and enthymemes and topoi, on the other, are listed as separate fields; these do not seem to interact with each other in the framework she uses, Type Theory with Records (TTR, Cooper 2016; Ginzburg 2012), which is a completely different computational approach than SDRT or QUD (Onea & Zimmermann 2019).

[8] This conclusion differs from Asher & Vieu (2005), who claim that *Result* is ambiguous. Onea (2019) argues that this relation is unambiguously subordinating when the preceding assertion licenses a PQ about its result. Another difference is that the result clause is sometimes subordinate to the cause clause in the previous accounts (e.g., Asher & Vieu 2005), whereas the cause clause is subordinate to the result clause in the proposed analysis. The current analysis seems to line up better with the cognitive processes in which the origin (cause) and the target (result) of the force in causal situations can be fairly easily identified, after which the goal bias (Do et al. 2019; Stefanowitsch & Rohde 2004) selects the target (result) as the focus of attention.

subquestion first and then the answer to the main QUD, i.e., the at-issue content. (30b) and (30d) reverse the presentation of information, putting forward the at-issue content first, and then explains it or denies a preventer. Since the former encodes the default presentation from the premise to the conclusion in the implicational relation in (33) (deductive), it will be treated as **basic order**. The latter encodes the presentation from the conclusion to the premise (inductive), displaying a **non-basic order**. (31a) and (31b) are consistent with the defeasible inferential axiom (33), whereas (31c) and (31d) are not, i.e., the inference is defeated. Hence, the former is **positive**, and the latter, a **negative** relation. In the negative RRs, although the answer to the subquestion is "the least experience", it does not automatically lead to a negative answer to the main QUD (as in (31c) and (31d)) because there are other factors that can affect the election outcome. In this case, a different subquestion like (35c) to the bridging QUD in (35b) may be raised, making salient a (competing) defeasible axiom (36) in the CG.

(35) a. Will Trump win the election?
b. What factors determine Trump's chances of winning the election?,
c. Does Trump appeal to populism?

(36) If x is a presidential candidate and x appeals to populism, x will win the election.

Intuitively, the local discourses in (31) are embedded in the larger discourse with the big QUD "Who will win the election?". Hence, the discourse is predicted to continue with a discussion most likely on qualifications of different candidates and their prospects at winning the election.

So-called 'contiguity'-based RRs include *Occasion* in (37) and *Elaboration* in (38). These relations are not causal in a strict sense but still involve situations where two eventualities affect each other in the world. For example, in (37), traveling to Vietnam creates a condition for which Trump can meet Kim.

(37) Trump traveled to Vietnam (π_1). He met with the leader of North Korea, Kim Jong-un (π_2). [*Occasion* (or *Narration*)]

(38) A young aspiring politician was arrested in Texas today (π_1). John Smith, 34, was nabbed in a Houston law firm while attempting to embezzle funds for his campaign (π_2). [*Elaboration*]

The implicit QUDs reconstructed from (37) following Step 1 are listed in (39b) and (39c):

(39) a. QUD_0 (from $\pi_1 + \pi_2$): What did Trump do?
b. QUD_1 (from π_1): Where did Trump go?
c. QUD_2 (from π_2): Whom did Trump meet?

According to Step 2, QUD_1 and QUD_2 do not stand in a subquestion relation because the answer to QUD_1 does not provide a partial answer to QUD_2 and vice versa. Rather, they are both subquestions of a higher question, namely, QUD_0 in (39a). This question is answered by a summary and abstraction of π_1 and π_2, "Trump met Kim in Vietnam". Taking Step 3 leads to the conclusion that *Occasion* is a coordinating RR (Case 2 in (30)). Applying the steps in (30) to the *Elaboration* relation in (38), on the other hand, we discover that the main QUD in (40a) is the same as the QUD of π_1 and that the sub-questions in (40b-d) are answered by π_2. This means that π_1 is dominant, serving as the main assertion of (38) (thus underlined).

(40) a. QUD_1 (from π_1): What happened in Texas today?
b. QUD_2 (from π_2): Who was arrested?
c. QUD_2 (from π_2): Where did it happen?
d. QUD_2 (from π_2): When did it happen?

Although previous studies treat *Elaboration* as a sub-type of *Parallel* (Hobbs 1985) or a broader *Resemblance* relation (Kehler 2002), the QUD-based approach in this paper classifies it as a subordinating RR. *Occasion* and *Elaboration* are distinguished in terms of **temporal sequence** and **inclusion** relations. Let us treat the temporal sequential relation as the basic/default order and inclusion relation as non-basic order, since by default each EDU describes a new eventuality (to be informative). Polarity is irrelevant here because no causal/implicational relation is presupposed that can be observed (positive) or violated (negative).

Calculating the assertion of segments standing in Kehler's (2002) *Resemblance* category involves abstracting over the similar arguments and/or properties, as Hobbs (1985) originally proposed. (41) contains a minimal pair of *Parallel* and *Contrast*.

(41) a. Nancy Pelosi admires Biden (π_1), and Chuck Schumer looks up to him (π_2). [*Parallel*]
b. Nancy Pelosi admires Biden (π_1), but Trump loathes him (π_2). [*Contrast*]

(41a) and (41b) share the same QUD_0 given in (42a). In (41a), Nancy Pelosi and Chuck Schumer are similar in that both are high-ranking democratic politicians. The parallel predicates here are "admire" and "look up to", which can be interpreted as the same predicate meaning "like". The subquestions are presented in (42b) and (42c), which are congruent with the information structure of π_1 and π_2, respectively.

(42) a. QUD_0: Who likes Biden?
b. QUD_1 (from π_1 of (41a)): Does Nancy Pelosi like Biden?
c. QUD_2 (from π_2 of (41a)): Does Chuck Schumer like Biden?
d. QUD_2 (from π_2 of (41b)): Does Trump like Biden?

In (41b), Nancy Pelosi and Trump are similar in that both are well-known politicians but different in that they are from opposing parties. The contrasting predicates are "admires" and "loathes". π_1 in (41b) provides a positive answer to the subquestion (42b) and π_2 provides a negative answer to the subquestion (42d). Since no subquestion relation holds between the EDUs in them, *Parallel* and *Contrast* are coordinating RRs (Case 2 in (30)). These RRs are **symmetric**, i.e., the two EDUs stand in equal footing, contributing equally to the CDU, so basic vs. non-basic order cannot be distinguished. Polarity, however, is relevant: *Parallel* is positive, and *Contrast* is negative.

The *Resemblance* category also includes **asymmetric** RRs, in which a membership or a subset relation between arguments typically holds, making one utterance more dominant. These RRs are further subdivided into four relations, as illustrated in the minimal quadruple in (43).

(43) a. Young aspiring politicians often support their party's presidential candidate (π_1). For instance, Pete Buttigieg campaigned hard for Biden in 2020 (π_2). [*Exemplification*]

b. Pete Buttigieg campaigned hard for Biden in 2000 (π_2). Young aspiring politicians often support their party's presidential candidate (π_1). [*Generalization*]

c. Young aspiring politicians often support their party's presidential candidate (π_1). However, Jeff Van Drew supported Trump in 2020 (π_2). [*Exceptional Example*]

d. Jeff Van Drew supported Trump in 2020 (π_2). Nonetheless, young aspiring politicians often support their party's presidential candidate (π_1). [*Exceptional Generalization*]

The discourses in (43) share the same main QUD_1 in (44a) reconstructed from π_1, with subquestions in (44b) and (44c) obtained from π_2 following Step 1 and 2 from (30).

(44) a. QUD_1 (from π_1): Who do young aspiring politicians support?

b. QUD_2 (from π_2 of (43a,b)): Who did Pete Buttigieg support?

c. QUD_2 (from π_2 of (43c,d)): Who did Jeff Van Drew support?

The main assertion of the CDUs in (43) is the same as the assertion of the more general statement, underlined in the examples. This means that *Exemplification*, *Generalization*, *Exceptional Example*, and *Exceptional Generalization* are subordinating RRs (Case 1 in Step 3 in (30)). Like the minimal quadruple in (31) above, different RRs in (43) are distinguished in terms of order and polarity. (43a) and (43c) have the basic order (inferring a specific example based on a general principle, i.e., deductive) whereas (43b) and (43d) have the non-basic order (inferring a general principle from a specific example, i.e., inductive). (43) also equally invokes the defeasible inferential axiom in (45)

(45) If x is a young aspiring politician, x (typically) supports x's party's presidential candidate.

(43a) and (43b) are consistent with this axiom (positive), whereas (43c) and (43d) are inconsistent with it (negative). In sum, the subquestion-hood test we applied has revealed that only *Parallel, Contrast* and *Occasion* are coordinating RRs and that most RRs are subordinating. This analysis gains empirical support from Mann & Thompson's (1988) corpus studies, which found that the observed relations were mostly asymmetric. This observation led them to make an important theoretical distinction between ‘nucleus’ and ‘satellite’ in their Rhetorical Structure Theory (RST). They characterize nuclei as the most important and central parts of text, and satellites as only contributing to the nuclei and thus being secondary. This intuitive distinction is made precise in the proposed account by delineating a process of obtaining the coordinating and subordinating RRs from reconstructed QUDs and their subquestion relations.

The preceding discussions naturally generate a more systematic feature-based inventory of RRs presented in **Figure 3**. Following Sanders et al. (1992), RRs are defined in such a way that they are not theoretical primitives but decomposed into clusters of binary features from a feature hierarchy. Using a feature hierarchy makes significant generalizations holding across different RRs, and it results in a more restricted and well-defined set of relations. This hierarchy does not presuppose any preconceived organizing principles (cf. Kehler’s (2002) classification of *Resemblance*, *Cause-Effect*, and *Contiguity* based on Hume’s three basic cognitive mechanisms for connecting ideas).

[+dynamic]	[+causal]	[+positive]	[+basic]	*Result*
			[–basic]	*Explanation*
		[–positive]	[+basic]	*Violated Expectation*
			[–basic]	*Denial of Preventer*
	[–causal]		[+basic]	*Occasion*
			[–basic]	*Elaboration*
[–dynamic]	[+symmetric]	[+positive]		*Parallel*
		[–positive]		*Contrast*
	[–symmetric]	[+positive]	[+basic]	*Exemplification*
			[–basic]	*Generalization*
		[–positive]	[+basic]	*Exceptional Exemplification*
			[–basic]	*Exceptional Generalization*

Figure 3: A feature-based inventory of RRs.

The most basic relational types concern the dynamic vs. static relations, distinguished by the presence or absence of the highest feature **[± dynamic]** in the feature hierarchy. The dynamic relation includes Kehler’s (2002) higher categories *Cause-Effect* and *Contiguity*, the latter of which only includes a single RR, namely, *Occasion*. Note that *Cause-Effect* and *Contiguity* have something in common. Causing an event or creating a condition for it are conceptually similar in that both situations describe how events typically occur together in the world. Hence, they are placed under the dynamic relation. In a dynamic relation, the described states of affairs are asserted to exert force or influence each other in the world. In a non-dynamic or static relation, they are simply juxtaposed for a comparison, whose similarities or differences lead to coherence inferences. Within [+dynamic] RRs, a more specific feature **[±causal]** distinguishes *Result* from *Occasion*, the latter of which is defined as a dynamic non-causal RR instead of a weak relation of being merely additive (cf. Sanders et al. 1992). A dynamic causal relation obtains when an eventuality directly or indirectly causes another eventuality to occur. A dynamic non-causal relation holds when an eventuality provides a condition for which another eventuality occurs, or the second eventuality occurs as a response to the first. Static RRs, on the other hand, are divided into two groups depending on whether the relation is symmetric or not (**[±symmetric]**). Since eventualities are not asserted to exert force or influence one another in the world in a static relation, causality does not play a role. A symmetric relation (in static RRs) holds between two utterances that contribute to the discourse equally. An asymmetric relation holds when one utterance dominates the other. Lower in the feature hierarchy, polarity and order are the two important parameters, which are also treated as features, namely, **[±positive]** and **[±basic (order)]**. A positive relation holds when the presupposed implicational relation is observed, whereas a negative relation holds when it is violated. This feature, however, is irrelevant for dynamic non-causal RRs because no implicational relation is presupposed that can be upheld (positive) or defeated (negative). Lastly, basic order encodes the default presentation pattern, from a premise to a conclusion in implicational relation (deductive) or the temporal sequence relation (for *Occasion*). Non-basic order encodes the reverse presentation from a conclusion to a premise in implicational relation (inductive) or the temporal inclusion relation (for *Elaboration*).

Formal definitions of the RRs are presented in **Table 1**. The defeasible inference in the CG is treated as presuppositions because both positive and negative relations imply the same propositions.[9] In these definitions, all relations are uniformly represented in the first-order predicate calculus specifying the internal predicate-argument structure of asserted and presupposed propositions (cf. Kehler's (2002) three higher-order categories have different types of input and inference patterns, as observed in (8)–(10) above). The inference processes used are simple, that of modus ponens/deduction or making generalizations/induction. $p \rightsquigarrow q$ is a non-monotonic implication, meaning "p then typically q," $<$ is a temporal precedence relation and $\supseteq$ is a temporal inclusion relation.

[9] Mann & Thompson (1986) claim that RRs (which they call 'relational predicates') are not presuppositions because the former are inherently combinatorial while the latter are not. This does not seem irrefutable evidence and we assume that RRs trigger combinatorial presuppositions. They also argue that the diversity of relational predicates cannot be explained by the existing theories of presupposition. In the proposed definitions, only the background axioms are presupposed, not the relations themselves.

RR	Assertion	Presupposition
Result	$P(a)$ expressed by π_1 and $Q(a)$ expressed by π_2	$\forall x(P(x) \rightsquigarrow Q(x))$
Explanation	$Q(a)$ expressed by π_2 and $P(a)$ expressed by π_1	$\forall x(P(x) \rightsquigarrow Q(x))$
Violated Expectation	$P(a)$ expressed by π_1 and $\neg Q(a)$ expressed by π_2	$\forall x(P(x) \rightsquigarrow Q(x))$
Denial of Preventer	$\neg Q(a)$ expressed by π_2 and $P(a)$ described by π_1	$\forall x(P(x) \rightsquigarrow Q(x))$
Occasion	$P(a)$ expressed by π_1 and $Q(a)$ expressed by π_2	$P(a) < Q(a)$
Elaboration	$P(a)$ expressed by π_1 and $Q(a)$ expressed by π_1	$P(a) \supseteq Q(a)$
Parallel	$P(a)$ expressed by π_1 and $P(b)$ expressed by π_2	a and b share a property Q, i.e., $a, b \in \{x \vert\ Q(x)\}$
Contrast	$P(a)$ expressed by π_1 and $\neg P(b)$ expressed by π_2	a and b share a property Q, i.e., $a, b \in \{x \vert\ Q(x)\}$
Exemplification	$\forall x(P(x) \rightsquigarrow Q(x))$ expressed in π_1 and $Q(a)$ expressed in π_2	$P(a)$
Generalization	$Q(a)$ expressed in π_2 and $\forall x(P(x) \rightsquigarrow Q(x))$ expressed in π_1	$P(a)$
Exceptional Exemplification	$\forall x(P(x) \rightsquigarrow Q(x))$ expressed in π_1 and $\neg Q(a)$ expressed in π_2	$P(a)$
Exceptional Generalization	$\neg Q(a)$ expressed in π_2 and $\forall x(P(x) \rightsquigarrow Q(x))$ expressed in π_1	$P(a)$

Table 1: Formal definitions of RRs.

These definitions characterize dynamic RRs as contributing to the defeasible inferential presuppositions, rather than assertions. What is asserted in these relations is simply the truth of the two EDUs.[10] Static RRs, on the other hand, require more world knowledge or presupposition accommodation (e.g., in (43) above, even if the addressee doesn't know who Pete Buttigieg is, she will accommodate the presupposition that he is a young aspiring democratic politician).

[10] Using these definitions, the denotation/lexical entry of an implicit RR like *Result* can be given (a colon introduces a presupposition and a dot, an assertion, Heim & Kratzer 1998): $[\![$***Result***$]\!] = \lambda f \in D_{\langle e,t \rangle}.\ [\lambda g \in D_{\langle e,t \rangle}$: for all x, f(x) $\rightsquigarrow$ g(x). [λy. f(y) & g(y)]]. Applying this function to the EDUs of (31a), for example, its meaning is calculated as follows: $[\![$***Result***$]\!]([\![$**has the least experience in government**$]\!])([\![$**will not win the election**$]\!])([\![$**Trump**$]\!])$ = For all x, x has the least experience in government $\rightsquigarrow$ x will not win the election. Trump has the least experience in government & Trump will not win the election.

The proposed taxonomy of RRs and QUD-based analysis preserve a crucial feature of RR-based theories, namely, the right frontier constraint, which requires a new clause to attach either to the last node entered to the tree or to one of the nodes that dominate the last node. To show how this constraint is observed, consider (12) above, repeated below.

(12) John had a lovely evening (π_1). He had a great meal (π_2). He ate salmon (π_3). He devoured lots of cheese (π_4). He won a dancing competition (π_5). #It was a beautiful pink (π_6).

The QUD stack for (12) is presented in (46). The subquestion relation correctly predicts that *Elaboration* is a subordinating RR and *Occasion* is a coordinating RR. The pronoun "it" in π_6 fails to refer back to "salmon" in π_3 because QUD_3 has been answered, which means it was removed from the QUD stack by the time QUD_5 is added.

(46) QUD_1 (from π_1): What was John's evening like?
QUD_2 (from π_2): What did he eat?
QUD_3 (from π_3): Did he eat salmon?
QUD_4 (from π_4): Did he eat cheese?
QUD_5 (from π_5): What did he win?

Before concluding this paper, let us go back to Hunter & Abrusán's counterexamples to their R/CDU-QUD congruence hypotheses in (16) and (18) above to see if the proposed analysis can explain these. (16) is repeated below:

(16) a. We had so much fun in London! (π_1) We got to see the Lion King! (π_2) I've been wanting to go for a really long time (π_3) and my mom finally gave me tickets for my birthday! (π_4) We also got to ride on the big Ferris wheel (π_5) ...
b. *Elaboration*(π_1, π_2), *Background*(π_2, [π_3, π_4]), *Continuation*(π_3, π_4), *Elaboration*(π_1, π_5), *Continuation*(π_2, π_5).
c. (q_1) What did you do? (q_2) What makes that so exciting?

Applying Step 1, the QUD for π_1 should be (47a) for which the answer including an evaluative predicate "fun" becomes felicitous. As an anonymous reviewer pointed out, uttering π_1 out of blue is awkward, when the addressee doesn't know about the speaker's trip to London. This intuition follows directly from the Maximize Q-Anaphoricity. The remaining implicit QUDs reconstructed observing the principle are listed in (47b) and (47d). Regarding the QUD in (47d), the same reviewer pointed out that π_3 and π_4 are not simply background to π_2 but instead serve as an explanation of why Lion King was so much fun. Following Step 2, QUD_2 and QUD_5 become subquestions of QUD_1 (i.e., π_2 and π_5 are partial answers to QUD_1). The RR is *Elaboration*, which is subordinating. A subquestion relation can also be established between (47b) and (47d) via the bridging question in (47c). The defeasible axiom in (48) makes π_3 and π_4 relevant. The RR is *Explanation*, which is subordinating.

(47) a. QUD_1 (from π_1): What was your trip to London like? Was it fun?
b. $QUD_{2,5}$ (from $\pi_{2,5}$): What fun things did you do?
c. $QUD_{bridging}$: What makes an activity (during a trip) fun?
d. $QUD_{3,4}$ (from $\pi_{3,4}$): What makes seeing the Lion King fun?

(48) If x is a gratification of a long-term desire (facilitated by a loving family member), x is (usually) fun/exciting.

Turning to (18), repeated below, this example also does not seem significantly different from the *Explanation* example analyzed in (31b) above.

(18) a. Yesterday John and his wife went to the fanciest restaurant in Paris (π_1). It was John's birthday (π_2), and his wife wanted to spoil him (π_3).
b. *Explanation*(π_1, $\pi_{2\text{–}3}$), *Result*(π_2, π_3)
c. (q_1) What did John do yesterday? (q_2) Why did he do this?

Part of Hunter & Abrusán's difficulty is that their QUDs (q_1 and q_2 in (17c)) are not sufficiently constrained. It is also unclear how they came up with q_1 for the entire discourse (to test the CDU-QUD correspondence hypothesis). It appears to have been obtained from the broad VP focus structure of π_1 alone. Applying the Maximize Q-Anaphoricity! principle in Step 1 of (30), the QUDs reconstructed from (18a) are given in (49a), (49c) and (49d). In addition, a contextually-given bridging QUD in (49b) intervenes, which serves as a higher question of QUD_2 and QUD_3 and whose answer provides a partial answer to QUD_1.

(49) a. QUD_1 (from π_1): What (kind of) restaurant John and his wife go to yesterday?
b. $QUD_{bridging}$: What do John and his wife consider when choosing a restaurant?
c. QUD_2 (from π_2): Was it a special occasion?
d. QUD_3 (from π_3): Did John's wife want to do something special for him?

In this setup, QUD_2 and QUD_3 can reasonably count as subquestions or strategies to answer the main QUD_1 with the help of a contextually-given defeasible axiom like (50).

(50) If x has a special occasion (like birthdays), x (usually) goes to a fancy (not a cheap) restaurant.

This confirms that *Explanation* builds a subordinating relation with the result EDU (π_1 in (18a)) as the main assertion.

5 Conclusion

This paper proposed an inclusive theory of discourse coherence by integrating the QUD and RR theories. It provided a simple and concrete procedure to derive the hierarchical structure of discourse from the subquestion relations between implicit QUDs reconstructed using informational structural principles and contextual entailment relations. It then applied the procedure to discourse examples involving various RRs to determine subordinating and coordinating RRs and to build a parsimonious feature-based inventory of RRs with formal definitions. The resulting theory shows that establishing the QUD-RR correspondence is possible and [that] coherent discourse is strategic, capturing the inherent connection between the informational and intentional tropes of discourse. This analysis can be viewed as spelling out Roberts' (2004) idea that specific types of RRs are building blocks of strategies of inquiry.

The empirical scope of the paper was rather narrow, focusing mostly on two-sentence sequences involving a single speaker (and a potential interlocutor). Analyzing participants' situated utterances, non-verbal actions, cognitive states, or interactions between two or more parties was outside the scope of the paper. As such, repair, self-correction, evasion, etc. were not dealt with in the paper, which focused on narrative-style discourse (not conversational discourse). As pointed out by an anonymous reviewer, much progress has been made in formal theories of dialogue/conversation involving multiple speakers and their separate discourse representations (Breitholtz 2021; Ginzburg 2012; Ginzburg & Cooper 2015; Schlangen 2015; a.o.). Modeling the complexity of conversational discourse, however, does not by itself solve the problem of integrating QUD and RR theories, which was the main goal of this paper. Future research will need to determine if and how the current proposal can be extended to longer and more complex discourse and multi-party conversational data. A formal implementation of the descriptive rules in (30) in discourse-level semantic framework like (S)DRT will help make precise the elusive notion of 'discourse topic'.

Competing interests

The author has no competing interests to declare.

References

Asher, Nicholas & Lascarides, Alex. 2003. *Logics of Conversation.* Cambridge: Cambridge University Press.

Asher, Nicholas & Vieu, Laure. 2005. Subordinating and coordinating discourse relations. *Lingua* 115. 591–610. DOI: https://doi.org/10.1016/j.lingua.2003.09.017

Beaver, David & Clark, Brady. 2008. *Sense and Sensitivity: How Focus Determines Meaning.* Oxford: Wiley-Blackwell. DOI: https://doi.org/10.1002/9781444304176

Bloom, Lois & Lahey, Margaret & Hood, Lois & Lifter, Karin & Fiess, Kathleen. 1980. Complex sentences: acquisition of syntactic connectives and the semantic relations they encode. *Journal of Child Language* 7. 235–261. DOI: https://doi.org/10.1017/S0305000900002610

Breitholtz, Ellen. 2021. *Enthymemes and Topoi in Dialogue: The Use of Common Sense Reasoning in Conversation*. Leiden: Brill. DOI: https://doi.org/10.1163/9789004436794

Büring, Daniel. 2003. On d-trees, beans, and B-accent. *Linguistics and Philosophy* 26. 511–545. DOI: https://doi.org/10.1023/A:1025887707652

Büring, Daniel. 2008. What's new (and what's given) in the theory of focus? *Berkeley Linguistics Society* 34. 403–424. DOI: https://doi.org/10.3765/bls.v34i1.3586

Carlson, Lauri. 1983. *Dialogue Games: An Approach to Discourse Analysis* (Studies in Linguistics and Philosophy), vol. 17. Netherlands: Springer.

Clifton, Charles & Frazier, Lyn. 2012. Discourse integration guided by the 'Question under Discussion' *Cognitive Psychology* 65. 352–379. DOI: https://doi.org/10.1016/j.cogpsych.2012.04.001

Cooper, Robin. 2016. Frames as records. In Foret, Annie, Morrill, Glyn, Muskens, Reinhard Osswald, Rainer & Pogodalla, Sylvain (eds.), *Formal Grammar: 20th and 21st International Conferences FG 2015*, Barcelona, Spain, August 2015, Revised Selected Papers FG 2016, Bozen, Italy, August 2016, Proceedings, number 9804 in LNCS, 3–18. Springer.

Cooper, Robin & Ginzburg, Jonathan. 2015. Type theory with records for natural language semantics. In Lappin, Shalom & Fox, Chris (eds.), *The Handbook of Contemporary Semantic Theory*, 375–407. New Jersey: Wiley. DOI: https://doi.org/10.1002/9781118882139.ch12

Crible, Ludivine. 2021. Negation cancels discourse-level processing differences: Evidence from reading times in concession and result relations. *Journal of Psycholinguistic Research* 50. 1283–1308. DOI: https://doi.org/10.1007/s10936-021-09802-2

Do, Monica & Papafragou, Anna & Trueswell, John. 2019. The goal bias in language and memory: Explaining the asymmetry. Proceedings of the Annual Conference of the Cognitive Science Society, 268–274.

Evers-Vermeul, Jacqueline & Sanders, Ted. 2009. The emergence of Dutch connectives; how cumulative cognitive complexity explains the order of acquisition. *Journal of Child Language* 36. 829–854. DOI: https://doi.org/10.1017/S0305000908009227

Ginzburg, Jonathan. 1996. Dynamics and the semantics of dialog. In Seligman, Jerry & Westerståhl, Dag (eds.), *Language, Logic and Computation*, Volume 1, Ch. 15. Stanford: CSLI.

Ginzburg, Jonathan. 2012. *The Interactive Stance*. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199697922.001.0001

Groenendijk, Jeroen & Stokhof, Martin. 1984. Studies on the semantics of questions and the pragmatics of answers. Ph.D. dissertation, University of Amsterdam.

Grosz, Barbara & Sidner, Candace. 1986. Attention, intentions, and the structure of discourse. *Computational Linguistics* 12. 175–204.

Heim, Irene & Kratzer, Angelika. 1998. *Semantics in Generative Grammar.* Oxford: Blackwell.

Hobbs, Jerry. 1979. Coherence and coreference. *Cognitive Science* 3. 67–90. DOI: https://doi.org/10.1207/s15516709cog0301_4

Hobbs, Jerry. 1985. On the coherence and structure of discourse. Tech. Rep. CSLI-85-37, Center for the study of language and information, Stanford University.

Hobbs, Jerry. 1990. *Literature and Cognition.* Chicago: University of Chicago Press.

Hobbs, Jerry. 2006. Abduction as natural language understanding. In Horn, Laurence & Ward, Gregory (eds.), *The Handbook of Pragmatics*, Chapter 32. Wiley. DOI: https://doi.org/10.1002/9780470756959.ch32

Hunter, Julie & Abrusán, Márta. 2017. Rhetorical structure and QUDs. In Otake, Mihoko & Kurahashi, Setsuya & Ota, Yuiko & Satoh, Ken & Bekki, Daisuke (eds.), *New Frontiers in Artificial Intelligence*: JSAI-isAI 2015, 41–57. Springer International Publishing. DOI: https://doi.org/10.1007/978-3-319-50953-2_4

Kehler, Andrew. 2002. *Coherence, Reference, and the Theory of Grammar*. Stanford, CA: CSLI.

Kehler, Andrew. 2022. Coherence establishment as a source of explanation in linguistic theory. *Annual Review of Linguistics* 8. 123–142. DOI: https://doi.org/10.1146/annurev-linguistics-011619-030357

Kehler, Andrew & Rohde, Hanna. 2017. Evaluating an expectation-driven QUD model of discourse interpretation. *Discourse Processes* 54. 219–238. DOI: https://doi.org/10.1080/0163853X.2016.1169069

Knoepke, Julia & Richtter, Tobias & Isberner, Maj-Britt & Naumann, Johannes & Neeb, Yvonne & Weinert, Sabine. 2017. Processing of positive-causal and negative-causal coherence relations in primary school children and adults: A test of the cumulative cognitive complexity approach in German. *Journal of Child Language* 44. 297–328. DOI: https://doi.org/10.1017/S0305000915000872

Knott, Alistair & Dale, Robert. 1994. Using linguistic phenomena to motivate a set of coherence relations. *Discourse Processes* 18. 35–62. DOI: https://doi.org/10.1080/01638539409544883

Knott, Alistair & Sanders, Ted. 1998. The classification of coherence relations and their linguistic markers: An exploration of two languages. *Journal of Pragmatics* 30. 135–175. DOI: https://doi.org/10.1016/S0378-2166(98)00023-X

Köhne-Fuetterer, Judith & Drenhaus, Heiner & Delogu, Francesca & Demberg, Vera. 2021. The online processing of causal and concessive discourse connectives. *Linguistics* 59. 417–448. DOI: https://doi.org/10.1515/ling-2021-0011

Mann, William & Thompson, Sandra. 1986. Relational propositions in discourse. *Discourse Processes* 9. 57–90. DOI: https://doi.org/10.1080/01638538609544632

Mann, William & Thompson, Sandra. 1988. Rhetorical Structure Theory: Toward a functional theory of text organization. *Text* 8. 243–281. DOI: https://doi.org/10.1515/text.1.1988.8.3.243

Onea, Edgar. 2016. *Potential Questions at the Semantics-Pragmatics Interface*. Leiden: Brill. DOI: https://doi.org/10.1163/9789004217935

Onea, Edgar. 2019. Underneath rhetorical relations. The case of RESULT. In Zimmermann, Malte & von Heusinger, Klaus & Onea, Edgar (eds.), *Questions in Discourse* Vol. 2, 194–250. Leiden: Brill. DOI: https://doi.org/10.1163/9789004378322_008

Polanyi, Livia. 1985. A theory of discourse structure and discourse coherence. In *Proceedings of Chicago Linguistics Society (CLS)* 21, 306–322.

Polanyi, Livia. 2001. The linguistic structure of discourse. In Schiffrin, Deborah & Tannen, Deborah & Hamilton, Heidi (eds.), *The Handbook of Discourse Analysis*, 265–281. Oxford: Blackwell.

Potts, Christopher. 2005. *The Logic of Conventional Implicatures*. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199273829.001.0001

Reyle, Uwe & Riester, Arndt. 2016. Joint information structure and discourse structure analysis in an underspecified DRT framework. In Hunter, Julie & Simons, Mandy & Stone, Matthew (eds.), *JerSem: The 20th Workshop on the Semantics and Pragmatics of Dialogue*, 15–24. NJ: New Brunswick.

Riester, Arndt. 2019. Constructing QUD trees. In Zimmermann, Malte & von Heusinger, Klaus & Onea, Edgar (eds.), *Questions in Discourse*, 164–193. Leiden: Brill. DOI: https://doi.org/10.1163/9789004378322_007

Roberts, Craig. 2004. Context in dynamic interpretation. In Horn, Laurence & Ward, Gregory (eds.), *The Handbook of Pragmatics*, 197–220. Oxford: Blackwell. DOI: https://doi.org/10.1002/9780470756959.ch9

Roberts, Craig. 2012. Information structure in discourse: towards an integrated formal theory of pragmatics. *Semantics and Pragmatics* 5. 1–69. DOI: https://doi.org/10.3765/sp.5.6

Rohde, Hanna & Levy, Roger & Kehler, Andrew. 2011. Anticipating explanations in relative clause processing. *Cognition* 118. 339–358. DOI: https://doi.org/10.1016/j.cognition.2010.10.016

Rojas-Esponda, Tania. 2013. The roadsigns of communication. *Proceedings of the 17th Workshop on the Semantics and Pragmatics of Dialogue*, December 16–18, 2013, Amsterdam, The Netherlands.

Rojas-Esponda. Tania. 2014. A discourse model for *überhaupt. Semantics & Pragmatics* 7. 1–45. DOI: https://doi.org/10.3765/sp.7.1

Ronai, Eszter & Xiang, Ming. 2020. Pragmatic inferences are QUD-sensitive: an experimental study. *Journal of Linguistics* 57. 1–30. DOI: https://doi.org/10.1017/S0022226720000389

Sanders, Ted & Spooren, Wilbert & Noordman, Rio. 1992. Toward a taxonomy of coherence relations. *Discourse Processes* 15. 1–35. DOI: https://doi.org/10.1080/01638539209544800

Schlangen, David. 2015. Semantics and dialogue. In Lappin, Shalom & Fox, Chris (eds.), *The Handbook of Contemporary Semantic Theory*, 687–713. Hoboken: Wiley. DOI: https://doi.org/10.1002/9781118882139.ch22

Schwarzschild, Roger. 1999. GIVENness, AvoidF, and other constraints on the placement of accent. *Natural Language Semantics* 7. 141–177. DOI: https://doi.org/10.1023/A:1008370902407

Stefanowitsch, Anatol & Rohde, Ada. 2004. The goal bias in the encoding of motion events. In Radden, Günter & Panther, Klaus-Uwe (eds.), *Studies in Linguistic Motivation*, 249–268. Berlin & New York: Mouton de Gruyter.

Tonhauser, Judith & Beaver, David & Simons, Mandy & Roberts, Craig. 2013. Towards a taxonomy of projective content. *Language* 89. 66–109. DOI: https://doi.org/10.1353/lan.2013.0001

van Kuppevelt, Jan. 1995. Discourse structure, topicality, and questioning. *Journal of Linguistics* 31. 109–147. DOI: https://doi.org/10.1017/S002222670000058X

von Stechow, Arnim. 1991. Focusing and backgrounding operators. In Abraham, Werner (ed.), *Discourse Particles: Descriptive and Theoretical Investigations on the Logical, Syntactic and Pragmatic Properties of Discourse Particles in German* (Pragmatics & Beyond: New Series 12), 37–84. Amsterdam: John Benjamins Publishing Company. DOI: https://doi.org/10.1075/pbns.12.04ste

von Stutterheim, Christiane & Klein, Wolfgang. 1989. Referential movement in descriptive and narrative discourse. In Dietrich, Rainer & Graumann, Carl (eds), *Language Processing in Social Context*, 39–76. Amsterdam: North Holland. DOI: https://doi.org/10.1016/B978-0-444-87144-2.50005-7

Wisniewski, Andrzej. 1995. The Posing of Questions: Logical Foundations of Erotetic Inferences. Berlin: Springer.

Zimmermann, Malte & von Heusinger, Klaus & Onea, Edgar (eds.). 2019. *Questions in Discourse*. Leiden: Brill. DOI: https://doi.org/10.1163/9789004378308

Zondervan, Arjen & Meroni, Luisa & Gualmini, Andrea. 2008. Experiments on the role of the question under discussion for ambiguity resolution and implicature computation in adults. *Semantics and Linguistic Theory* 13. 765–777. DOI: https://doi.org/10.3765/salt.v18i0.2486