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# Signalling conditional relations

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**Abstract:** We investigate how discourse relations and their subtypes are signalled, extending the set of discourse signals from connectives and lexical cue phrases to the wide range of semantic, syntactic, and orthographic signals of the RST Signalling Corpus (Das, Debopam & Maite Taboada. 2018. RST signalling corpus. *Language Resources and Evaluation* 52. 149–184). This extension requires re-evaluating previous predictions on discourse signalling, in particular, those of Sanders, Ted. 2005. Coherence, causality and cognitive complexity in discourse. In M. Aurnague, M. Bras, A. Le Draoulec & L. Vieu (eds.), *Proceedings/Actes SEM-05, first international symposium on the exploration and modelling of meaning*, 105–114. Biarritz causality-by-default hypothesis, the hypothesis of uniform information density (Frank, Austin & Florian Jaeger. 2008. Speaking rationally: Uniform information density as an optimal strategy for language production. In *Proceedings of the 30th annual meeting of the Cognitive Science Society*, 933–938. <https://escholarship.org/uc/item/7d08h6j4> (accessed 18 May 2022)), and the hypothesis that discourse is continuous by preference (Segal, Erwin, Judith Duchan & Paula Scott. 1991. The role of interclausal connectives in narrative structuring. *Discourse Processes* 14. 27–54; Murray, John. 1997. Connectives and narrative text. *Memory and Cognition* 25. 227–236). We evaluate the predictions of these theories on the CONDITIONAL relations in the RST Discourse Treebank (Carlson, Lynn, Daniel Marcu & Mary Ellen Okurowski. 2002. *RST Discourse Treebank. LDC2002T07*. Philadelphia: Linguistic Data Consortium), using CAUSAL relations as a control group. Informativity and continuity are operationalized in terms of semantic complexity and Givón, Talmy. 1993. *English grammar: A function-based introduction*, vol. 2. Amsterdam: John Benjamins dimensions of deictic shift. Our results show that the hypotheses make accurate predictions only for the relation groups in their entirety but not for the observed in-group variation, in particular, the low amount of marking for the HYPOTHETICAL subtype of CONDITIONAL relations. We attribute this difference to the distribution of intra- and inter-sentential occurrences across the CONDITIONAL subtypes: intra-sentential relations are consistently more marked than inter-sentential ones, and HYPOTHETICAL relations are special in that they appear predominantly inter-sententially.

**Keywords:** causality by default; continuity; discourse marking; discourse relations; uniform information density

## 1 Introduction

Many discourse relations are signalled by connectives like *because* and *if* or lexical cue phrases like *as a result*, which have both been subsumed under “discourse markers” (DMs; Fraser 2009). Earlier inquiries into the signalling of discourse relations have largely been confined to DMs, in particular, their presence or absence in a given relation (among others, Asr and Demberg 2012; Grote and Stede 1998; Patterson and Kehler 2013; Yung et al. 2017). Recent work (e.g., Das and Taboada 2018, 2019; Redeker et al. 2012; Webber 2013), however, extends the range of signals of discourse relations, for example, to lexical chains, subject-verb inversion, punctuation, and lexical sense relations. For instance, the CONDITIONAL<sup>1</sup> relation in (1) is not only marked by *if* but also by the antonyms *decline* and *increase*:

<sup>1</sup> Small caps indicate types of discourse relations. Example (1) instantiates the CONDITION subtype of CONDITIONAL relations; see Section 2.

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(1) [If the price of the stock declines,] [the put will increase in value] (wsj1962; Carlson et al. 2002)

This extension has ramifications for all attempts to investigate the signalling of discourse relations; in particular, it requires examining anew theories of relation marking made for and tested on DMs only. We intend to contribute to this goal by investigating the signalling of discourse relations on *CONDITIONAL* relations and their subtypes.

We will test three predictions on the signalling of discourse relations, which link the degree of signalling of specific relations to their expectedness but define expectedness differently. First, according to the *causality-by-default* hypothesis (Sanders 2005), the expected linking of discourse units in text is causal, so causal discourse relations should be little marked. Second, the hypothesis of *uniform information density* (Frank and Jaeger 2008) claims that information is spread out as evenly as possible across a discourse; this suggests more marking for discourse relations whose contribution is more informative and hence less expected. Finally, the hypothesis that discourse is *continuous by preference* (Murray 1997; Segal et al. 1991) entails preference for discourse relations that shift fewer deictic centres like time, space, or perspective; hence, they should exhibit less marking.

Our data is drawn from the RST Signalling Corpus (RST-SC; Das and Taboada 2018). It provides annotation of a wide range of discourse signals for the relations identified in the RST Discourse Treebank (RST-DT; Carlson et al. 2002), including DMs.

The paper is structured as follows. After briefly characterizing *CONDITIONAL* relations and their subtypes, we define and operationalize the properties on which expectedness ratings are based. We then present our analyses on the RST-SC data and discuss their consequences for the hypotheses.

## 2 Defining conditional relations, their subtypes, and their properties

The RST-SC follows the RST-DT in distinguishing four subtypes of *CONDITIONAL* relations: *CONDITION*, *CONTINGENCY*, *HYPOTHETICAL*, and *OTHERWISE*. We define the subtypes in a way that highlights the similarity of the RST-DT subgroups (Carlson and Marcu 2001)<sup>2</sup> to the classes of the Penn Discourse Treebank (PDTB) 2.0 (Prasad et al. 2007). For all subtypes of *CONDITIONAL* relations, the two arguments of the relation (antecedent and consequent, the propositions denoted by the two segments or discourse units linked by the relation) introduce unrealized, non-factual situations.

The first distinction targets the contexts in which a *CONDITIONAL* relation holds. This contrasts *CONDITION* relations, valid in their specific contexts, with *CONTINGENCY* relations, valid in any context. Second, the antecedent is supposed to be true in *HYPOTHETICAL* relations, but not in the other subtypes. And, finally, *OTHERWISE* relations differ from all others by indicating that if the antecedent holds, the consequent does not hold, whereas for all other relations, the consequent holds if the antecedent holds. Table 1 summarizes these distinctions.

Next, we define informativity to predict the marking of discourse relations, assuming that more informative linguistic entities are less expected and hence more marked. While Frank and Jaeger (2008) calculate informativity of a linguistic entity in terms of its probability (with respect to its immediate context), we gauge it in terms of the complexity of its semantic contribution: a linguistic item is semantically more complex than another if the description of its semantic contribution introduces additional elements.<sup>3</sup>

This definition is illustrated by the four subtypes of conditional relations defined in Table 1. *CONDITION* is the most basic subtype, requiring only that its antecedent is a condition for its consequent to hold. *CONTINGENCY* extends the validity of this requirement to all contexts, not just the one in which it is expressed (which is what *CONDITION* does). The *HYPOTHETICAL* subtype introduces the additional condition that the speaker believes the antecedent. Finally, *OTHERWISE* adds to the conditions of *CONDITION* that the consequent is negated. Higher

<sup>2</sup> For the RST-DT definitions and examples of the *CONDITIONAL* and *CAUSAL* subtypes, see the Appendix.

<sup>3</sup> Such elements can be operators (like negation) or predicates. This notion of elements of a semantic description is related to the semantic primitives of decompositional lexical semantics, e.g., in Dowty (1979).

**Table 1:** The four subtypes of CONDITIONAL relations in the RST-DT.

<small>CONDITION</small>	the consequent holds if the antecedent holds
<small>CONTINGENCY</small>	in any context, the consequent holds if the antecedent holds
<small>HYPOTHETICAL</small>	like <small>CONDITION</small> ; in addition, the antecedent is supposed to be true
<small>OTHERWISE</small>	the consequent does not hold if the antecedent does

semantic complexity can introduce entailment, for instance, from HYPOTHETICAL to CONDITION; but the lack of entailment between OTHERWISE and CONDITION shows that this is not necessary. In Table 2, which summarizes these comparisons, “<” abbreviates “less informative than”.

Finally, continuity is based on preserving (or shifting) deictic centres along different dimensions (Fetzer 2018; Murray 1997; Segal et al. 1991). We define continuity in terms of Givón’s (1993) continuity dimensions; relevant for our analysis are time, reference, perspective, and modality. The perspective and modality dimensions are binary: Discourse relations are discontinuous for them if their discourse units are attributed to different sources, or have a different modal status.<sup>4</sup> Reference continuity is formalized in Centering Theory (Grosz et al. 1995; Poesio et al. 2004). We classified as referentially continuous relations whose discourse unit pairs are linked by some form of shared referent; otherwise, they are classified as discontinuous.<sup>5</sup> For the temporal dimension, we regard as discontinuous discourse units where causes are mentioned after their results when these causes temporally precede their results.

Following Givón, we distinguish local dimensions (here, time and reference) and global ones (here, perspective and modality). Shifts along a global dimension constitute a greater break of continuity; within the two groups we do not weigh dimensions differently. We illustrate the dimensions with the CONDITION relation in (2).

(2) “... [if the management thinks the stock is cheap,] [they can go in and buy it.”] (wsj1111)

In (2), the situation described in the antecedent causes and temporarily precedes the situation in the consequent. Consequently, the order in which the situations are described involves no backward shift along the temporal dimension, and hence the relation counts as temporally continuous. The segments differ in modality because the consequent includes the modal *can* whereas the antecedent contains none, and thus the relation is discontinuous on the modal dimension. Similarly, the segments are attributed to different sources (the stock is cheap according to the management, the possibility to go in and buy it holds according to the person quoted, as indicated by the quotes), which makes the relation discontinuous on the perspective dimension. Finally, since the two segments share a referent (the stock), the relation is referentially continuous (in Centering Theory, it is Establishment).

On the basis of these definitions and distinctions we will now test the three hypotheses against the RST-SC data.

**Table 2:** Comparing informativity for the CONDITIONAL subtypes.

<b>Informativity</b>	<b>Reason for the comparison</b>
<small>CONDITION</small> < <small>CONTINGENCY</small>	The relation expressed in <small>CONTINGENCY</small> holds in all contexts.
<small>CONDITION</small> < <small>HYPOTHETICAL</small>	<small>HYPOTHETICAL</small> has the additional element of believing the antecedent.
<small>CONDITION</small> < <small>OTHERWISE</small>	<small>OTHERWISE</small> introduces the additional element of negation in the consequent.

<sup>4</sup> This criterion targets modality that operates at the level of clausal discourse units, which includes *have to* and *be to* constructions, but no other instances of covert modality (not expressed by a lexical element; Bhatt 2006). Note that unselected sentence-level *to*-infinitives constitute discourse units of their own.

<sup>5</sup> In terms of Centering Theory, we regard as continuous Continuation, Establish, Retain, and Smooth or Rough Shift; Null or Zero (Poesio et al. 2004) count as non-continuous.

### 3 Testing the hypotheses

#### 3.1 The data

From the 327 tokens of **CONDITIONAL** relations in the RST-SC, 239 are **CONDITION**, 46 **HYPOTHETICAL**, 27 **CONTINGENCY**, and 15 **OTHERWISE**. Our analysis also includes 693 **CAUSAL** relations comprising 52 **CAUSE**, 159 **RESULT**, and 65 **CAUSE-RESULT** relations (where the relation name indicates which argument(s) of the relation are central); in addition, 417 **CONSEQUENCE** relations indicate a more indirect link between cause and result (See the Appendix for more details).

#### 3.2 The causality-by-default hypothesis

The causality-by-default hypothesis is relevant for **CONDITIONAL** relations since they are closely related to **CAUSAL** relations: both groups introduce a causal link between the antecedent and consequent. This is reflected in several classifications; for example, both groups carry the feature “causal” in the classification of Sanders et al. (1992) and form the **CONTINGENCY** group in the PDTB 2.0 and 3.0 (Prasad et al. 2007; Webber et al. 2018). Both frameworks distinguish the two groups by assuming factivity of the arguments for **CAUSAL** relations, whereas **CONDITIONAL** relations have non-factive arguments.

We found that 85.6 and 81.4% of **CONDITIONAL** and **CAUSAL** relations are signalled in the RST-SC (Tables 3 and 4). However, these average values hide considerable differences between the subtypes of **CONDITIONAL** relations: **CONDITION** and **OTHERWISE** are the most explicit types that are almost always signalled (97.9 and 93.3%, respectively), whereas **HYPOTHETICAL** is unsignalled in 82.6% of cases. Only **CONTINGENCY** and, to a lesser extent, **CONDITION** approximate the average ratios of the signalling of **CONDITIONAL** relations.

This variety strongly contrasts with the results of the different subtypes of **CAUSAL** relations. These uniformly show a clear tendency towards marking by one or, in the second place, two or zero discourse signals.

Both **CAUSAL** and **CONDITIONAL** relations on average comply with the causality-by-default hypothesis in that they show less marking than non-causal relations. While in the RST-SC, 81.4% of the **CAUSAL** and 85.6% of the **CONDITIONAL** relations are signalled, this holds for 93.2% of the other relations.

These numbers match previous results only partially. Looking at discourse connectives only, Asr and Demberg (2012) found **CAUSAL** relations to be more implicit than non-causal relations, but report an extremely low

**Table 3:** Marking of **CONDITIONAL** relations.

Relation	Tokens	Unsignalled	One signal	Two signals
CONDITION	239	5 (2.1%)	233 (97.5%)	1 (0.4%)
CONTINGENCY	27	3 (11.1%)	23 (85.2%)	1 (3.7%)
HYPOTHETICAL	46	38 (82.6%)	8 (17.4%)	0 (0.0%)
OTHERWISE	15	1 (6.7%)	6 (40.0%)	8 (53.3%)
<b>Total</b>	<b>327</b>	<b>47 (14.4%)</b>	<b>270 (82.6%)</b>	<b>10 (3.1%)</b>

**Table 4:** Marking of **CAUSAL** relations.

Relation	Tokens	Unsignalled	One signal	Two signals	Three signals
CAUSE	52	9 (17.3%)	28 (53.9%)	15 (28.9%)	0 (0.0%)
RESULT	159	37 (23.3%)	92 (57.9%)	30 (18.9%)	0 (0.0%)
CAUSE-RESULT	65	9 (13.9%)	36 (55.4%)	20 (30.8%)	0 (0.0%)
CONSEQUENCE	417	74 (17.8%)	259 (62.1%)	80 (19.2%)	4 (1.0%)
<b>Total</b>	<b>693</b>	<b>129 (18.6%)</b>	<b>415 (59.9%)</b>	<b>145 (20.9%)</b>	<b>4 (0.6%)</b>

degree of implicitness for *CONDITIONAL* relations. We counted 33.2% of signalled *CAUSAL* and 99.7% of signalled *CONDITIONAL* relations in the PDTB 2.0. The second value is much higher than the average 45.8% of signalled relations.<sup>6</sup> Yet another pattern emerges in the RST-SC when only connectives are counted: 44.4 and 80.1% of the *CAUSAL* and *CONDITIONAL* relations are marked by connectives, while the average for all relations is only 18.2%.

What is more, the different subtypes of *CONDITIONAL* relations widely differ in markedness, which is not predicted by the causality-by-default hypothesis. *CONDITION* and *OTHERWISE* relations are more marked than average, and only due to the overwhelmingly low marking of *HYPOTHETICAL* relations is the average marking percentage of *CONDITIONAL* relations lower than the average of all other relations.

We draw two conclusions from our data. First, causality by default only holds once a wide range of discourse signals is taken into account. We take this as motivation for extending the range of discourse signals beyond connectives. Second, the hypothesis seems to apply only at a more general level of classifying relations; for the fine-grained subclasses, differences in marking cannot be explained in terms of causality as an overarching factor.

### 3.3 The hypothesis of uniform information density

For the hypothesis of uniform information density, we follow work like Asr and Demberg (2012) in predicting more marking for more informative and hence less expected discourse relations, but consider the full range of discourse signals. The relevant data was compiled in Table 3.

The first prediction is that *CONDITIONAL* relations are (due to the non-factivity of their arguments) more informative than *CAUSAL* ones: the non-factivity must be indicated by additional modal operators (see Prasad et al. 2007 for such an analysis), which increases complexity, and, with it, informativity. To keep the average level of informativity equal, this predicts that there should be more marking for the more informative *CONDITIONAL* relations in comparison to *CAUSAL* ones. This is confirmed by the RST-SC for the two types of relations in their entirety, 85.6 and 81.4% of which are signalled.

We can now correlate the degrees of informativity of the *CONDITIONAL* subtypes with their marking. Recall that the *CONDITION* subtype is predicted to be the least marked in the *CONDITIONAL* group, as the other subtypes are more informative. However, the RST-SC data confirms this claim only for *OTHERWISE*. *CONDITION* is more marked than the *HYPOTHETICAL* and *CONTINGENCY* subtypes, with *HYPOTHETICAL* relations exhibiting the least marking, despite their high degree of informativity. Again, the predictions of the hypothesis are only corroborated by the entire groups of relations, but the hypothesis seems at variance with the microvariation in the *CONDITIONAL* group.

### 3.4 The continuity hypothesis

Finally, the continuity hypothesis suggests that continuous relations are less marked than non-continuous ones. We tested this hypothesis on the subtypes of *CONDITIONAL* relations, annotating 164 *CONDITIONAL* relations (50% of the set of 327 relations, divided into 108 *CONDITION*, 27 *CONTINGENCY*, 14 *HYPOTHETICAL*, and 15 *OTHERWISE* relations<sup>7</sup>) separately for each subtype along the relevant dimensions of Givón (1993). Results are summarized in Table 5.

*CONDITIONAL* relations are not homogeneously continuous: their subtypes vary strongly, with *HYPOTHETICAL* relations exhibiting the least continuity (across all dimensions) while *OTHERWISE* relations emerge as the most continuous. *CONDITION* relations are closest to the average of the whole *CONDITIONAL* group. Also, continuity is much higher in the dimensions of time and perspective than in those of reference and modality, that is, its degree does not depend on whether the respective dimension is local or global.<sup>8</sup>

<sup>6</sup> The counts exclude the “NoRel” cases of the PDTB, where no discourse relation was assigned.

<sup>7</sup> During the annotation, we replaced potentially misclassified *HYPOTHETICAL* relations in the corpus by additional examples of *CONDITION* relations.

<sup>8</sup> The low degree of referential continuity is partially due to the fine-grained segmenting in the RST-DT, however. Taboada and Hadic Zabala (2008) discuss the relation between segmentation granularity and referential continuity.

**Table 5:** Distribution of *CONDITIONAL* relations for continuity dimensions.

Relation	Time		Reference		Perspective		Modality		Total
	Con	Discon	Con	Discon	Con	Discon	Con	Discon	
CONDITION	84 (77.8%)	24 (22.2%)	41 (38.0%)	67 (62.0%)	107 (99.1%)	1 (0.9%)	67 (62.0%)	41 (38.0%)	108
CONTINGENCY	26 (96.3%)	1 (3.7%)	9 (33.3%)	18 (66.7%)	25 (92.6%)	2 (7.4%)	21 (77.8%)	6 (22.2%)	27
HYPOTHETICAL	8 (57.1%)	6 (42.9%)	4 (28.6%)	10 (71.4%)	9 (64.3%)	5 (35.7%)	6 (42.9%)	8 (57.1%)	14
OTHERWISE	14 (93.3%)	1 (6.7%)	6 (40.0%)	9 (60.0%)	14 (93.3%)	1 (6.7%)	12 (80.0%)	3 (20.0%)	15
<b>Total</b>	<b>132 (80.5%)</b>	<b>32 (19.5%)</b>	<b>60 (36.6%)</b>	<b>104 (63.4%)</b>	<b>155 (94.5%)</b>	<b>9 (5.5%)</b>	<b>106 (64.6%)</b>	<b>58 (35.4%)</b>	<b>164</b>

**Table 6:** Distribution of signalled *CONDITIONAL* relations for continuity dimensions.

Relation	Time		Reference		Perspective		Modality		Total
	Con	Discon	Con	Discon	Con	Discon	Con	Discon	
CONDITION	83 (98.8%)	24 (100.0%)	41 (100.0%)	66 (98.5%)	106 (99.1%)	1 (100.0%)	66 (98.5%)	41 (100.0%)	
CONTINGENCY	23 (88.5%)	1 (100.0%)	7 (77.8%)	17 (94.4%)	24 (96.0%)	0 (0.0%)	19 (90.5%)	5 (83.3%)	
HYPOTHETICAL	1 (12.5%)	2 (33.3%)	0 (0.0%)	3 (30.0%)	3 (33.3%)	0 (0.0%)	1 (16.7%)	2 (25.0%)	
OTHERWISE	13 (92.9%)	1 (100.0%)	6 (100.0%)	8 (88.9%)	14 (100.0%)	0 (0.0%)	12 (100.0%)	2 (67.7%)	
<b>Total</b>	<b>120 (90.9%)</b>	<b>28 (87.5%)</b>	<b>54 (90.0%)</b>	<b>94 (90.4%)</b>	<b>147 (94.8%)</b>	<b>1 (11.1%)</b>	<b>98 (92.5%)</b>	<b>50 (86.2%)</b>	

On the basis of this analysis, we calculated the percentage of signalled relations for all subtypes according to the continuity dimensions (Table 6).

Apart from an overall low marking of *HYPOTHETICAL* relations, the data shows that the marking for continuous and discontinuous relations is comparable across all dimensions, except for perspective, where only one out of nine discontinuous relations is marked. Since shifts in both local and global dimensions tend not to increase the amount of marking of the relations in which they occur, the data does not support the claim that a lower degree of continuity correlates with higher degrees of marking.

To test this tentative conclusion, we compiled the analogous data for the *CAUSAL* relations in the RST-SC. Again, the data is more homogeneous, with *RESULT* and *CONSEQUENCE* relations emerging as slightly less continuous (Table 7).

For the *CAUSAL* subtypes, Table 8 shows that continuity has no uniform impact on marking for *CAUSE* and *RESULT* and almost none for *CAUSE-RESULT* and *CONSEQUENCE*, which corroborates our tentative conclusion from our analysis of *CONDITIONAL* relations.

In sum, *CONDITIONAL* relations fail to exhibit a correlation between continuity and marking; if anything, there is a general weak tendency for discontinuous relations to be less marked than continuous ones (excepting only *HYPOTHETICAL* relations). Since the corresponding data for the *CAUSAL* group of relations likewise fails to exhibit

**Table 7:** Distribution of *CAUSAL* relations for continuity dimensions.

Relation	Time		Reference		Perspective		Modality		Total
	Con	Discon	Con	Discon	Con	Discon	Con	Discon	
CAUSE	18 (81.8%)	4 (18.2%)	10 (45.5%)	12 (54.5%)	20 (90.9%)	2 (9.1%)	17 (77.3%)	5 (22.7%)	22
RESULT	15 (68.2%)	7 (31.8%)	4 (18.2%)	18 (81.8%)	16 (72.7%)	6 (27.3%)	19 (86.4%)	3 (13.6%)	22
CAUSE-RESULT	19 (86.4%)	3 (13.6%)	7 (31.8%)	15 (68.2%)	18 (81.8%)	4 (18.2%)	17 (77.3%)	5 (22.7%)	22
CONSEQUENCE	17 (77.3%)	5 (22.7%)	3 (13.6%)	19 (86.4%)	18 (81.8%)	4 (18.2%)	16 (72.7%)	6 (27.3%)	22
<b>Total</b>	<b>69 (78.4%)</b>	<b>19 (21.6%)</b>	<b>24 (27.3%)</b>	<b>64 (72.7%)</b>	<b>72 (81.8%)</b>	<b>16 (18.2%)</b>	<b>69 (78.4%)</b>	<b>19 (21.6%)</b>	<b>88</b>

**Table 8:** Distribution of signalled CAUSAL relations for continuity dimensions.

Relation	Time		Reference		Perspective		Modality	
	Con	Discon	Con	Discon	Con	Discon	Con	Discon
CAUSE	14 (77.8%)	3 (75.0%)	6 (60.0%)	11 (91.7%)	16 (80.0%)	1 (50.0%)	14 (82.4%)	3 (60.0%)
RESULT	11 (73.3%)	5 (71.4%)	2 (50.0%)	14 (77.8%)	12 (75.0%)	4 (66.7%)	13 (68.4%)	3 (100.0%)
CAUSE-RESULT	18 (94.7%)	3 (100.0%)	7 (100.0%)	14 (93.3%)	18 (100.0%)	3 (75.0%)	16 (94.1%)	5 (100.0%)
CONSEQUENCE	17 (100.0%)	5 (100.0%)	3 (100.0%)	19 (100.0%)	18 (100.0%)	4 (100.0%)	16 (100.0%)	6 (100.0%)
<b>Total</b>	<b>60 (86.9%)</b>	<b>16 (84.2%)</b>	<b>18 (75.0%)</b>	<b>58 (90.6%)</b>	<b>64 (88.9%)</b>	<b>12 (75.0%)</b>	<b>59 (85.5%)</b>	<b>17 (89.5%)</b>

this correlation, we conclude that at least in the domain of CONDITIONAL and CAUSAL relations, degrees of marking the relations cannot be explained by their continuity or discontinuity. Again, we could not explain an exceptional position for the HYPOTHETICAL relations.

### 3.5 An alternative explanation?

In sum, our results provide mixed evidence for the three hypotheses tested in this section. Still, we wish to argue that even the results for the subtypes of the CONDITIONAL relations are not necessarily evidence against the hypotheses, but rather, that they suggest other interacting factors, especially to explain the exceptional case of HYPOTHETICAL relations. One confounding factor in our data is the distribution of relations in sentence-internal and sentence-external constellations. Intra-sentential discourse relations most often call for signalling, mostly by connectives (Hoek et al. 2017).

HYPOTHETICAL relations are special here in that they occur sentence-externally to 80.4%, whereas all other relations of the subgroup overwhelmingly (CONDITION and CONTINGENCY) or predominantly (OTHERWISE) occur within sentences (Table 9).

For all subtypes, the percentage of unsignalled inter-sentential relations is higher than the one for intra-sentential ones. However, of all subtypes, HYPOTHETICAL relations exhibit the least clear instance of this pattern, with the majority of intra-sentential relations lacking marking as well. We link this unclear result to the observation that many HYPOTHETICAL relations in the RST-DT turned out to be at variance with the definition of the relation, which led us to include only 14 of them in Section 3.4.

Consequently, we redid the analysis with the 164 relations that we used for the analysis of continuity. The results, summarized in Table 10, show that now the HYPOTHETICAL relations follow suit in that they are predominantly marked intra-sententially but never inter-sententially. Thus, the fact that these relations appear mostly in between sentences can explain why they are much less marked than other CONDITIONAL subtypes.

To check this result for CONDITIONAL relations, we did an analogous calculation for CAUSAL relations (Table 11). The data corroborate the interdependency between intra-sententiality and higher marking in that relations in sentences are marked to a much higher degree than their counterparts in between sentences.

We consider the high percentage of intra-sentential CONDITION discourse relations responsible for its consistent signalling, even though its informativity is lower than the one of HYPOTHETICAL relations. This subtype occurs predominantly inter-sententially, and hence shows less marking despite its higher informativity.

**Table 9:** Intra- and inter-sentential CONDITIONAL relations.

Relation	Tokens	Intra-sentential	Inter-sentential	Unsignalled when intra-sentential	Unsignalled when inter-sentential
CONDITION	239	234 (97.9%)	5 (2.1%)	4 (1.7%)	1 (20.0%)
CONTINGENCY	27	25 (92.6%)	2 (7.4%)	1 (4.0%)	2 (100.0%)
HYPOTHETICAL	46	9 (19.6%)	37 (80.4%)	7 (77.8%)	31 (83.8%)
OTHERWISE	15	10 (66.7%)	5 (33.3%)	0 (0.0%)	1 (20.0%)
<b>Total</b>	<b>327</b>	<b>278 (85.0%)</b>	<b>49 (15.0%)</b>	<b>12 (4.3%)</b>	<b>35 (71.4%)</b>

**Table 10:** Intra- and inter-sentential CONDITIONAL relations (second analysis).

Relation	Tokens	Intra-sentential	Inter-sentential	Unsignalled when intra-sentential	Unsignalled when inter-sentential
<small>CONDITION</small>	108	105 (97.9%)	3 (2.1%)	1 (1.0%)	0 (0.0%)
<small>CONTINGENCY</small>	27	25 (92.6%)	2 (7.4%)	1 (4.0%)	2 (100.0%)
<small>HYPOTHETICAL</small>	14	5 (19.6%)	9 (80.4%)	2 (40.0%)	9 (100.0%)
<small>OTHERWISE</small>	15	10 (66.7%)	5 (33.3%)	0 (0.0%)	1 (20.0%)
<b>Total</b>	<b>164</b>	<b>145 (88.4%)</b>	<b>19 (11.6%)</b>	<b>4 (2.8%)</b>	<b>12 (63.2%)</b>

**Table 11:** Intra- and inter-sentential CAUSAL relations.

Relation	Tokens	Intra-sentential	Inter-sentential	Unsignalled when intra-sentential	Unsignalled when inter-sentential
<small>CAUSE</small>	52	37 (71.2%)	15 (28.8%)	4 (10.8%)	5 (33.3%)
<small>RESULT</small>	159	93 (58.5%)	66 (41.5%)	6 (6.5%)	31 (47.0%)
<small>CAUSE-RESULT</small>	65	39 (60.0%)	26 (40.0%)	0 (0.0%)	9 (34.6%)
<small>CONSEQUENCE</small>	417	251 (60.2%)	166 (39.8%)	17 (6.8%)	57 (34.3%)
<b>Total</b>	<b>693</b>	<b>420 (60.6%)</b>	<b>273 (39.4%)</b>	<b>27 (6.4%)</b>	<b>102 (37.4%)</b>

## 4 Conclusions and further work

We investigated the signalling of relations in the RST-SC in the light of the causality-by-default, uniform-information-density, and continuity hypotheses. The predictions of the hypotheses could be corroborated for the CONDITIONAL and the CAUSAL group of relations; however, they failed to explain the variation in signalling across the subtypes of CONDITIONAL relations. This variation could be explained in terms of the distribution between sentence-internal and sentence-external relations.

One extension of this line of work will be to use our results as hypotheses to be tested against larger databases like the PDTB. Even though, unlike the RST-SC, the PDTB includes mostly lexical signals (connectives and AltLex expressions), a meaningful comparison is possible because we could identify substantial comparable subsets of the two data sets. We will also examine the use of CONDITIONAL relations in different genres – for example, in narrative – to investigate the role of genre on the signalling of discourse relations. For instance, genre might influence the continuity dimensions of CONDITIONAL relations, which in turn could affect their degree of being signalled.

Finally, we will extend the investigation to other discourse relations and their subtypes, including also non-causal relations (according to Sanders et al. 2021), because we expect that, for some of them, their subtypes exhibit different behaviour just like CONDITIONAL relations. Such variation might point us to additional, as yet undetected factors that influence the marking of discourse relations. In particular, we will investigate CONTRAST relations in the RST-SC with the subgroups CONTRAST, CONCESSION, and ANTITHESIS, which combine causal and non-causal relations.

## Appendix

The Appendix includes the original RST-DT definitions for the CONDITIONAL and CAUSAL discourse relations that are discussed in this paper (Tables 12 and 13). In the definitions, “nucleus” (N) refers to discourse units that are considered central among the arguments of a specific discourse relation. A less central unit is called “satellite” (S). In the RST-DT, discourse relations can be mononuclear (having only one nucleus) or multinuclear (having several).



**Table 12:** Description of CONDITIONAL subtypes adopted from the RST-DT manual (Carlson and Marcu 2001).

Relation type	Definition	Example
<small>CONDITION</small>	In a <small>CONDITION</small> relation, the truth of the proposition associated with the nucleus is a consequence of the fulfilment of the condition in the satellite. The satellite presents a situation that is not realized.	[S.A. brewing would make a takeover offer for all of Bell Resources]N [if it exercises the option,]S according to the commission. (wsj630)
<small>CONTINGENCY</small>	In a <small>CONTINGENCY</small> relation, the satellite suggests an abstract notion of recurrence or habituality. Hence, the expression of time, place, or condition is not the primary focus.	[They have a life of their own and can be counted on to look good and perform]N [whenever a cast isn't up to either.]S (wsj1154)
<small>HYPOTHETICAL</small>	In a <small>HYPOTHETICAL</small> relation, the satellite presents a situation that is not factual, but that one supposes or conjectures to be true. The nucleus presents the consequences that would arise should the situation come true. A <small>HYPOTHETICAL</small> relation presents a more abstract scenario than a <small>CONDITION</small> relation. This relation is always mononuclear.	[Theoretically, the brokers will then be able to funnel "leads" on corporate finance opportunities to Kidder's investment bankers,]S [possibly easing the longstanding tension between the two camps.]N (wsj604)
<small>OTHERWISE</small>	This is a mutually exclusive relation between two elements of equal importance. The situations presented by both the satellite and the nucleus are unrealized. Realizing the situation associated with the nucleus will prevent the realization of the consequences associated with the satellite. This relation may also be multinuclear.	... [unless the company can start shipments of the new product sometime this quarter,]S [the fourth-quarter loss is likely to be "comparable to the third quarter's."]N (wsj1973)

**Table 13:** Description of CAUSAL subtypes adopted from the RST-DT manual (Carlson and Marcu 2001).

Relation type	Definition	Example
<small>CAUSE</small>	The situation presented in the nucleus is the cause of the situation presented in the satellite. The cause, which is the nucleus, is the most important part. The satellite represents the result of the action. The intention of the writer is to emphasize the cause.	[This year, a commission appointed by the mayor to revise New York's system of government completed a new charter,]N [expanding the City Council to 51 from 35 members.]S (wsj1137)
<small>RESULT</small>	The situation presented in the satellite is the cause of the situation presented in the nucleus. The result, which is the nucleus, is the most important part. Without presenting the satellite, the reader may not know what caused the result in the nucleus.	[The explosions began]N [when a seal blew out.]S (wsj1320)
<small>CAUSE-RESULT</small>	This is a causal relation in which two elementary discourse units, one representing the cause and the other representing the result, are of equal importance or weight.	To try to combat the traffic slow-down, airlines started reducing fares; average fares rose only 1.7% in August, in contrast to increases of 16% each in February and March. [But so far, the effort has failed,]N [and traffic is still slow.]N (wsj1192)
<small>CONSEQUENCE</small>	In a <small>CONSEQUENCE</small> relation, the situation presented in one span is a consequence of the situation presented in the other span. The reader/writer intentions are irrelevant to determining whether such a relation holds. The relations <small>CAUSE</small> and <small>RESULT</small> imply a more direct linkage between the events in the nucleus and the satellite, whereas a <small>CONSEQUENCE-S</small> or <small>CONSEQUENCE-N</small> relation suggests a more indirect linkage. If both spans carry equal weight in the discourse, select the multinuclear <small>CONSEQUENCE</small> .	[This hasn't been Kellogg Co.'s year. The oat-bran craze has cost the world's largest cereal maker market share.]N [The company's president quit suddenly.]S (wsj610)

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