

Ambiguity in Explicit Discourse Connectives

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Abstract

Discourse connectives are known to be subject to both *usage* and *sense* ambiguity, as has already been discussed in the literature. But discourse connectives are no different from other linguistic expressions in being subject to other types of ambiguity as well. Four are illustrated and discussed here.

1 Introduction

Discourse connectives, like other linguistic expressions, are subject to ambiguity. Two types of ambiguity — *usage ambiguity*, whether or not a given token is serving as a discourse connective in its context, and *sense ambiguity*, what discourse relation(s) a given token is signalling — were the subject of a study by Pitler and Nenkova (2009), who showed how syntactic features could help resolve them both.

But discourse connectives are no different from other linguistic expressions in being subject to other types of ambiguity as well. Four of them are discussed here, as a way of encouraging researchers to determine whether existing disambiguation methods suffice to handle them or whether the methods need to be extended. Ignoring the full range of ambiguity of discourse connectives can lead to discourse relations being mis-labelled both manually (during annotation) and automatically (during discourse parsing).

As background to presenting these ambiguities, Section 2 briefly reviews the original Penn Discourse TreeBank (the PDTB-2), the findings of Pitler and Nenkova (2009), and how the recently released PDTB-3 extends and, in some cases corrects, annotation in the PDTB-2. We then turn to four additional types of discourse connective ambiguity that have been discussed in the context of other linguistic forms. Section 3 discusses *part-of-speech ambiguity*, which can affect how a given token functions as a discourse connective. Section 4 discusses *multi-word ambiguity*, where a sequence of tokens can be ambiguous between a sequence of separate elements and a single multi-word discourse connective. Section 5 discusses a *scope ambiguity* that affects the sense of discourse connectives. Finally, Section 6 discusses *semantic role ambiguity* involving the arguments of certain CONCESSION relations.

2 Background

2.1 PDTB-2

The Penn Discourse Treebank (Prasad et al., 2008) was created as the largest public repository of annotated discourse relations (over 43K), including over 18.4K signalled by explicit discourse connectives (coordinating or subordinating conjunctions, or discourse adverbials). All relations in the corpus are labelled with either one or two senses from a three-level sense hierarchy, whose top level comprised four non-terminal senses: EXPANSION, COMPARISON, CONTINGENCY and TEMPORAL. Most discourse relations were labelled with terminal senses, except where annotators were unable to decide and backed off

to a level-2 (or in some cases, a top-level) sense. **Discourse relations** consisted of two arguments labelled *Arg1* and **Arg2**, with each relation anchored by either an explicit discourse connective or adjacency. In the latter case, annotators inserted one or more *implicit connectives* that signalled the sense(s) they inferred to hold between the arguments. The approach in the PDTB-2 is agnostic about any higher-level discourse structure, and as such, made no attempt to build a tree or graph structure of relations over the text as a whole. The size and availability of the PDTB-2 spawned the field of *shallow discourse parsing*, as in the 2015 and 2016 CoNLL shared tasks (Xue et al., 2015, 2016), as well as the development of similar resources for other languages, including Chinese, Hindi, and Turkish. An in-depth discussion of the PDTB-2 can be found in (Prasad et al., 2014).

2.2 Pitler & Nenkova (2009)

Pitler and Nenkova (2009) showed how syntactic features could be used in disambiguating both *usage ambiguity* and *sense ambiguity*. To understand these types of ambiguity, consider the word *since*. Ex. 1 illustrates its non-discourse usage, where *since* is simply a temporal preposition. Both Ex. 2 and Ex. 3 illustrate discourse usages and also the *sense ambiguity* of *since*, signalling a purely temporal relation in Ex. 2 and a purely causal relation in Ex. 3.

(1) She has been up since 5am.

(2) There have been over 100 mergers since the most recent wave of friendly takeovers ended.

(3) It was a far safer deal since the company has a healthier cash flow.

Using data in the PDTB-2, Pitler and Nenkova (2009) showed that *usage ambiguity* can be resolved with high accuracy, as can *sense ambiguity* with respect to the four top-level sense classes (cf. Section 2.1). (N.B. They took multi-labelled tokens to be classified correctly if at least one of the senses was correctly identified.) They showed how high accuracy could be achieved in both disambiguation tasks by using both the token itself and its syntactic features in classification. Features included the syntactic category of the node dominating all and only the token itself, the category of its immediate parent, and the categories of its siblings. When they added interactions between connectives and syntactic features, and interactions between the features themselves, accuracy increased over 10 points and f-score, nearly 20 points.

Since Pitler & Nenkova’s results are not incompatible with other types of discourse connective ambiguity, their work is a good jumping off point for experimenting with the additional types of discourse connective ambiguity we discuss here.

2.3 PDTB-3

The PDTB-3¹ contains ~12.5K more intra-sentential relations (i.e., ones that lie wholly within the projection of a top-level S-node) and ~1K more inter-sentential relations than the PDTB-2 (Webber et al., 2019). New senses have been added to the sense hierarchy (Table 1) and used for annotating new tokens, as well as for re-annotating existing tokens.

Newly annotated intra-sentential relations include ones between the conjuncts of conjoined verb phrases and conjoined clauses; ones between free or headed adjuncts and the clauses they adjoin to; ones associated with subordinators such as *in order*, prepositions such as *with*, *for*, and *in*; and ones between infinitival clauses (or other subordinating structures) and their matrix clause. New annotation also includes explicitly marked question-response pairs, and lexico-syntactic constructions that are *unambiguous* signals of particular discourse relations, such as the *so*-construction, signalling RESULT (Ex. 4), the *too*-construction, signalling NEGATIVE-RESULT (Ex. 5), and *auxiliary inversion*, signalling a CONDITIONAL relation (Ex. 6).²

¹<https://catalog.ldc.upenn.edu/LDC2019T05>

²Discourse relations in the paper are formatted with *Arg1* indicated in italics and **Arg2** in bold, with the discourse connective (explicit or implicit) or alternative lexicalization underlined.

Level-1	Level-2	Level-3
TEMPORAL	SYNCHRONOUS	–
	ASYNCHRONOUS	[PRECEDENCE,SUCCESION]
CONTINGENCY	CAUSE	REASON
		RESULT
		NEGRESULT
	CAUSE+BELIEF	REASON+BELIEF
		RESULT+BELIEF
	CAUSE+SPEECHACT	REASON+SPEECHACT
		RESULT+SPEECHACT
	CONDITION	[ARG1,ARG2]-AS-COND
	CONDITION+SPEECHACT	–
	NEGATIVE-CONDITION	[ARG1,ARG2]-AS-NEGCOND
COMPARISON	NEGATIVE-CONDITION+SPEECHACT	–
	PURPOSE	[ARG1,ARG2]-AS-GOAL
	CONCESSION	[ARG1,ARG2]-AS-DENIER
	CONCESSION+SPEECHACT	ARG2-AS-DENIER+SPEECHACT
EXPANSION	CONTRAST	–
	SIMILARITY	–
	CONJUNCTION	–
	DISJUNCTION	–
	EQUIVALENCE	–
	EXCEPTION	[ARG1,ARG2]-AS-EXCPT
	INSTANTIATION	[ARG1,ARG2]-AS-INSTANCE
	LEVEL-OF-DETAIL	[ARG1,ARG2]-AS-DETAIL
	MANNER	[ARG1,ARG2]-AS-MANNER
	SUBSTITUTION	[ARG1,ARG2]-AS-SUBST

Table 1: PDTB-3 Sense Hierarchy. Only asymmetric senses extend to Level-3.

- (4) *The fit is so good, we see this as a time of opportunity.* [wsj_0317]
(5) *Things have gone too far for the government to stop them now* [wsj_2454]
(6) *...but would have climbed 0.6%, had it not been for the storm* [wsj_0573]

Differences in how discourse relations are annotated in the PDTB-2 and the PDTB-3 reflect (1) changes and/or additions to the sense hierarchy; (2) different criteria for choosing one sense label over another; and (3) rigorous attention to *semantic consistency* (Hollenstein et al., 2016), checking that similar tokens have been annotated in a similar way, thereby reducing annotation noise and improving what can be induced from the corpus.

Note that additions to the sense hierarchy have introduced new *sense ambiguities* that weren’t present in the PDTB-2. A case in point is the discourse adverbial *as well*, all of whose tokens were sense-annotated EXPANSION.CONJUNCTION in the PDTB-2 (cf. Ex. 7 and Ex. 8). With the new sense COMPARISON.SIMILARITY, *as well* is now ambiguous between conveying EXPANSION.CONJUNCTION, which Ex. 7 is still taken to do, and COMPARISON.SIMILARITY, which Ex. 8 was re-annotated as.

- (7) There is speculation that property/casualty firms will sell even more munis *as they scramble to raise cash to pay claims related to Hurricane Hugo and the Northern California earthquake. **Fundamental factors are at work** as well.* [wsj_0671]
(8) “*They continue to pay their bills and will do so,*” says Ms. Sanger. “We’re confident **we’ll be paying our bills for spring merchandise** as well.” [wsj_1002]

The PDTB-3 records the *provenance* of each token. This shows that, of the ~53600 tokens annotated in the PDTB-3, ~57% are unchanged from the PDTB-2, ~19% (~9900 tokens) have been changed in some way from their earlier annotation, and the remaining 24% are new to the PDTB-3. Provenance allows us to compare the use of new senses in annotating new tokens and in re-annotating existing tokens. For example, the new sense COMPARISON.SIMILARITY was used in annotating 135 new tokens and in re-annotating 68 tokens, of which 41 were associated with explicit connectives. Of the 41, 18 involved the discourse adverbial *similarly*; 10, the subordinating conjunction *as if*; while the rest involved tokens of *as*, *as though*, *as well*, *much as*, *just as meanwhile* and *while*. While *similarly* thus unambiguously signals COMPARISON.SIMILARITY, for these other connectives, the new sense has meant a new ambiguity. These additional sense ambiguities argue for re-applying Pitler & Nenkova’s analysis to the PDTB-3.

3 Part-of-Speech Ambiguity

Part-of-Speech (PoS) affects how three items function as discourse connectives: *since*, *before*, and *however*. *Since* is ambiguous between a subordinating conjunction (PoS=IN), as in Ex. 9, and an adverbial (PoS=RB), as in Ex. 10.

- (9) *However, since Eastern first filed for Chapter 11 protection March 9, it has consistently promised to pay creditors 100 cents on the dollar.* [wsj_0475]
- (10) His company, Misa Manufacturing Inc., *was forced to seek protection from creditors under federal bankruptcy law in 1987 and has since been liquidated.* [wsj_1830]

This ambiguity also affects the sense of *since*. As a subordinating conjunction, *since* signals either REASON or (temporal) SUCCESSION (cf. Ex 9), while as a discourse adverbial, its temporal sense is the reverse — PRECEDENCE (cf. Ex. 10).

The same holds for *before*, which is also ambiguous between a subordinating conjunction (PoS=IN) and an adverbial (PoS=RB). As a subordinating conjunction, it conveys PRECEDENCE (cf. Ex. 11), while as a discourse adverbial, it conveys the reverse — SUCCESSION (cf. Ex. 12).

- (11) They said they wanted to wait for the outcome of any government investigation before deciding what to do. [wsj_0357]
- (12) *The Japanese are in the early stage right now,” said Thomas Kenney, . . . “Before, they were interested in hard assets and they saw magazines as soft.* [wsj_1650]

Finally, *however* is ambiguous between a simple adverbial (PoS=RB) and a WH-Adverb subordinator (Pos=WRB). The latter is shown in Ex. 13.

- (13) *The 1987 crash was “a false alarm however you view it,” says University of Chicago economist Victor Zarnowitz.* [wsj_2397]

As a simple discourse adverbial, the most common sense of *however* is COMPARISON.CONCESSION.ARG2-AS-DENIER. As a subordinator, the most common sense of *however* is the reverse, COMPARISON.CONCESSION.ARG1-AS-DENIER.³

As for resolving these ambiguities, reliable disambiguation of their *usage* as discourse connectives only requires correct PoS-tagging to disambiguate how they are functioning as discourse connectives.

4 Multi-word Expression Ambiguity

Another ambiguity arises when a multi-word sequence can be analyzed either as a sequence of separate elements or as a single multi-word connective. Four sequences (*but then*, *only to*, *or otherwise* and *but also*) are ambiguous in this way.

Take *but then*: It can be interpreted as as a sequence of connectives, with *but* conveying COMPARISON.CONTRAST or COMPARISON.CONCESSION.ARG2-AS-DENIER and *then* conveying TEMPORAL.ASYNCHRONOUS.PRECEDENCE, as in

- (14) Small businesses say a recent trend is like a dream come true: more-affordable rates for employee-health insurance, initially at least. But then they wake up to a nightmare. [wsj_0518]

Alternatively, it can be interpreted as a single multi-word connective that expresses COMPARISON.CONCESSION.ARG2-AS-DENIER, as in

- (15) *To many, it was a ceremony more befitting a king than a rural judge seated in the isolated foothills of the southern Allegheny Mountains. But then Judge O’Kicki often behaved like a man who would be king – and, some say, an arrogant and abusive one.* [wsj_0267]

³ CONCESSION is annotated when a causal relation expected on the basis of one argument is cancelled or denied by the situation described in the other.

(N.B. The CONCESSION label corresponds to a paraphrase with *even though* – e.g. “Even though it was a ceremony more befitting a king than a rural judge seated in the isolated foothills of the southern Allegheny Mountains, Judge O’Kicki often behaved like a man who would be king ...”. Multi-word *but then* also implies that “you shouldn’t be surprised at this because”, but this is not something that was annotated in the PDTB-3.)

Another ambiguous sequence is *only to*. On the one hand, *only* can be interpreted as modifying *to*, as it does in *only because*, *only when*, etc., indicating that Arg2 is the only thing in the given relation with Arg1, cf.

- (16) *Tax-exempt airport and street-corner solicitations were intended **only to provide start-up funds***. [wsj_0282]

On the other hand, *only to* can be interpreted as a single multi-word connective conveying that Arg2 is a surprising, unexpected situation that follows Arg1, as in

- (17) *Two former secretaries told the grand jury they were summoned to the judge’s chambers on separate occasions to take dictation, only to **find the judge in his bikini underwear***. [wsj_0267]

This is indicated by *only to* being labelled both PRECEDENCE and CONCESSION.ARG2-AS-DENIER.

A third ambiguous sequence is *or otherwise*. It can be analyzed as two separate connectives, with *otherwise* expressing CONTINGENCY.NEGATIVE-CONDITION.ARG1-AS-NEGCOND, as in Example 18 (paraphrasable as “if you don’t stay in the center of the path, you might trip and fall.”), or as a single multi-word connective, with *or otherwise* conveying that the disjuncts are mutually exclusive **and** that their union covers the full set, as in Example 19.

- (18) *Walk down the center of the path, or otherwise, **you might trip and fall***.

- (19) A new Maryland law frees store owners of liability if a customer *trips* or otherwise **gets hurt** on the way to the restroom. [wsj_1270]

The final ambiguous sequence that we note here, *but also* (or in some cases, just the word *but*), sometimes appears as part of the paired connective *not only ... but also* (cf. Ex. 20), usually sense-annotated as CONJUNCTION.

- (20) Market participants say *investors are not only licking their wounds following the turbulence last week, but they have also been made nervous by two events in West Germany*. [wsj_1187]

Alternatively, the sequence can be analyzed as two distinct connectives — *but*, signalling CONTRAST or CONCESSION.ARG2-AS-DENIER, and *also*, signalling CONJUNCTION. This is how they have been labelled in wsj_0044 (Ex. 21).

- (21) a. Editorials in the Greenville newspaper *allowed that Mrs. Yeargin was wrong, but **also said the case showed how testing was being overused***. [wsj_0044]
b. Editorials in the Greenville newspaper *allowed that Mrs. Yeargin was wrong, but also **said the case showed how testing was being overused***. [wsj_0044]

As with both usage and sense ambiguity, it would be useful to determine whether syntactic features might help distinguish whether a particular multi-word span should be analyzed as a single connective or separate elements.

5 Scope Ambiguity

Scope was only an issue in the PDTB-2 with respect to attribution, where a verb of attribution such as *say* or *think* might be superficially negated, while having the negation actually work to reverse the polarity of the attributed argument or relation (The PDTB Research Group, 2008). But scope is also a source of ambiguity in the PDTB-3, where it can affect the sense of *to-clause* constructions.

Absent modality or negation, a *to-clause* construction has a simple sense ambiguity. The *to-clause* can be **Arg2** of either a CONTINGENCY.PURPOSE.ARG2-AS-GOAL relation (Ex. 22), or of a CONTINGENCY.CAUSE.RESULT relation (Ex. 23).

(22) The Galileo project started in 1977, and *a number of project veterans were on hand* **to watch the launch**. [wsj_1817]

(23) *Georgia Gulf stock rose \$1.75 a share yesterday* **to close at \$51.25 a share**. [wsj_0080]

(By definition, PURPOSE requires a volitional agent, and generally can be paraphrased by inserting *in order*, while with RESULT, inserting *therefore* leads to a more appropriate paraphrase.)

However, in the context of a modal (e.g., *need, have to, must, require*. etc.) or future tense (or present tense used as future), an additional ambiguity appears, whose disambiguation depends on whether the scope of the modal or future tense includes just *Arg1* or both arguments. Specifically, if the scope includes just *Arg1*, annotators have taken the sense as being conditional (ARG2-AS-COND), because while the situation specified in the *to-clause* (**Arg2**) might be the agent's purpose, there is no assertion that it is so. This can be seen in the use of *if* as an appropriate paraphrase, as in Ex. 24–25

(24) *Banks need a competitive edge* **to sell their products**. [wsj_0238]

paraphrase: Banks need a competitive edge *if* they are to sell their products.

(25) He said *the index would have to be in the low 40% range for several months* **to be considered a forecast of recession**. [wsj_0036]

paraphrase: He said the index would have to be in the low 40% range for several months *if* it is to be considered a forecast of recession.

In contrast, if the modal or future operator seems best interpreted as scoping both arguments, as in

(26) The two companies have been discussing a transaction *under which Fresenius would buy Delmed stock for cash* **to bring its beneficial ownership to between 70% and 80% of Delmed's fully diluted common stock**. [wsj_1066]

paraphrase: ... under which it **would** be the case that Fresenius buys Delmed stock for cash to bring its beneficial ownership to ...

then we are back to the original sense ambiguity between PURPOSE.ARG2-AS-GOAL and RESULT.

This same CONDITIONAL sense ambiguity also arises when there is negation or a question in *Arg1*, because its scope is again ambiguous between being just over *Arg1* or over both arguments. This can be manually disambiguated by seeing whether *if* can be appropriately inserted in a positive paraphrase of *Arg1* (in the case of negation) or a non-question paraphrase of *Arg1* (in a question context). If so, scope only extends over *Arg1*, and the sense is CONDITION.ARG2-AS-COND, as in

(27) ... which, unlike utilities, aren't regulated *and therefore don't need government approval* **to construct new plants**. [wsj_0560]

paraphrase: ... and therefore they need government approval *if* they are to construct new plants

In the case of the question in Ex. 28,

(28) *Do you really need this much money* **to put up these investments?** [wsj_0629]

“You really need this much money if you are to put up these investments” was not considered an appropriate non-question paraphrase of the original: The question was taken to scope both arguments. As such, one is back to the original sense ambiguity of *to-clause* constructions between PURPOSE.ARG2-AS-GOAL and RESULT. Since here, an appropriate paraphrase involves *in order* — “You really need this much money in order to put up these investments” — PURPOSE.ARG2-AS-GOAL was taken to be an appropriate sense label. In all, of over 1600 relations whose **Arg2** was a *to-clause* construction, about 9% were sense-labelled CONDITION.ARG2-AS-COND.

While scope cannot be disambiguated by purely syntactic means, disambiguating these cases may require methods that go beyond the purely syntax-based approach of Pitler and Nenkova (2009).

6 Semantic Role Ambiguity

In English, *semantic role ambiguity* has mainly been discussed in the context of “garden path” sentences (Konstas et al., 2014), where in

- (29) a. The horse raced past the barn ...
 b. The man served the potatoes ...

there is an ambiguity as to whether *the horse* (*the man*) is in the agent role of main verb *raced* (*served*) or the patient role of *raced* (*served*) as head of a reduced relative clause. Where listeners consistently make the wrong choice, it is considered a “garden path” sentence.

A few verbs in English such as *shame* demonstrate *semantic role ambiguity* even without considering reduced relative clauses. As shown in Ex. 30, even after processing the direct object of *shame* (i.e., *me*), there is still an ambiguity as to who plays the role of shamer and who, the shamee.

- (30) My son shamed me ...
 a. into giving some of our cookies to the other children.
paraphrase: My son made me feel ashamed of myself (causing me to do something)
 b. by keeping all the cookies for himself.
paraphrase: My son made me feel ashamed of him (by keeping the cookies for himself)

With discourse connectives, four subordinating conjunctions that can signal a CONCESSION relation — *although*, *though*, *even though*, and *while* — show a similar ambiguity when they head a postposed subordinate clause. The ambiguity here is which clause raises the causal inference and which denies it. It is an ambiguity that does not appear with preposed subordinate clauses.

More specifically, we noted in Section 2.3 that some senses are asymmetric, meaning that the relation is directional. To capture this directionality, each asymmetric relation has two Level-3 senses, in one of which *Arg1* plays the specified role, while in the other case, **Arg2** does so (cf. Table 1).

In general, an explicit connective that signals an asymmetric sense does so unambiguously. For example, when *otherwise* signals exception, the exception is *Arg1* (EXPANSION.EXCEPTION.ARG1-AS-EXCPT), as in Ex. 31. In contrast, when *except* signals exception, the exception is **Arg2** (EXPANSION.EXCEPTION.ARG2-AS-EXCPT), as in Ex. 32.

- (31) *Twenty-five years ago the poet Richard Wilbur modernized this 17th-century comedy merely by avoiding “the zounds sort of thing,” as he wrote in his introduction. Otherwise, the scene remained Celimene’s house in 1666.* [wsj_0936]
 (32) *Boston Co. officials declined to comment on Moody’s action on the unit’s financial performance this year except to deny a published report that outside accountants had discovered evidence of significant accounting errors in the first three quarters’ results.*

While CONCESSION relations are asymmetric, the subordinating conjunctions *although*, *though*, *even though* and *while* are not always unambiguous signals. That is, when they head a preposed subordinate clause (402 tokens in the PDTB-3), they were taken as unambiguously signalling the relation COMPARISON.CONCESSION.ARG1-AS-DENIER, where the matrix clause (*Arg1*) denies the causal inference raised by the subordinate clause, **Arg2**, as in Ex. 33.

- (33) The documents also said *that although the 64-year-old Mr. Cray has been working on the project for more than six years, the Cray-3 machine is at least another year away from a fully operational prototype.* [wsj_0018]

However, when postposed with respect to its matrix clause, there is an ambiguity as to whether the matrix clause (*Arg1*) plays the role of denying the causal inference raised in **Arg2**, as in Ex. 34, or whether the subordinate clause (**Arg2**) plays the role of denying the causal inference raised in *Arg1*, as in Ex. 35.

- (34) The company’s research suggests *that its name recognition among most consumers remains unusually low, although (CONCESSION.ARG1-AS-DENIER) its array of brands – including Maxwell House coffee, Jell-O, Cheez Whiz, and Miller beer – blanket supermarket shelves.* [wsj_0326]
 (35) *Unemployment still is officially recorded at 16.5%, the highest rate in Europe, although (CONCESSION.ARG2-AS-DENIER) actual joblessness may be lower.* [wsj_0456]

In the PDTB-3, there are 324 tokens of postposed CONCESSION relations with one of these four connectives. Of these, 260 have been labelled CONCESSION.ARG1-AS-DENIER, as with comparable preposed subordinate clauses, while the remaining 64 have been labelled CONCESSION.ARG2-AS-DENIER. The only differences between the four connectives is their relative frequency with which they appear in post-position and the degree of ambiguity when they do.

Conn	total labelled CONCESSION	Proportion in post-position	ARG1-AS-DENIER	ARG2-AS-DENIER
even though	95	0.74	44	26
though	219	0.60	7	125
although	311	0.37	11	103
while	237	0.03	2	6

While further analysis should identify features that will help disambiguate the sense of post-posed CONCESSIVES, it is nevertheless worth establishing that semantic role ambiguity is not limited to verbs.

7 Conclusion

We hope to have shown that discourse connectives are no different from other linguistic expressions in being subject to many types of ambiguity. Besides *usage ambiguity* and *sense ambiguity* (Pitler and Nenkova, 2009), we hope to have shown that discourse connectives are subject to ambiguities associated with *parts-of-speech*, *multi-word expressions*, *scope* and *semantic roles*. We hope this will now encourage researchers to explore whether existing disambiguation methods suffice to handle this larger range of discourse connective ambiguities or whether such methods need to be extended.

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