The use of antithesis and other contrastive relations in argumentation

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Abstract. This paper presents a study of use of the rhetorical figure of antithesis and other contrastive relations in several modern-day environmental science policy journal articles on issues of food security, climate change, and water resource management. The articles present the conflicting perspectives of environmentalists and engineers, i.e., the view that nature should be preserved and protected versus the view that it should be engineered to solve human problems. The main contribution of this paper is a taxonomy characterizing argumentative uses of contrastive relations in these articles based on our semantic/pragmatic interpretation of text including, in some cases, discourse coherence relations. The number of examples and the breadth of the taxonomy is indicative of the key role of contrastive relations in argumentation in this genre. This investigation is a necessary step towards comprehensive computational approaches to detecting antithesis and other contrastive relations and to identifying their argumentative roles.

Keywords: Antithesis, concession, contrastive relations, adversatives, Rhetorical Structure Theory, rhetoric, argumentation, environmental science policy

1. Introduction

We have been investigating use of the rhetorical figure of antithesis and other contrastive relations in several modern-day environmental science policy journal articles on issues of food security, climate change, and water resource management.[1] The articles present the conflicting perspectives of environmentalists and engineers, i.e., the view that nature should be preserved and protected versus the view that it should be engineered to solve human problems. The main contribution of this paper is a characterization of argumentative uses of contrastive relations in these articles based on our semantic/pragmatic interpretation of text including, in some cases, discourse coherence relations. This investigation is a necessary step towards comprehensive computational approaches to detecting antithesis and other contrastive relations and to identifying their argumentative roles. Furthermore, the study may inform computational methods for identifying stance and sentiment. Also, the taxonomy of contrastive relations presented here could be helpful in teaching argument analysis.

The rhetorical figure of antithesis[2] is used in catchy slogans such as "Buy low, sell high", as well as in serious writings, e.g., Martin Luther King Jr.'s argument in support of civil disobedience: "One has not only a legal but a moral responsibility to **obey just** laws. Conversely, one has a moral responsibility to **disobey unjust** laws. ... A **just law** is a man-made code that **squares with** the moral law or the law of

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[1]This paper supercedes our earlier investigation of antithesis in [11].

[2]On-line collections of literary uses of antithesis and other figures can be found on Silva Rhetorica (http://rhetoric.byu.edu/) and RhetFig (https://artsresearch.uwaterloo.ca/chiastic/display/).

God. An **unjust law** is a code that is **out of harmony with** the moral law... Any law that **uplifts** human personality is **just**. Any law that **degrades** human personality is **unjust**."[3]

According to Fahnestock, "A perfect antithesis takes pairs of terms opposed as contraries, contradictories, or correlatives and puts them in parallel phrases" [5, p. 232]. Contraries, also referred to as polar or scalar opposites, are gradable terms such as 'high'/'low'. Contradictories, also referred to as binary opposites or complementaries, are nongradable opposites such as 'dead'/'alive' or predicates and their negation. Correlatives refer to opposite roles in a relationship such as 'buy'/'sell'. Other types of lexical opposites or antonyms include reversives (reversed actions or events, such as 'build'/'destroy', 'start'/'finish') and directional opposites, opposites referring to a horizontal axis (such as 'front'/'back'), a vertical axis (such as 'head'/'feet'), a lateral axis (such as 'left'/'right'), or a temporal axis (such as 'past'/'present'/'future') [20]. In addition to lexical opposites, there are "local" opposite terms that are understood as opposites in certain times and places, such as 'Reaganite'/'Clintonite' [3].

On the other hand, in our investigation we adopted a broader definition of antithesis, namely, the "juxtaposition of contrasting words or ideas (often, although not always, in parallel structure)" [26]. By widening the scope of our investigation to include contrasting ideas, we intend to address cases such as (1), which contrasts the concept of transferring genes with studying genomes.

(1) a. Rather than transferring genes from wheat to kernza,
    b. we are studying the genomes in an effort to identify useful genes from wheat ... [29]

Furthermore, by broadening the investigation's scope beyond parallel syntactic structures, we consider how certain cases relate to discourse coherence relations of Rhetorical Structure Theory (RST) [24].[4] (1a–1b), for example, can be described by the RST relation of Antithesis.

Moreover, we found that to describe some cases, it was necessary to consider not just ideas expressed directly in the text, but also certain implicatures of the text.[5] Consider (2a–2b), in which (2a) could implicate (2c), (2b) could implicate (2d), and (2d) cancels (2c).

(2) a. Most carbon dioxide remains in the air,
    b. but as much as 25% is absorbed by the world's oceans. [21]
    c. *Carbon dioxide emissions cannot harm the ocean.*
    d. *Carbon dioxide emissions can harm the ocean.*

Also note that (2a–2b) can be described by the RST relation of Concession.

There has not been much previous work addressing the use of antithesis in argumentation. In argumentation theory, Azar [1] proposed to model argumentation using certain RST relations including Antithesis and Concession. Fahnestock [3–5] and Harris [15] discussed its use from the perspective of rhetorical studies (see Section 2.1). Green [7] attempted to represent discourse structure and argument structure in a single model integrating RST's Antithesis and Concession with certain causal argument schemes, but later argued for modeling argument structure independently of discourse structure [8,9]. In [10], Green analyzed the argument schemes and a variety of rhetorical devices in two of the papers from the corpus used in the current study, but did not specifically examine the argumentative uses of antithesis and concession. Harris and colleagues [16,17] encouraged computational research on rhetorical

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[3]("Letter from a Birmingham Jail", 1963) [5, p. 233]. Bold font added by Fahnestock.

[4]RST is described in Section 2.2.

[5]In linguistic pragmatics, an implicature [13] is information that is conveyed indirectly by an utterance in a particular context. Unlike entailments, implicatures may be canceled or denied. Some, 'conventional implicatures', are associated with discourse connectives such as 'but'; others, 'conversational implicatures', are derived by reasoning about the speaker's intent. In the context of the article containing (2), it is plausible that the writer intended for (2a) and (2b) to implicate (2c) and (2d), respectively.

figures for argument mining. Mitrović et al. [25] investigated automatic detection of irony, simile, and oxymoron, rhetorical figures that like antithesis involve meaning. Computational research on detecting the figure of antithesis addressed only "easy" cases involving antonyms listed in on-line resources and negated predicates [12,23].

This paper is organized as follows. The next section briefly covers some related work on the rhetorical figure of antithesis (Section 2.1), discourse coherence relations (Section 2.2), and the linguistic analysis of opposition relations (Section 2.3). After that, we present a taxonomy of contrastive relations used in the collection of environmental science policy articles. We conclude with a summary of our findings and discussion of some implications.

2. Background

This section summarizes related work on contrastive relations from three different scholarly perspectives: rhetorical analysis, discourse analysis, and linguistic semantics. Although there is some overlap in what they address, the studies make little or no explicit reference to the other perspectives.

2.1. Antithesis in rhetorical studies

In an historical survey of the figure of antithesis [3], Fahnestock notes that antithesis has been used in argumentation for over two thousand years. The sophist Gorgias used the antithetical phrase "the stronger leads, the weaker follows" as the warrant in an argument that Helen of Troy was not to blame for the Trojan War. Antithesis is frequently used in orally transmitted literature, e.g. in Proverbs 10:1: "A wise son makes a glad father/but a foolish son is a sorrow to this mother." According to Aristotle, antithesis requires use of opposite terms in parallel phrases. Fahnestock proposes an explanation for the effect of Aristotle's type of antithesis: "An antithesis as a figure of speech at the sentence level builds on these powerful natural pairs, the use of one in the first half of the figure creating the expectation of its verbal partner in the second half" (p. 47). Rhetorical force is lost when the second half does not meet the lexical expectation created by a term in the first half. To illustrate, she contrasts "the wise fail and the foolish succeed" with the less pleasing, alternate wording, "the wise fail and the foolish do much better". Furthermore, parallelism "brings the opposed terms into relief, foregrounding them in the listener's or reader's attention. The parallelism can come from the precise repetition of all but the opposed words in each of the two parts or from similar grammatical forms. Either way, the parallel cola place the opposed terms in similar positions, heightening their difference so that the contrast between them becomes greater than it would be if they occurred in unbalanced cola or simply appeared randomly in one or more sentences. Furthermore, a well-structured antithesis places at least one pair of its contrasted terms … at the end of its parallel parts in positions of emphasis" (p. 49–50). For illustration, she contrasts "You have a lot to gain by winning/ and if you lose, it won't cost you anything", "You have everything to win, and you will lose nothing", and "You have everything to win/and nothing to lose." While the three sentences have similar meanings and the second makes use of lexical opposites, "only the third qualifies as the figure; here the contrast is finally shaped or epitomized into an antithesis by using parallel forms (the complements 'everything' and 'nothing' and the infinitives 'to win' and 'to lose'), by placing these opposites in parallel positions, and, as an added touch, by placing one of the pairs at the ends of the balanced cola" (p. 50). However, Fahnestock documents various treatments of antithesis since Aristotle's discussion of it that have loosened the requirement for lexical opposites and/or parallelism.

Fahnestock [5] notes several uses of the figure of antithesis in argumentation. As discussed by Aristotle, antithesis can be used to invent an argument from opposites, e.g., that excess is bad since its opposite, moderation, is good. Also, in the above quote from Martin Luther King Jr.'s argument in support of civil disobedience (see Section 1), antithesis is used to "draw stark contrasts" (p. 233). In scientific writing, antithesis is often used due to its ability to succinctly express single difference experimental design [4], i.e., to make an argument that the single differing factor in two situations is causally related to their different outcomes, as in (3).

(3) a. In central Alaska, where grizzly bears, wolves, and moose have continuously lived together for millennia, moose were extremely sensitive to olfactory signals or vocal signs of predators. . .
    b. In contrast, farther south in Wyomings's Grand Teton National Park, moose that had been isolated from wolves and grizzly bears for no more than 75 years . . . were devoid of any ability to detect predators. [4, p. 25]

In this example, the absence of wolves and grizzlies in Grand Teton National Park is claimed to be responsible for the inability of the Grand Teton moose to detect predators. An "imperfect antithesis" (according to Fahnestock's criteria given in Section 1), this example involves contrasting ideas rather than pairs of lexical opposites. Although it does not have a high degree of syntactic parallelism, its clauses, (3a) and (3b), can be described by the RST relation of Contrast.

Harris accounts for judgments that some instances of antithesis seem more perfect than others by noting that "figures rarely travel alone. Some figures entail certain other figures, some have natural affinities for certain other figures, and some just co-occur from a convergence of motives" [15, p. 595]. Thus, when the rhetorical figure of antithesis is used in concert with parallelism, its effect may be strengthened. Furthermore, Harris et al. suggest that ". . . when two or more figures combine in certain recurrent collocations, the functions they convey tend to be highly consistent" [17, p. 160]. For example, in the well-known quotation from the 1961 inaugural address of J.F. Kennedy, "Ask not what your country can do for you. Ask what you can do for your country," antithesis is collocated with antimetabole (reverse lexical repetition: 'you'/'your country') and mesodiplosis (clause medial repetition: 'can do'); and ". . . the combined function is primarily to reject the negated predicate utterly and replace it with the positive predication" (p. 160). In another example, from an internet blog, "Ultrabooks are laptops after all, but not all laptops are ultrabooks," antithesis is collocated with antimetabole; the combined function is Subclassification ([17], p. 161). Lastly, in the tweet "Women in Middle East attacked for not wearing hijab. Women in the West attacked for wearing hijab. It's almost like women aren't the problem," antithesis ('not wearing'/'wearing') collocates with mesodiplosis ('attacked for'), and simple lexical repetition ('women'), expressing a paradox [16].

2.2. Rhetorical structure theory

Despite its name, Rhetorical Structure Theory (RST) [24] does not address the traditional subject matter of rhetorical studies [16]. Instead, it describes the implicit relations among clauses in a coherent text. In RST, adjacent spans of text may be modeled in a hierarchical structure of coherence relations. In many coherence relations, the more important span is labeled as the 'nucleus' (N), while the other span is labeled as 'satellite' (S). In 'multi-nuclear' relations, the spans are of equal importance, and each is labeled as a nucleus. RST relations are defined in terms of 'constraints' on N and S and the 'effect', "which gives plausible reasons for why the writer might have included each part of the entire text." The

coherence relations that are most relevant to our study are Concession, Antithesis, and Contrast.[6] RST Concession[7] and RST Antithesis are classified as 'presentational relations', which are relations whose effect is to "increase some inclination" in the reader, e.g., to increase 'positive regard' (RST Concession, RST Antithesis), increase acceptance (RST Justify), increase belief (RST Evidence), etc. On the other hand, RST Contrast is one of many 'subject matter' relations "whose intended effect is that the reader recognizes the relation in question."

RST Concession, often signaled by 'although', is defined as follows: "W [the writer] has positive regard for the situation described in N; W is not claiming that the situation presented in S doesn't hold; W acknowledges a potential or apparent incompatibility between the situations presented in N and S; W regards the situations presented in N and S as compatible; recognizing that the compatibility between the situations presented in N and S increases R's [the reader's] positive regard for the situation presented in N; [the effect is that] R's positive regard for the situation presented in N is increased."

Like RST Concession, the intended effect of RST Antithesis to increase R's positive regard for the situation presented in N, and W has positive regard for that situation. However, "the situations presented in N and S are in contrast ... [and] because of an incompatibility that arises from the contrast, one cannot have positive regard for both situations presented in N and S; comprehending S and the incompatibility between the situations presented in N and S increases R's positive regard for the situation presented in N."

Illustrating RST Concession and RST Antithesis (in [24]), (4a) is the satellite of an RST Concession relation, whose nucleus (4b–4c) is an embedded RST Antithesis relation with nucleus (4b) and satellite (4c).[8]

(4) a. [Every rule has exceptions,]$_{\text{S-Concession}}$
    b. [[but the tragic and too-common tableaux of hundreds or even thousands of people snake-lining up for any task with a paycheck illustrates a lack of jobs,]$_{\text{N-Anthesis}}$
    c. [not laziness.]$_{\text{S-Antithesis}}$]$_{\text{N-Concession}}$

The multi-nuclear, subject-matter relation, RST Contrast, is defined as follows: "the situations presented in these two nuclei are (a) comprehended as the same in many respects (b) comprehended as differing in a few respects and (c) compared with respect to one or more of these differences; [the effect is that] R recognizes the comparability and the difference(s) yielded by the comparison being made," as in (5) (from [24]).

(5) a. [Animals heal]$_{\text{N}}$
    b. [but trees compartmentalize.]$_{\text{N}}$

It has been noted frequently in RST corpus studies that discourse connectives are sometimes absent and even if present, may not be sufficient to distinguish among coherence relations. For example, in a study of a large corpus, Das [2] found that 'but' and 'although' were frequently used with RST Concession and RST Antithesis, while 'but' and 'while' were frequently used with RST Concession and RST Contrast. The following criteria to aid corpus annotators in distinguishing these three relations are given in an RST annotation manual [28]. Although RST Contrast is similar to RST Antithesis, "if neither

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[6]Complete definitions of all RST relations are given at http://www.sfu.ca/rst/01intro/definitions.html.

[7]From this point on, to avoid confusion with similar terms, RST relation names will be prefixed with "RST".

[8]Rather than depict embedded RST relations in the diagram notation often used in RST papers, we are using nested bracketing to represent hierarchical structure.

segment is deemed more important than the other, then Contrast is to be chosen" (p. 23). On distinguishing RST Concession and RST Antithesis (p. 24), one important difference is that "the claim which is represented by S is dismissed in Antithesis, but is acknowledged in Concession" (p. 24) A subtype of Antithesis is the corrective relation, as illustrated (p. 24) in (6).

(6) a. [This is not coke,]$_S$
    b. [this is red wine.]$_N$

The satellite (a) rejects an expectation from context that this is coke, and the nucleus (b) asserts the correction, that it is red wine.

2.3. Adversatives

Linguists have studied opposition relations (sometimes referred to as "adversative" or "contrastive" relations) associated with discourse connectives such as 'but', 'although', 'while', and 'however'. Izutsu [19] proposed a three-way semantic classification of opposition relations – contrast, concession, and corrective – based upon linguistic evidence, i.e., lexical differences and syntactic behavior. First, "contrast is a simple opposition between the propositional contents of two symmetrical clauses", e.g., (7) (p. 658).

(7) Contrast: John is small, but Tom is big

Concession is the second type of opposition relation identified by Izutsu, who distinguishes two types of concessive relations, Direct concessive and Indirect concessive, e.g., (8) and (9) (p. 662).

(8) D-concessive: Although John is poor, he is happy.
(9) I-concessive: The car is stylish and spacious, but it is expensive.

"D-concessive expresses an implication that the relation between the situations of two clauses is unexpected in terms of a natural course of events assumed by a language user. An assumption inferentially evoked in a D-concessive sentence (such as *Although S1, S2*) is formulated as follows: 'If S1, (then normally) not S2.'" (p. 662). In (8), the first clause may create the expectation that John is not happy, while the second clause cancels that expectation. In contrast, in an I-concessive sentence, the implications of the two clauses are mutually exclusive. The first clause of an I-concessive may be formulated as 'If S1, (then normally) C, while the second clause may be formulated as 'If S1, (then normally) not C'. In (9), the first clause may create the expectation that we should buy that car while the second clause may create the expectation that we should not buy that car.

The corrective relation is illustrated in (10). "The negation . . . is used for making a denial of a previous assertion or implication" and "anticipates the occurrence of a valid alternative" (p. 668).

(10) Corrective: He likes not coffee but tea.

2.4. Summary

Traditional descriptions of the rhetorical figure of antithesis emphasized the role of lexical opposites and parallelism in perfect exemplars of the figure. However, Harris and others noted that parallelism and other collocated rhetorical figures may contribute to the effect of antithesis. Describing coherence relations in a text, RST put little emphasis on the wording of text spans and noted that discourse connectives may be ambiguous or absent. Izutsu's description of contrastive relations focused on different uses of certain discourse connectives, some involving expectations. In the following section, we present a taxonomy of argumentative uses of contrastive relations and relate them to the insights of these three different perspectives.

3. Taxonomy of contrastive relations

To create the taxonomy, we analyzed the collection of five articles informed by the studies covered in the previous section. Note that we have not created a corpus in the sense of an annotated copy of the examples presented in this paper, since our goal was not to create a dataset for computational use (yet). It would be premature to do so, as this taxonomy is not necessarily exhaustive nor is it clear what set of annotations may be useful to future researchers. In the following, as a mnemonic device, we identify examples from the collection with abbreviations of keywords from the title of the source: OA ("Ocean Acidification", [21]), Wild ("Wild Plants to the Rescue", [29]), GM ("Genetically Modified Food", [6]), Geo ("Solar Geoengineering", [22]), River ("Colorado River", [14]). Note that OA and Wild take pro-environmental stances, Geo takes a pro-engineering stance, and the other two purport to present both sides. However, River seems to favor the former, while GM seems to favor the latter. Underlining has been added to examples to highlight contrasting terms/ideas in the text. All the examples contain at least one pair of contrasting expressions. Different styles of underlining are used to differentiate the pairs when more than one pair occurs in an example. Discourse connectives are highlighted in bold. The names of top-level branches of the taxonomy are based upon related RST relations.

3.1. Concession

The contrastive relations in this group are related to Izutsu's semantic relation of concession, both direct and indirect, and the RST relation of Concession. In RST Concession, the writer acknowledges the situation presented in the satellite (S), while intending to increase the reader's positive regard for the situation given in the nucleus (N). Note that although there are many instances of RST Concession in the collection, the taxonomy includes only those with contrasting terms or ideas given in the text.

3.1.1. Direct concession

Izutsu's example of direct concession, which can be analyzed as an instance of RST Concession, is repeated below in (11) with our annotations added for N and S. Furthermore, as a direct concession, (a) may implicate (c),[9] but (c) is cancelled by (b).

(11) a. [Although John is poor]$_S$
     b. [he is happy.]$_N$
     c. *John is not happy*

The following examples of RST Concession from our collection can be characterized similarly, i.e., (a) may implicate (c), but (c) is cancelled by (b).

(12) a. [**Although** we use each plant's pedigree, along with <u>sophisticated</u> genetics software . . .]$_S$
     b. [our overall approach could be considered rather <u>old-fashioned</u> . . .]$_N$ (Wild)
     c. *our approach is not old-fashioned*
(13) a. [**Although** <u>most</u> of Earth's plant species are <u>perennial</u>,]$_S$
     b. [<u>all</u> of our grain crops . . . are either <u>strictly annual or are grown as annuals</u>.]$_N$ (Wild)
     c. *some of our grain crops are perennial*

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[9]We have provided Izutsu's explanation of the implicatures in D-concessives and I-concessives in Section 2.3. It is not feasible, however, to provide sufficient context for each example in the taxonomy to justify the implicatures. Thus, the reader is asked to imagine a context in which the implicature reasonably could be derived.

Although consisting of a single clause and thus not described in RST, the following examples have an inferential property similar to that of direct concession: (a) may implicate (c), but (c) is cancelled by (b).

(14) a. The <u>tiniest</u> animals
    b. are often the <u>most important</u> and underestimated species in any environment; (OA)
    c. *The tiniest animals are not important*
(15) a. Furthermore, a <u>modest</u> research effort
    b. can yield <u>rapid</u> progress.(Geo)
    c. *a modest research effort will yield slow progress*

In summary, in (12)–(15) there is opposition between pairs of terms/ideas given in two adjacent spans of text, i.e., the (a) and (b) spans as well as between the implicature of the first span and the text of the adjacent span, i.e., between the implicated (c) and the (b) span.

The following example of direct concession, (16a–e), conveys three potential implicatures. Part (a) may implicate (f), which is cancelled by (b); (b) may implicate (g), which is cancelled by (c). Then (d) may implicate (h), which is cancelled by (e). However, like (14) and (15), RST does not play a role. The net effect in (14)–(16) is to express paradoxical situations.

(16) a. I was molding a <u>hardy</u>
    b. **but** <u>agriculturally useless wild plant</u>
    c. into an oilseed grain <u>crop</u>, something natural selection could never have accomplished.
    d. Like a <u>god</u>
    e. – **but** a <u>sweaty, exhausted</u> one. (Wild)
    f. *I was molding an agriculturally useful . . .*
    g. *it was not a crop*
    h. *I was not sweaty or exhausted*

3.1.2. Indirect concession

Izutsu's example of indirect concession, which also can be analyzed as an instance of RST Concession, is repeated below in (17) with our annotations added for N and S. Furthermore, as an indirect concession, (a) may implicate (c); (b) may implicate (d); and (d) cancels (c).

(17) a. [The car is stylish and spacious]$_S$
    b. [but it is expensive.]$_N$
    c. *we should buy the car*
    d. *we should not buy the car*

The following instances of RST Concession from our corpus can be characterized similarly.

(18) a. [Those eggs <u>can</u> get <u>wet</u>,]$_S$
    b. [**but** they <u>cannot</u> get <u>dry</u>; eggs laid at high tide dessicate with an hour of the water dropping.]$_N$ (River)
    c. *the eggs will not be harmed by a changing water level*
    d. *the eggs will be harmed by a changing water level*
(19) a. [certain marine species are <u>vulnerable</u> to acidification]$_N$
    b. [**whereas** others are relatively <u>resilient</u>.]$_S$ (OA)[10]
    c. *Ocean acidification is harmful*.

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[10]Unlike the other examples, in (19) N is before S. Given that the article's position is that OA is harmful, (19c) cancels (19d).

  d. *Ocean acidification is not harmful.*

For more examples of indirect concession cooccurring with RST Concession, see the Appendix.

Although consisting of a single clause and thus not described in RST, the following example is similar to the above examples: (a) may implicate (c); (b) may implicate (d); and (d) cancels (c).

(20) a. These <u>great advances</u> in technology, **however**,
  b. have come at a <u>steep price</u>. (OA)
  c. *Technology is good.*
  d. *Technology is not all good.*

In summary, like the examples of direct concession, there is opposition between pairs of terms/ideas given in two adjacent spans of text, i.e., the (a) span and (b) span; but unlike the examples of direct concession, there also is opposition between the implicature of the (a) span and the implicature of the (b) span.

3.2. Antithesis

The contrastive relations in this group are related to the rhetorical figure of antithesis and the RST relation of Antithesis. According to the definition of RST Antithesis, one cannot have positive regard for both the situations presented in N and S; and by having negative regard for the position presented in S, the reader will have positive regard for the situation presented in N.

3.2.1. Plain antithesis
The following are some simple examples of the RST relation of Antithesis and the rhetorical figure of antithesis. Note that, based upon our reading of the articles from which the examples came, N describes the position favored by the writer. (See for comparison "Plain contrast" in Section 3.3.1.)

(21) a. [The difference is that <u>selective breeding or mutagenic techniques</u> tend to result in <u>large swaths</u> of genes being <u>swapped or altered</u>.]_S
  b. [<u>GM technology</u>, **in contrast**, enables scientists to <u>insert</u> into a plant's genome a <u>single</u> gene (or a few of them) from another species of plant or even from a bacterium, virus or animal.]_N (GM)
(22) a. [<u>Annuals</u> <u>die</u> each year and must be replanted.]_S
  b. [<u>Perennials</u> can <u>stay green</u> year-round …]_N (Wild)
(23) a. [It is **nevertheless** remarkable that <u>young</u> <u>nonprofit organizations</u> should <u>undertake</u> projects]_N
  b. [that <u>older, much better funded institutions</u> <u>won't touch or have abandoned</u>.]_S (Wild)

For other examples similar to (21)–(23), see the Appendix.

In the following example, an instance of RST Antithesis is embedded in the nucleus of an instance of RST Concession. The satellite of the RST Concession, (a), acknowledges the pro-GM side's statement that fewer genes are affected in GM plants than in conventionally bred plants; however, the intended effect is for the reader to have positive regard for the nucleus, (b–c). In this instance of RST Anthesis, (b) is the nucleus and (c) the satellite; the positions described in (b) and (c) are incompatible and the intended effect is for the reader to have positive regard for the statement in (b) describing conventional plant breeding techniques, and negative regard for the statement in (c), describing GM techniques. Furthermore, like indirect concession, there are two implicatures in this example, with one implicature cancelling the other. However, unlike the example of indirect concession in Section 3.1.2, one of the

implicatures comes from the satellite of the Antithesis embedded in the nucleus of the Concession: (a) may implicate (d), (c) may implicate (e); and (e) cancels (d).[11]

(24) a. [True, the number of genes affected in a GM plant most likely will be far, far smaller than in conventional breeding techniques.]_{S-Concession}

    b. [[Yet opponents maintain that because the <u>wholesale swapping</u> or alteration of entire genes is a <u>natural process</u>, it tends to produce <u>few scary surprises</u> today.]_{N-Antithesis}

    c. [<u>Changing a single gene</u>, on the other hand, might turn out to be a more <u>subversive action</u>, with <u>unexplained ripple effects</u>...]_{S-Antithesis}]_{N-Concession} (GM)

    d. *GM is safe*

    e. *GM is not safe*

3.2.2. Antithesis with corrective interpretation

The next examples illustrate the subtype of RST Antithesis with a corrective reading (see other examples in Section 2.2 and 2.3), where S rejects an expectation from the preceding context, and N provides the correction.

(25) a. [Solar geoengineering is <u>not a substitute</u> for cutting emissions.]_S

    b. [It is – at best – a <u>supplement</u> ...]_N (Geo)

(26) a. [These concerns <u>do suggest</u> some specific ways in which research programs might be managed to minimize risks;]_N

    b. [they <u>do not, individually or collectively, amount</u> to a strong argument against research.]_S (Geo)

(27) a. [I <u>do not attempt</u> to describe a <u>research program</u> here,]_S

    b. [but rather <u>suggest</u> <u>a few crosscutting principles</u> ...]_N (Geo)

(28) a. [Goldberg ... is <u>not battling psychosis</u>.]_S

    b. [He is <u>expressing despair</u> at the relentless need to confront what he sees as bogus fears ...]_N (GM)

3.3. Contrast

According to the definition of RST Contrast, which is a multinuclear relation, neither span is considered more important than the other.

3.3.1. Plain contrast

The following examples of RST Contrast present two sides of an issue. Unlike plain antithesis (Section 3.2.1), the writer does not favor the position in one span over the other.

(29) a. [Scientists want the <u>flexibility to experiment</u>]_N

    b. [**whereas** <u>power and water managers</u> want <u>stability</u>.]_N (River)

(30) a. [<u>Proponents</u> of genetically modified crops say <u>the technology is the only way to feed a warming</u>, <u>increasingly populous world</u>.]_N

    b. [Critics say <u>we tamper with nature at our peril</u>.]_N (GM)

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[11]It is not clear why (24c) and not (24b) would generate the implicature. More cases need to be studied before attempting to explain this.

3.3.2. Contrast with argument for point between two extremes

The following example conveys a kind of argument from negative consequences (see also Section 3.5). By comparing two extremes in (a) and (b), each having negative consequences, it supports the writer's claim in text preceding (31) ("A balance of trace metals ... is crucial") that a level between the two extremes is desirable. Note that in addition to having a high degree of syntactic parallelism, each span in this example can be described by the RST relation of Condition.

(31) a. [If trace-metal concentrations <u>fall too low</u>, photosynthesis falters;]$_N$
 b. [if they <u>rise too high</u>, the excess of metal may prove toxic.]$_N$ (OA)

3.3.3. Contrast with single difference argument

The next two examples convey arguments based on single difference experimental design (see Section 2.1); (c) represents the implicit claim of the argument.

(32) a. [<u>Normally</u>, both hydroxide and carbonate form strong complexes with divalent and trivalent metals, effectively <u>sequestering those compounds</u> from uptake by photosynthetic organisms;]$_N$
 b. [<u>under acidified conditions</u>, **however**, hydroxide and carbonate <u>remain as free metals</u> that are bioavailable.]$_N$ (OA)
 c. *Acidified conditions cause hydroxide and carbonate to remain as free bioavailable metals.*
(33) a. [<u>Native prairies</u> often <u>remain productive</u> ...]$_N$
 b. [**By contrast**, <u>adjacent prairies plowed up for wheat</u> quickly <u>degraded</u> ...]$_N$ (Wild)
 c. *Plowing up prairies for wheat caused them to degrade.*

3.4. Result: Argument from opposites

RST Result is an RST subject matter relation, whose intended effect is that R recognize N as a cause of S, e.g., [Jack fell]$_S$ [because Jill pushed him.]$_N$ The following example of RST Result conveys an argument from opposites [30]: if the opposite of X has a property P, then X has the opposite of property P. In particular, if water released from Lake Powell causes stress to endangered fish, then the natural state of the Colorado river does not cause stress to those fish.[12] This branch of the taxonomy and the one described in Section 3.5 show that RST relations other than Concession, Antithesis, and Contrast may cooccur with contrastive relations.

(34) a. [The <u>clear</u>, <u>48-degree water</u>, released from the depths of Lake Powell, <u>stressed</u> endangered fish,]$_S$
 b. [which were <u>adapted</u> to <u>silty</u>, <u>80-degree flows.</u>]$_N$ (River)

3.5. Cause: Argument from negative consequences

RST Cause is an RST subject matter relation, whose intended effect is that R recognize S as a cause of N. Each of the following examples conveys an argument from negative consequences [30], i.e., that if X causes Y and Y is undesirable, then X is undesirable. (Increasing influxes of CO_2 have undesirable results, so increasing influxes of CO_2 are undesirable; changing something has undesirable results so changing something is undesirable.)

(35) a. [Increasing influxes of CO_2 cause a <u>decrease</u> in pH,]$_{S\text{-}Cause}$

---

[12]Although the example does not contain a causal connective, we analyzed it as RST Result since it could be paraphrased as "The clear, 48-degree water ... stressed endangered fish, because they were adapted to silty, 80-degree flows."

    b. [[which results in an <u>increase</u> in H+]$_{\text{S-Cause}}$

    c. [**and thus** a <u>decrease</u> in hydroxide and carbonate ions in most surface waters.]$_{\text{N-Cause}}$]$_{\text{N-Cause}}$(OA)

(36) a. ["We change <u>something</u> we <u>can control</u>,]$_{\text{S}}$

    b. [**and then** <u>two things</u> we <u>can't control</u> very quickly change,"

    says geologist Ted Melis . . .]$_{\text{N}}$(River)[13]

4. Conclusion and discussion

We have presented a taxonomy of contrastive relations found in a collection of five environmental science policy journal articles. The number of examples and the breadth of the taxonomy is indicative of the key role of contrastive relations in argumentation in this genre. Contrastive relations may involve not just antonyms and negated predicates, but also contrasting ideas. Furthermore, as illustrated in examples of concession, they may involve implicatures. As we have shown, many examples of contrastive relations in the taxonomy cooccur with discourse coherence relations, which may strengthen their effect and/or contribute to their meaning, just as collocated figures do. Unfortunately, detecting contrastive relations and understanding their argumentative role in a text is beyond the state-of-the-art in natural language processing (NLP) today. Nevertheless, rather than addressing only the "easy" cases, it is worthwhile to be aware of the challenges that remain.

In the near term, what is the significance of this work? First, consider corpus studies such as [23] designed to investigate the correlation of certain rhetorical figures, including antithesis, and dialogic argument structure. Derived from transcripts of radio program dialogues, the corpus contained human-interpreted propositional content of dialogue turns and argument relations ('conflict', 'support') between propositions. A turn was considered to involve antithesis if the transcript of that dialogue turn contained a pair of antonyms. The authors of the study had predicted a strong association between antithesis and the conflict relation, yet the frequency of conflict relations with antithesis was lower than expected. The authors explain this result by saying that the number of true instances of antithesis in the corpus could be lower, due to the occurrence of 'pseudo-antithesis,' as in (37) for example. They state that although their algorithm counts (37) as an occurrence of antithesis since it contains the antonyms 'ethical'/'unethical', it should not be so marked since the concept of 'ethical problem' is not the opposite of the concept of 'unethical.' We agree with that, but also see an occurrence of antithesis that those authors missed, shown in (38)[14] annotated with our RST analysis; the contrasted terms are 'because' and 'despite'. In short, to gather accurate statistics about antithesis, a more refined approach is needed, taking into account the use of contrasting concepts, not just antonyms, as well as typical collocations of figures (such as antithesis and parallelism) and RST structure. Furthermore, in addition to the problem of inaccurate labeling of antithesis, the approach taken in that study failed to distinguish the different argumentative uses of contrastive relations in the taxonomy presented here.

(37) Investment banks that have highly public ethical problems don't lose their clients. So people are still going to them, probably because they are unethical rather than despite it.

(38) a. [Investment banks that have highly public ethical problems don't lose their clients.]$_{\text{N-Reason}}$

    b. [[So people are still going to them (the banks),]$_{\text{N-Reason}}$

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[13] Also note that this contains a rhetorical figure of chiasmus (inverted pairs of words: 'change'/'can control'/ 'can't control'/'change').

[14] We have added phrases in parentheses to the original example to disambiguate the pronouns.

    c.   [[probably <u>because</u> they (the banks) are unethical]$_{\text{N-Antithesis}}$

    d.   [**rather than** <u>despite</u> it (the banks being unethical).]$_{\text{S-Antithesis}}$]$_{\text{S-Reason}}$]$_{\text{S-Reason}}$

Second, this work is relevant to the NLP task of sentiment analysis, defined as determining the polarity (positive, negative, or neutral) of a document such as a tweet or product review with respect to an issue or product [27]. RST structure has been used to determine the part of a document whose lexical items are most likely to indicate the overall polarity of the document [18]. However, going beyond tweets and reviews, suppose the task were to identify the sentiment in environmental science policy articles such as those in our collection. Aside from the polarity of lexical items, given an analysis of the RST relations of Concession and Antithesis, it is possible to determine the object of a writer's positive regard, which is expressed in the nucleus of those relations. For example in (21) repeated below in (39), it is not possible to ascertain stance from the neutral polarity of its lexical items. However, given an automated analysis of (b) as the nucleus of an instance of RST Antithesis, it is possible to infer the writer's positive regard for GM technology.

(39) a. [The difference is that <u>selective breeding or mutagenic techniques</u> tend to result in <u>large swaths</u> of genes being swapped or altered.]$_{\text{S-Antithesis}}$

      b. [<u>GM technology</u>, **in contrast**, enables scientists to <u>insert</u> into a plant's genome a <u>single</u> gene (or a few of them) from another species of plant or even from a bacterium, virus or animal.]$_{\text{N-Antithesis}}$ (GM)

Third, although we have not created a corpus for computational uses, creation of this taxonomy is a useful contribution to developing such a corpus.

Fourth, the taxonomy illustrates different argumentative properties of various uses of contrastive relations. Although it is beyond current NLP technology to grasp them, a student analyzing the arguments in articles such as those in our collection should be able to. So studying the taxonomy may help by making the student aware of these uses.

Finally, this work raises interesting questions for future research. Will analysis of other articles in this genre or other genres reveal further argumentative uses of contrastive relations to add to the taxonomy? (We suspect so.) An important practical question is how can the different uses of contrastive relations, especially those involving implicature, be detected by NLP methods? Since context and world knowledge are involved, perhaps research on use of knowledge graphs will contribute to a solution to interpretation of implicatures. Theoretically speaking, what is the relationship of other rhetorical figures to RST relations? How should the argumentative uses in the taxonomy be represented in models of argumentation?

Acknowledgements

Appendix. More examples

A.1. Indirect concession

a. [Forces fighting genetic modification in Europe have rallied support for "the Precautionary Prin-
   ciple," which holds that given the kind of catastrophe that would emerge from loosing a toxic,
   invasive GM crop on the world, GM efforts should be shut down until <u>the technology is proved
   absolutely safe</u>.] _S
b. [But as medical researchers know, <u>nothing can really be "proved safe."</u>]_N (GM)
c. *It's possible GM may be proved safe.*
d. *It's not possible for GM to be proved safe.*

a. [<u>Thirty years</u> ago we <u>didn't know</u>. . .]_S
b. [But <u>now</u> anyone in this field <u>knows</u> . . .]_N (GM)
c. *There's no evidence GM is not safe.*
d. *There is evidence that GM is not safe.*

a. [Although our best estimates showed that it would take <u>about 30 years</u> to <u>match the yield</u> of
   wheat,]_S
b. [we also saw that it would be possible to obtain a crop that farmers could <u>successfully grow</u> and
   market <u>in much less time</u>.]_N (Wild)
c. *it would take too long to obtain a good crop*
d. *it would not take too long to obtain a good crop*

Could eating plants with altered genes allow new DNA to work its way into our own?

a. [It is <u>theoretically possible</u>]_S
b. [but <u>hugely improbable.</u>]_N (GM)
c. *It* [*new DNA from GM plants getting into our DNA*] *will happen*
d. *It will never happen*

a. [<u>Most</u> carbon dioxide <u>remains</u> in the <u>air</u>,]_S
b. [but as much as <u>25 percent</u> <u>is absorbed</u> by the world's <u>oceans</u> . . .]_N(OA)
c. *carbon dioxide emissions can't harm the ocean*
d. *carbon dioxide emissions can harm the ocean*

a. [Although we occasionally use DeHaan's <u>wooden contraption</u> to lay out small plots,]_S
b. [more often we use a <u>mechanical transplanter</u>, capable of planting in hours the number of plants
   we used to set in days spent on hands and knees.]_N (Wild)
c. *the old transplanter is useful*
d. *the old transplanter is not useful compared to the new transplanter*

a. [And although it might <u>seem creepy</u> to add virus DNA to a plant,]_S
b. [doing so is, <u>in fact, no big deal</u>, proponents say.]_N (GM)
c. *It's not safe to add virus DNA to a plant.*
d. *It's safe to add virus DNA to a plant.*

a. [The insect research is a <u>meaningful step</u> toward sustaining the river for habitat as well as for
   humans.]_S
b. [It also runs straight into a <u>core conflict</u> between science and Colorado river policy.]_N(River)

    c. *The insect research may lead to a solution to sustaining the river*
    d. *The insect research may fail to lead to a solution to sustaining the river*

A.2. Plain antithesis

    a. [Rather than <u>transferring genes</u> from wheat to kernza,]$_S$
    b. [we are <u>studying the genomes</u> in an effort to identify useful genes from wheat that are already present in kernza, but need only be discovered.]$_N$ (Wild)

    a. [A second difference between mainstream research and nonprofits is that funding for universities and experiment stations increasingly comes from competitive grants. Allocation of funds at this scale becomes dependent on an average of opinions of numerous <u>bureaucrats, lawmakers, administrators</u> and <u>committees.</u>]$_S$
    b. [This is a far cry from the <u>privately wealthy gentlemen</u> of science of the 17th to 19th centuries, some of whom (including Darwin) were able to spend decades developing their theories without having to convince grant reviewers of their ideas' merit or utility.]$_N$ (Wild)

    a. [Economists have estimated that global climate change could result in worldwide economic damage <u>of more than a trillion dollars per year</u> . . .]$_S$
    b. [A geoengineering project large enough to cut the economic damage in half could be implemented at a cost of <u>a few billion dollars per year</u> . . .]$_N$ (Geo)

    a. [A fair argument, but a <u>claim</u> that perfect governance is <u>impossible</u>]$_S$
    b. [does not amount to a <u>proof</u> that no system of governance is <u>practical</u>.]$_N$ (Geo)

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