

Antonymy and Contrast Relations

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Abstract

In this paper we report on experiments to determine if antonymy is a good predictor of contrast, using 124 texts from the British National Corpus and the antonymy relations for adjectives recognized by WordNet. Further, we considered whether antonyms are key arguments in the inferences that license contrast. We looked at the frequency of both indirect and direct antonym pairs in contrastive sentences marked with *but* and sentences with antonym pairs without *but*. Antonyms and *but* co-occurred in only 1% of the 218,017 sentences studied. However, in 81% of *but* marked sentences with true antonyms pairs, the feature the antonyms described was a source of the contrast. In the non-*but* marked sentences, antonymy alone was a poor predictor, licensing a contrast in only 15% of the cases. We also found that direct antonyms are better predictors of contrast than indirect antonyms, and certain antonym pairs, like *same-different*, are consistently good predictors. These results could be used to find unmarked contrast relations with antonyms alone.

1 Introduction

CONTRAST is considered a major category in information organization, evidenced by its inclusion in almost all major taxonomies of rhetorical relations (e.g. Hobbs 1990, Martin 1992, Mann and Thompson 1988, Asher and Lascarides 2003). Since Lakoff (1971), two types of contrast are generally recognized, *denial of expectation* (1) and *semantic opposition* (2):

(1) It's raining *but* I'm taking an umbrella

(2) John is tall *but* Bill is short. (Lakoff 1971: 133)

A common analysis for (1) is that the first conjunct implies something that an implication of the second conjunct contradicts. The inferences from each conjunct to the contradicting inference, e.g. it's raining defeasibly implies getting wet versus the umbrella implying not getting wet, are believed to be world knowledge based inferences, known or otherwise accommodated

by the hearer. Because the contradiction is entirely inference based, it is called *indirect contrast*. To give a parallel analysis for (2) we must imagine a context where John and Bill’s height difference relates to a salient discourse issue. Say John and Bill are twins, and someone asks if twins always have the same height. Then (2) is a good ‘no’ answer because ‘John (Bill’s twin) is tall’ would then imply that Bill is tall. In that context, the second conjunct, ‘Bill is short’, would directly contradict a defeasible inference of the first conjunct, so it’s termed *direct contrast*.

Ideally, we would like to be able to automatically identify the inferences that license contrast, but this is an extremely challenging, if not unachievable goal with current resources and methods. For the class of antonymy based *semantic opposition* like (2) however, we might be able to identify part of the source of the contrast. Further, we may be able to identify cases of unmarked *semantic opposition* contrast relations like (3), where the contrast is licensed by the antonym pair *open-closed*:

- (3) Everyone assured us the offices would be open on Saturday. They were closed.

In examining the Rhetorical Structure Theory treebank built by Carlson, Marcu, and Okurowski (2001), Marcu and Echihabi (2002) found that 74% (177 of 238) of all contrast relations in the texts were not marked with any type of contrastive cue word, so finding ways to automatically identify unmarked contrast is a useful goal for computational discourse work.

A satisfactory computational approach to contrast should identify the inference licensing contrast and recognize cases of unmarked contrast. In this work we approach these goals by answering subquestions related to the contrast type of antonym based *semantic opposition*. We report on experiments with the British National Corpus (BNC) and WordNet looking at *but* marked and non-*but* marked sentences to determine 1) the extent to which antonym based *semantic opposition* occurs as a kind of contrast, 2) what kinds of antonyms are good sources of contrastive inferences, and 3) how good a predictor antonymy is in identifying cases of unmarked contrast.

2 Background

2.1 Semantics of contrast and semantic opposition

Formal semantic treatments of contrast as used by e.g. Winter and Rimon (1994) or Spender (2004), treat contrast as a relationship licensed by defeasible world knowledge based inferences. This further implies that these inferences cannot be derived from the sentence alone, and are constrained by the context. So if (1) is the reply to the question ‘Look at this weather! Are you really going out?’ then other contradicting defeasible inferences are more plausible, e.g. ‘It’s raining, so I’m not going out’, vs. ‘I have an

umbrella, so I am going out' (c.f. the inferences suggested in section 1). This approach emphasizes contradicting defeasible inferences as the source of contrast.¹

Another traditional approach to contrast instead defines it as a relation between two things that are similar yet different. Adopted by computational discourse theories, e.g. Mann and Thompson (1988) and Asher and Lascarides (2003), it has however long been acknowledged that this definition doesn't distinguish contrastively marked sentences from other coordination (e.g. Lang 1977, Umbach 2005). *Denial of expectation* examples don't readily fit this definition, but roughly for (1) we would consider each conjunct to be contributing information about the same spatial-time situation, where the speaker faces two different outcomes, getting wet or not getting wet. Thus we end up with quite similar contrastive inferences, yet in different terminology.

Semantic opposition cases are more easily analyzed with the similar-yet-different approach. In (2) we simply recognize that John and Bill are both male individuals, (in the twins context they also share DNA), and they differ in the feature of height. Note that while the inference based analysis requires some connection to be made with the context for the *semantic opposition* example, the similar-yet-different analysis doesn't require this. The inferential analysis thus harder to apply to *semantic opposition*, but at the same time more complete. The similar-yet-difference analysis seems to stop short of determining the reason for the contrast.

Semantic opposition cases also fit well with the information structural view of *contrastive topics*. Umbach (2005) has argued that *but* is focus sensitive. There is a tendency for contrastive topics to be focussed. In (2), being tall or being short are considered contrastive topics, and *tall* and *short* would naturally get phonetic focus. Note this analysis recognizes a more sophisticated connection with the context than the similar-yet-different analysis, see Umbach (2005) for more details.

Until now we've been looking at cases of antonym based *semantic opposition* compared to *denial of expectation*, but the class Lakoff (1971) identified is broader. Most examples are typified by the use of antonyms or 'extended antonyms' (Lakoff's term). Consider the following examples:

- (4) John is rich but dumb. (Lakoff 1971: 134)

Lakoff (1971) argues that the source of contrast (2) and (4) is the antonym relationship of *tall-short* and *rich-dumb*. The inference needed to interpret the contrast is 'part of the lexical item that is contrasted, rather than the speakers knowledge' (Lakoff 1971: 133). Thus the antonymy itself licenses the contrast.

¹ In direct contrast the contradiction is between a defeasible inference from the first conjunct and the second conjunct.

Because antonym pairs are clearly alternatives of each other, *semantic opposition* pairs seem to have their contrastive topics built in. For (2), the topic is height and the alternatives are being tall or being short. So it's possible that for *semantic opposition* examples, once the antonyms are identified, the scale they characterize will be the topic. If this is consistently true for this class, then we can identify the topic and contrastive topics without a context and further (with Umbach 2005's observation) should be able to predict where focus should be realized, i.e. on the antonym pair itself.

Note that Lakoff (1971) further identifies cases where contrasts are made with a predicate and its negation as *semantic opposition*, e.g. 'Bill speaks French but his wife doesn't.' In this work we concentrate on *semantic opposition* expressed by antonyms.

Example (2) is termed 'double contrast' because two subjects are contrasted according to their values for some feature, here height. (4) is a case of simple contrast, because the same subject is contrasted along two features. The example also differs from (2) in that *rich-dumb* are not strictly speaking antonyms. Lakoff (1971) classifies them as contrasting on the very loose feature of one characteristic being positive while the other is negative. (5) illustrates that single contrasts with semantic antonyms are not possible.

(5) *John is rich but poor. (Lakoff 1971: 134)

It is essential to realize that antonymy is as much a semantic relationship as it is a conventional and arbitrary lexical relationship. For example, we recognize *rich-poor* as an antonym pair but *wealthy-poor* or *rich-broke* not as readily as antonyms, even though these latter two pairs are clearly semantic opposites. WordNet recognizes two kinds of antonyms, direct, where the antonymy is made up of two traditional pairs, and indirect antonyms, where synonyms of antonyms are related. Because *rich-poor* are antonyms and *rich-wealthy* are synonyms, the pair *wealthy-poor* is identified as an indirect antonym.

The indirect antonym pairs recognized by WordNet are still quite different from the extended antonyms like *dumb-rich* in Lakoff's (1971) example, and instead look more like the contrasting pairs found in (Marcu and Echi-habi)'s (2002) work on automatic identification of rhetorical relations. By using a massive corpus of more than 4 million words, they built a model of antonym-like relations that were good predictors of contrast. Consider the following example:

(6) Such standards would preclude arms sales to states like Libya, which is also currently subject to a U.N. embargo. *But* states like Rwanda before its present crisis would still be able to legally buy arms. (Marcu and Echi-habi 2002 :1)

Here the marked contrast relationship can be used to train the system to recognize even an unmarked contrast by identifying word pairs like *legally-embargo*. These aren't direct, indirect or extended antonyms. (Antonymy isn't well defined outside the realm of adjectives, let alone across parts of speech²). But these words do sum up part of the inference that makes the two sentences contrastive, e.g. Libya's embargo is an international community imposed limitation, while Rwanda could do something legally, legal things are permitted by the international community. Without more context the intended inference isn't totally clear but it seems to be an argument that some proposed standard on weapons sales will be too weak: strong enough to prevent Libya from purchasing arms but not rigorous enough to have prevented the arms buildup in Rwanda.³

Since theoretical work gives us examples of true antonyms licensing *semantic opposition* contrasts, and since the empirical work of Marcu and Echiabi (2002) shows us that extended antonyms are also good predictors of contrast, it seems fruitful to use available lexical resources and evaluate how true antonymy relates to contrast. Using WordNet we can also evaluate whether indirect or direct antonymy is a better indicator of contrast.

3 Method

We used 124 texts containing in total 3,380,251 words and 218,017 sentences from the BNC⁴ for the corpus work (BNC catalogues A0, B0, C0, DY, E0 and G0).

Adjective antonyms were automatically identified in the texts using the java query module for WordNet 2.0. We limited the analysis to intrasentential contrast. Two types of output were produced, sentences where *but* occurred with adjective antonym pairs, direct and indirect, split by *but*, and sentences with antonyms without *but*.⁵ For the sentences with *but*, each sentence and the WordNet identified antonyms was then examined manually by one, and sometimes both, of the authors. For the sentences without *but* only a selection from the BNC catalogue A0 were examined.⁶

For each sentence with *but* we determined 1) whether or not the *but* was being used as a contrast marker, 2) whether or not the sense of the identified antonym pair was the sense in which they were used in the text,

² WordNet also codes antonymy for some relational antonyms with other parts of speech, for noun pairs like *parent-child* and verbs like *buy-sell*, but this is not done systematically.

³ Unfortunately we didn't have access to the original text so we can't confirm this.

⁴ Data cited herein has been extracted from the British National Corpus, managed by Oxford University Computing Services on behalf of the BNC Consortium. All rights in the texts cited are reserved.

⁵ Direct antonyms were taken from WordNet's mark-up, but indirect antonyms were calculated based on the definition since this is not consistently identified. Note also that the only version of WordNet differs from the downloadable version.

⁶ A00, A01, A02, A03, A04, A05, A06, A07 and A08.

and noted whether or not the antonym was direct or indirect, and 3) in cases of true antonymy, whether or not the antonymy was part of the source of the contrast. For each sentence with antonym pairs and no *but* we determined 1) whether or not the sentence was contrastive, 2) whether or not the identified antonym pair was used with the sense that makes them antonyms, and 3) whether or not the antonymy contributed to the contrast. Further, we noted whether any other contrastive markers were present.

4 Results

10,628 of the 218,017 sentences (5%) were initially identified with WordNet as having an antonym pair. 14,110 of the 218,017 sentences contained the word *but*, and only 354 of the *but* marked sentences had antonyms separated by *but* (3% of all *but* marked sentences).

Results for the *but* marked sentences are given in Table 1. 12 cases where *but* was used as a correction marker, equivalent to German *sodern* or used as *only*, e.g. ‘He had but one friend.’, were excluded leaving 342 sentences.

Cases where the identified antonym pairs were not being used in the text with the sense that made them antonyms included example like *still-twisting* identified as antonyms related to movement when *still* was actually used as an adverb in the text. In many other cases the wrong sense was meant, such as e.g. the indirect antonym pair *sorry-good* in ‘Well I’m sorry but that’s not good enough.’ Both these cases could be avoided if correct part of speech tagging and (successful) word sense disambiguation is done first.

Some sentences contained more than one antonym pair. In such cases, we classified the examples as direct or indirect antonymy according to the first antonym pair used with the right sense, if present.

Examples where the antonym pair was a source of the contrast were most frequently found with direct antonyms.

(7) He had *few* friends but *many* acquaintances. Direct: many-few.

(8) Eastern parts of England will start *bright* and mainly dry but central areas will be *cloudy* with showers in places. Indirect: bright-cloudy.

An example where the antonym pair was not the source of contrast is shown in (9):

(9) It has survived many more *recent* attempts by central government to have it replaced but since a major overhaul took place in 1986 this fine landmark has a secure *future*. Direct: recent-future

Among the contrastive *but* sentences, if antonyms were used as opposites then they were the source of contrast 81% of the time (177 out of 218).

	All Antonyms	Direct	Indirect
Antonym Source of Contrast	177 (52%)	120 (68%)	57 (32%)
Antonym not Source of Contrast	41 (12%)	21 (51%)	20 (49%)
Wrong Sense	124 (36%)	38 (31%)	86 (69%)
Total	342 (100%)	179	163

Tab. 1: *but*-marked sentences with WordNet identified adjective antonyms

Table 1 also gives a rough indication of the differences between direct and indirect antonymy as a contrast source. Look first at how often each antonym pair found was used with the sense that made them antonyms. For direct antonyms this was 79% (141 out of 179) of the time, but for indirect antonyms it was 47% (77 out of 163) of the time. Indirect antonyms were more likely not to be used with an opposite meaning (in 86 out of 163 cases, or 53%) than direct antonyms (only 38 of 179, or 21%), indicating that they are less reliable indicators of true contrastive pairs. This is probably because direct antonyms are direct with one other word while indirect antonymy is a derived category and a single word can have several indirect antonyms. Direct antonyms were also more likely to be a source of contrast. In 85% (120 out of 141) of the cases if the direct antonym was used with the right sense then it also contributed to the contrast. For indirect antonyms this was 74% (57 out of 77).

For the sentences in which *but* appeared we also evaluated the reliability of particular antonym pairs as predictors of contrast by counting of how often each antonym pair was used to signal contrast and how often it was a false alarm. Certain antonym pairs were frequently good predictors: *same-different* was found 13 times in the material, was used with the incorrect sense only once, and the other 12 times it was used as a true antonym pair it was the source of contrast. The direct antonym pair *on-off* was used with the wrong sense 13 of the 17 times it was identified. Potentially this information could be used to more accurately identify pairs frequently used as real opposites. Many pairs occurred only once in the material, and then were the source of the contrast, e.g. *dry-wet*, *evil-good*, *integrated-segregated*. There were 38 examples (21%) of this type of ‘hapax legomenon’ pairs being used as the source of contrast with the direct antonyms. This is far more than the number of pairs used once that were not the source of contrast, which were only 6 (3%). But for the indirect antonyms 38% of the pairs were hapax legomenon that were the source of contrast, but 30% of the time the indirect antonym pair was not the source of contrast. Again, this contrast seems to show that direct antonymy is a more reliable predictor of contrast than indirect antonymy.

The results for sentences containing WordNet identified antonyms but without *but* are found in Table 2. There were 203,907 sentences without

but in the material; 9031 were identified by WordNet as containing antonym pairs (4%). This was far too large to do manual checking on the entire collection. Instead 288 examples were analyzed by hand. For these sentences we initially categorized each sentence as contrastive or non-contrastive. For sentences that included a non-*but* contrast marker it was considered contrastive. For all other sentences with more than one clause we considered whether the clausal connector(s) could be replaced by a contrast marker like *but*, including cases where the sentence would have to be reworded slightly. If the substitution was intuitively correct, not just possible, we considered the sentence contrastive. Then the antonym pair was evaluated. The presence of potential contrastive markers was also noted.

Sixteen percent of all sentences without *but* that WordNet identified as containing antonym pairs were actually contrastive (45 of 288). From this group of 32 of the identified antonym pairs were used with the correct sense in the sentence. From this group of true antonym pairs, antonymy was a source of contrast in 23 of the cases. Thus if a pair is used as opposites and the sentence is contrastive the antonymy is often a source of contrast (72%; 23 of 45). However, if you only know that the antonymy is correct, then the chance that the sentence is contrastive is only 20 % (32 of 158). In (10) contrast with a direct antonym as a source of the contrast in a double contrast sentence is shown, and (11) is an example with an indirect antonym as the source of contrast.

- (10) Since 1973, in Columbus, Georgia, a death sentence has been sought for 43.8 per cent of those accused of killing a *white female*, and only 2.6 per cent of those accused of killing a *black female*. Direct: white-black.
- (11) Early work is often *missing* from an artist's oeuvre, while student work or juvenilia may be *saved* only by chance or possibly by a devoted family. Indirect: missing-saved

Thirty-four of the 45 (75%) contrastive examples in the non-*but* marked sentences contained some other marker that suggested contrast such as *though*, *indeed* or *despite*. Sixteen of these sentences also had an antonym pair with the correct sense (i.e. 70% (16 of 23) of the sentences where a correct antonym pair was a source of contrast also had an additional lexical marker for contrast.).

5 Discussion

5.1 Antonymy as source of contrast

Is antonymy frequently found in contrastively marked sentences? The answer seems to be no. First, it seems clear that antonym-based contrast is not

Contrastive	+ Sense (32)	Source	Direct	19
			Indirect	4
		Not Source (9)	Direct	4
	Indirect		5	
	Wrong Sense (10)		Direct	0
		Indirect	10	
			Total	45 (16%)
Not Contrastive	+ Sense (126)		Direct	103
			Indirect	23
	Wrong Sense (117)		Direct	30
			Indirect	87
			Total	243 (84%)
Full Total				288 Examples

Tab. 2: Sentences without *but* with antonyms identified with WordNet.

very common.⁷ From the 14,110 *but* sentences only 218 had true antonym pairs, and from this 177 had antonyms as the source of the contrast. E.g. only 1% of all the sentences with *but* showed the defining characteristics of the class of antonym based *semantic opposition* with adjective antonyms. 99% of the time a *but* sentence expresses contrast by some other means than simple antonyms.

However, if we only look at the 218 cases where true antonyms occurred in *but* marked sentences, in 81% (177) of the cases antonyms were a source of the contrast.

This means that when a true antonym pair is found on either side of *but*, the chances are high that the antonymy is the source of the contrastiveness. This indicates that identifying antonym pairs will not help you identify a large number of contrast relationships (i.e. low recall), but when true antonyms are found with *but*, they have a high chance of contributing to the contrast relationship (i.e. high precision).

5.2 Antonymy as a predictor of contrast

Does the presence of a true antonym pair indicate a contrast relation? To see this we need to look at the non-*but* marked sentences. If you assume perfect part of speech and word sense disambiguation, then 158 sentences remain (126 + 32). Within this group only in 23 cases (15%) is the antonym pair a source of contrast; so as a predictor of contrast without any other clues direct and indirect antonymy as defined in WordNet isn't very useful.

Since antonymy is such a defining characteristic of semantic opposition, it seems to suggest that most cases of contrast, *but* marked or not, fall into

⁷ However, it could be common with some other contrastive marker or intersententially. This will have to be the focus of future research.

the category of *denial of expectation*. Since the class *semantic opposition* is such a major category in the theoretical literature why didn't we find more examples?

One reason is perhaps that we didn't look at the whole class of *semantic opposition*, only antonym based *semantic opposition* pairs. This already limits us to cases of double contrast, since single contrast is ruled out with true antonymy (c.f. (4)) We also excluded predicate negation *semantic opposition*, and cases where the opposition was based on verbal antonyms, e.g. *love-hate*. We only looked at direct and indirect antonymy, and were not able to deal with the extended antonymy that Lakoff (1971) also associated with this class, e.g. *rich-dumb*. WordNet itself is a relational approach to the lexicon, based on synonymy via its synsets. To identify contrasts like *rich-dumb* we would need a more feature based approach where some sort of principled lexical decomposition is done that associates *rich* with some positive feature and *dumb* with a negative one. Pustejovsky (1991)'s Generative Lexicon framework or another feature based framework might work, but since such resources aren't currently available we'll have to somehow automatically derive an 'extended antonym' database. It is perhaps possible using the methods that Marcu and Echihabi (2002) used, but they needed a massive corpus, and its not clear to what extent their method would overgenerate when applied to full texts.

It's also possible *semantic opposition* is actually just uncommon. Actually, Foolen (1991) and Lang (1977) have pointed out that in most cases *semantic opposition* can be reinterpreted as *denial of expectation*, by taking the context into account. Basically this then reduces to an inference based analysis. The similar-yet-different approach to contrast derives some of its appeal from the fact that it so readily applies to the class of semantic opposition. If this class is so marginal, the inference approach becomes more attractive.

In identifying cases of unmarked contrast it also became clear that the similar-yet-different definition was too inclusive to distinguish when a speaker intended contrast from simple coordination. We identified unmarked contrast in part with the criteria that the sentence must be rewordable with *but*, yet even this gives us ambiguous cases, e.g. (13) with indirect antonyms *gray-white*.

(12) The small twelfth-century edifice built right above the steep cliffs that dominate the northern beaches of France, and the cemetery with its hundred tombs and crosses are in harmony with Braque's colors.

(13) The church is gray; the cemetery crosses are of white marble.

A similar-yet-different definition would when examining only (13) classify it as contrastive (*but* is as good as *and*). It is only in combination with the

context in (12) that it becomes clear that contrast is not intended, and that *but* is also awkward.

6 Conclusions and Future Research

A few conclusions can be made. Antonymy is the source of contrast in a small number of contrastive sentences. When it co-occurs with the contrastive marker *but* it is quite often the source of contrast. Using it alone to identify contrast in unmarked sentences will give high precision, will most often coincide with contrastive topics and could help in predicting proper intonation, but will only give very low recall. Further, certain antonym pairs are useful in that they consistently indicate contrast, and direct contrast is a better predictor than indirect.

There are two next steps. First, we need to find methods to collect feature analyzed antonymy or ‘extended antonyms’, and we need to then test whether this improves the recall of *semantic opposition* contrast.

Second, we need to begin exploring ways to identify *denial of expectation* contrasts since this work seems to show that semantic opposition is a marginal category. A first step might be to recognize that the inferences leading to the contrastive contradiction in (1) are in a way ‘indexed’ by the words *raining* and *umbrella*. A wikipedia search for ‘raining’ redirects immediately to rain, while the definition of umbrella is ‘a device used to keep rain off a person’. Lesk (1986) early algorithms for Word Sense Disambiguation compared dictionary definitions from two words to determine which senses in a collocation were intended. The same method might work to determine what type of defeasible inference is relevant to a contrast relation, because in these definitions part of the world knowledge needed is already represented.

Many definitions aren’t usable. For example, WordNet defines the correct sense of umbrella as ‘a lightweight handheld collapsible canopy’, with no mention of function. Further, the fact that rain makes you wet isn’t listed in any of the definitions of rain we examined. For this inference we need the access to a defeasible world knowledge databases like the Open Mind Common Sense Knowledge Initiative⁸ or OpenCyc.⁹ And, of course (1) is a simple, made-up example. Real-life examples are going to be a much greater challenge, c.f. examples like (3). But given the importance of contrast in discourse it’s a challenge to be faced.

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⁸ <http://www.openmind.org/>

⁹ <http://www.ime.usp.br/fr/opencyc/>

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