

## QUALITIES AND THE RELATIONSHIP OF ANTONYMY IN WORDNET

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### 1. The "Unique Fascination" of Antonymy

Antonymy is the technical expression for the relation of opposition between words: examples of antonyms are *hot-cold*, *wet-dry*, *rise-fall*, *man-women* and so on. As Cruse noted (1986, p.197) antonyms possess "a unique fascination, and exhibit properties which may appear paradoxical" - e.g. their "simultaneous closeness and distance from one another". Despite the fact that this relationship is extremely intuitive, it is not easy to define it exhaustively. Antonymy has been described in terms of logical negation (the antonym of  $x$  is  $not-x$ ); logical negation, however, is valid only for contradictory adjectives (*perfect/imperfect*) not for the other kinds of opposition that we encounter in natural language (Miller & Fellbaum, 1991). A semantic description seems to fit better. If, however, opposition is a relationship between meanings of words (Murphy & Andrew, 1993) it is not clear why it can get lost when substituting one of the two antonyms with one of its synonyms. For instance (see Jones 2002, p. 10), why are *happy/sad* antonyms while *happy/miserable* are not, despite their being perceived as opposites in their meanings? A more fine-grained description of antonymy which might be able to capture its specificity not only at the semantic level is thus necessary. This seems to be the case for the solution adopted in WordNet in order to represent the "adjectival semantics". Or at least it seemed to be...

### 2. The Antonymic Organization of Adjectives in WordNet

WordNet is an on line dictionary created by Miller and his colleagues at the Cognitive Science Laboratory of Princeton. Its aim is to provide a psychologically real representation of the mapping between word forms and word meanings in human semantic memory. Meanings are represented by synonym sets, named "synset", which are connected to each other by semantic relationships of different kinds, depending on the kind of "entity" they express. Thus in WordNet different words are organized in different files, depending on their syntactical category. Antonymy is the basic relation organizing adjectives, which constitute the essential "lexicon" of qualities. Their basic function is to express the values of attributes. Given that attributes tend to be bipolar, pairs of adjectives express these opposing values of the same attribute (i.e. *speed* is an attribute that ranges over a continuum of values whose extremes are labelled by the adjectives *fast* and *slow*).

Adjectival synsets, however, cannot be *automatically* connected in antonymous pairs. In fact, adjectives having similar meanings do not necessarily share the same antonym. Moreover, not all adjectives have direct antonyms. Thus, in WordNet, conceptual and lexical opposition are distinguished, assuming that every adjective

without direct antonym can be connected by similarity to an adjective that has a direct antonym. In other words, a single attribute corresponds to a complex cluster of adjectives at the linguistic level, but its internal organization is essentially bipolar. Each pole consists of various adjectives, which express opposite values for the same attribute. This structure would represent the linguistic expression of the underlying bipolar quality (see Figure 1).

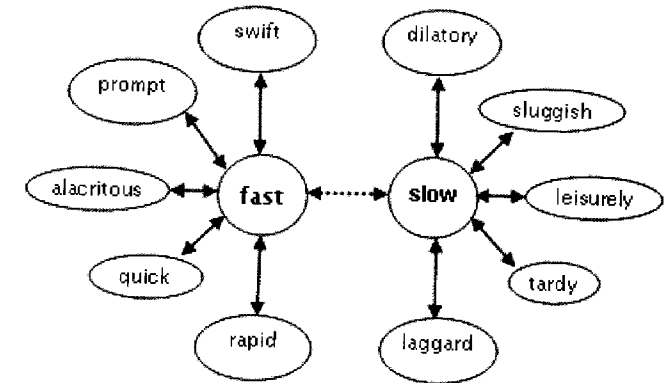


Figure 1: Bipolar adjective structure for SPEED on WordNet's model

WordNet's way of dealing with antonymy is interesting because it explicitly grounds this relationship in the ontological structure of qualities that language expresses.

The fact that adjectives express qualities and that antonymy plays a nodal role in adjective organization has been recognized for a long time. In this debate, however, the connection between the organization of adjectives and the organization of qualities has remained in the foreground. Miller himself has considered this connection as a direct consequence of people's folk psychology of perception (Miller, 1991, p. 253), but no empirical reference has been made to the structure of oppositeness at the perceptual level. Many of WordNet's assumptions about the organization and internal structure of qualities, if not founded on empirical studies on the perceptual organization of qualities, are at risk of remaining mere assumptions.

### 3. The Perceptual Basis of Antonymy

The general hypothesis of Savardi and Bianchi's research project (for an overview, see Bianchi & Savardi, 2008) is that opposition is a *basic perceptual relationship*, just like other kinds of directly perceived relationships. Their experimental research concerning how contrariety organizes observers' perceptual experience of space (Bianchi, Savardi & Tacchella 2002; Burro, Bianchi & Savardi 2006; Savardi & Bianchi 2000, 2003) shows that at the perceptual level:

a) Qualities are highly polarized but are also gradated: when asked to identify the spatial proprieties available in the ecological space, subjects gave proprieties

all connected to pairs of contraries (e.g. long/short, wide/narrow etc.). A detailed qualitative and quantitative study of the internal structure of each spatial dimension revealed, however, that these pairs are not only composed by contrary qualities, but also by intermediate states (this is true, even though natural languages rarely lexicalize intermediate experiences).

b) Opposite qualities are not symmetrical poles of the same dimension, but are characterized by different kinds of anisotropy. The analysis of their internal structure led to the identification of poles consisting of bounded ranges of variation (e.g. short) vs. poles consisting of unbounded ranges (e.g. long); poles consisting of a single experience (e.g. close) vs. poles consisting of ranges of experiences (e.g. open) or poles of the same qualitative kind (e.g. both bounded ranges) but having different extensions (e.g. acute-obtuse).

c) The uni-dimensionality of contrary properties, which is usually assumed to be the default characteristic of these pairs, has not been confirmed by a first set of experiments. A systematic comparison between metrics constructed by means of recognition tasks revealed that opposite qualities do not necessarily describe the same characteristics from two different points of view. For example, a scale defined by the degree of smallness perceived when looking at a given set of objects does not coincide with - nor is it simply inverted with respect to - the scale defined by the degrees of largeness perceived when looking at the same set of objects.

#### 4. Conclusions

These empirical findings suggest that the perceptual structure of opposite qualities is more complex than WordNet's accounts. WordNet's assumptions about the bipolar structure of dimensions remain too general and vague when compared to the perceptual bipolar organization of qualities. When examined at this level, qualities seem to be constituted by interconnected overlapping multiple dimensions, independent but none the less related to each other. The bipolar structure of dimension needs to be refined in the light of empirical research. This will be of interest not only for the psychology of perception, but also for deeper understandings of adjectival semantics.

#### Summary

Antonymy has been described from logical, semantic and linguistic perspectives, but an adequate definition of it has yet to be agreed upon. We will argue that antonymy is a pervasive cognitive structure which needs a perceptual grounding. In this short paper we will focus on some theoretical assumptions forming the basis of Miller and colleagues' work on WordNet, concerning the connections between the organization of adjectives and the structure of the qualities which these adjectives express. This assumption is consistent with the results of some recent studies conducted in the field of Experimental Phenomenology of Perception. The results of these studies support the hypothesis of the perceptual basis of contrariety and provide insights on the way the structure of perception shapes the organization of language.

**Keywords:** Antonymy, adjectival semantic, WordNet, perceptual oppositeness, experimental phenomenology.

#### Zusammenfassung

Der Begriff Antonymie ist aus logischer, semantischer und linguistischer Sicht ausreichend bekannt, aber eine zutreffende Definition fehlt. Wir schlagen hier vor, dass Antonymie eine durchgehende kognitive Struktur ist, die perzeptuell definiert werden muss. In dieser kurzen Arbeit beschränken wir uns auf einige theoretische Annahmen, die die Grundlage der Arbeit von Miller und Kollegen im WordNet bilden und die sich auf die Beziehungen zwischen der Organisation von Adjektiven und der Struktur von Qualitäten beziehen, welche diese Adjektive bezeichnen. Diese Annahme passt zu den Ergebnissen neuerer Arbeiten auf dem Gebiet der experimentellen Phänomenologie der Wahrnehmung. Die Ergebnisse dieser Arbeiten unterstützen die Hypothese einer perzeptuellen Grundlage von Gegensätzlichkeit und erlauben einen Einblick in die Art und Weise, wie die Struktur der Wahrnehmung die Organisation der Sprache prägt.

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See Contribution *Contrariety as a Perceptual Relationship* in this Volume

