THE CONNECTION BETWEEN ADJECTIVES AND QUALITIES IN WORDNET

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Sommario

La rappresentazione semantica degli aggettivi è estremamente complessa e si intreccia al problema di dare una descrizione adeguata della relazione di antonimia. Questo articolo analizza nelle sue linee generali l'organizzazione degli aggettivi in WordNet e gli assunti teorici che ne sono alla base, in particolare l'idea che la struttura semantica degli aggettivi sia fondata nell'organizzazione delle qualità; questa ipotesi è ricca di implicazioni, ma in WordNet non viene ulteriormente problematizzata né riferita alle ricerche compiute in ambito sperimentale sull'organizzazione delle qualità a livello percettivo. Al contrario, dal confronto con queste ultime risulta che la struttura interna delle qualità è ben più articolata di quella rappresentata in WordNet.

Abstract

Adjectival semantics is extremely complex and intertwined with the problem of finding an adequate description of antonymy relationship. In this paper, we will give an analysis of WordNet's treatment of the adjectival semantic and of its main theoretical assumptions, especially its grounding of adjectival semantics on the internal structure of qualities. As we will argue, this hypothesis is extremely insightful for understanding the antonymic organization of adjectives, but in WordNet it rests just a mere assumption, without any reference to the experimental literature on qualities organization at the perceptive level; when compared with it, qualities reveal to be much more articulated and complex than WordNet's assumptions.

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Introduction

Empiricists consider all our experience as essentially a multidimensional texture of qualitative aspects. Thus, the philosopher John Locke explaining the origins of all our ideas of concrete objects, took as starting point not objects themselves but moreover their *sensible qualities*: "First, our Senses, conversant about particular sensible objects, do convey into the mind several distinct perceptions of things, according to those various ways wherein those objects do affect them. And thus we come by those ideas we have of *yellow*, *white*, *heat*, *cold*, *soft*, *hard*, *bitter*, *sweet*, and all those which we call sensible qualities" (Locke, 1960/1959 p.122-123). What is interesting to point out from this excerpted of the opening of second's book of John Locke's *Essays in Human Understanding* is that from a linguistic point of view Locke's examples of sensible qualities are essentially a list of antonymous adjectives: *heat-cold*, *soft-hard*, *bitter-sweet*. This connection between qualities, adjectives and their antonymic organization will be the main object of this paper. Moreover, our main concern in what follows will be to show the needing of an integration and connection of analysis of adjectival semantics and of its antonymic organization, with empirical investigations on the structure and organization of qualities.

1. 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.[1] Often grouped together with other kinds of lexical relationships like hyponymy or synonymy, antonymy seems more intuitive and primitive than the other ones; results obtained with word association

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[1] We will follow here Jones's use of the term (Jones 2002) which comprises both gradable and non gradable pairs, instead of Lyons(1977) or Cruse(1986) who consider antonyms only gradable pairs of adjectives. Moreover, as this sample of antonyms shows antonymy concerns not only adjectives but also other kinds of syntactic classes; nevertheless we will focalize on the role of antonymy in adjectival organization because it is there that it constitutes the principal kind of semantic organization.

tests show that antonymy is the relationship "most readily apprehended".[2] As Cruse notes (1986, p.197) antonyms possess "a unique fascination, and exhibit properties which may appear paradoxical", first of all, their "simultaneous closeness and distance from one another" for that their meanings are felt intuitively to be maximally separated and at the same time maximally closer than any others. Despite of its intuitiveness, this relationship result difficult to be specified formally: many description have been given of antonymy, from logical, semantic and linguistic perspective but no ones seems to fit it completely. Antonymy has been described in terms of logical negation (the antonym of *x* is *not-x*), but this representation cannot capture the distinction essential in natural languages, between contraries and contradictories.[3] Logical negation is valid only for contradictory adjectives as *perfect/imperfect*, but not for the other kinds of oppositions that we encounter within natural languages (Miller, Fellbaum 1991). Intuitively a semantic description seems to better fit antonymy as opposition between meanings of words (Murphy and Andrew 1993; Cruse 1991); but in that way we cannot understand why we lose this relation substituting one antonym with its synonym[4]. For this reason a more fine-grained description of antonymy seems necessary, able to capture its specificity not only at the semantic level but also at the linguistic one. Thus, antonymy has been described as a relation between specific words and not between their meanings that is, as a lexical relationship. As we will see, this solution is the one adopted by WordNet's authors on their representation of adjectival semantic and its analysis will be our main concern in this paper. WordNet's treatment is particularly relevant on the general discussion about antonymy because it is the only one that explicitly ground this relationship on the ontological structure of qualities that language expresses, thus giving important insights on the understanding of its relevance on our experience. That adjectives express qualities in fact has been recognized for a long time and also that antonymy plays a nodal role in adjective organization. Anyway for the most part the debate on the

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[2] Cruse (1986) reports that 3-years-old children are perfectly capable of giving or recognizing antonymic pairs, much more than they are for other kinds of relations between words (i.e. like synonymy).

[3] In Miller's words, to say that someone is not rich does not means necessarily that he must be poor: many people consider themselves neither rich neither poor(Miller 1991).

[4] Why i.e. *happy/sad* are antonyms, but not *happy/miserable* also if they are yet perceived like opposites in their meanings (Jones2002: 10).

nature of antonymy has focalized on its linguistic and conceptual aspects, thus leaving in the foreground its connection with the organization of qualities. Miller himself (1991: p. 253) considers this connection between antonymy and the internal structure of qualities as directly following from "commonsense assumptions" of our folk psychology of perception, but then no more reference is made to the structure that oppositeness acquires in that. On the other hand our hypothesis in this paper will be exactly that a wide reference to the internal organization of qualities at the perceptive level as has been investigated from recent experimental researches in the field of perception psychology, can help to refine and better understanding the structures that organize meanings in our languages for what concerns adjectives.

2. WordNet's general structure and assumptions

WordNet is essentially a lexical reference system of English language developed since 1985 from Miller and his colleagues at the Cognitive Laboratory of Princeton (Fellbaum 1998). It is an on-line dictionary conceived to be useful for many real-world tasks but at the same time it aims to reflect the organization of our semantic memory.[5] Thus, while constituting an on-line linguistic resource, WordNet's main goal (at least originally) was to provide a psychologically real representation of the mapping between word forms and word meanings as it is realized in our semantic memory.

2.1 Synset's function

In natural languages relations between word forms and word meanings are not one:one, but many:many so that there are many polysemous and many synonymous words. WordNet's strategy in this respect, is to represents meanings by means of synonym sets, named "synset" that

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[5] Initially, his specific concern was that of testing the validity of the relational semantic against the full scope of the English lexicon; thus in accordance with relational semantic's principles, its basic assumption is that word meanings can be represented as a networks "with nodes to represent meanings and darts to represents relations between the meanings" (Miller in Fellbaum 1998: XVI).

function as unambiguous designators of different meanings and that constitute the basic building blocks of WordNet's structure[6]. Each synset in WordNet intentions represents the intended meaning connected to a word form and then correspond to a lexicalized concept of English language. Then, their complex structure and organization aims to reflect the conceptual inventory underlining natural languages (not only English, but all natural languages) and mapped in our semantic memory.

2.2. The relation between language and perception

In WordNet's assumptions natural languages lexicalize concepts that are sufficiently relevant in people's existence. Especially, for what concerns the relation between language and perception, they provide words not only for objects, but also for features by which objects can be distinguished from each other; and these latter are essentially of three important types: parts, functions and attributes[7]. Then, the remarkable fact is that parts are generally expressed by substantives, functions by verbs and attributes by adjectives.

2.3 Ontological grounding of semantic organization

The relevant hypothesis that Miller and his colleagues follow from these findings, is that different words hold different kinds of semantic relationships depending on the kind of entity they express. Thus, words denoting objects are organized hierarchically through the hyponymy relationship (i.e. animal-bird-canary), words denoting functions are semantically related by troponymy (i.e. fly-buzz-rack), words denoting

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[6] The notion of synonymy utilized in WN to build synsets does not imply inter-changeability in all contexts, but moreover a kind of "local" synonymy, that means a relationship that entail inter-changeability only in *some* contexts (Miller 1998: 24).

[7] Thus in Miller's example, the definitional phrase we find in a dictionary for *canary* will be: "a bird that is small, yellow and sings"; this structure is such that the super-ordinate noun phrase 'a bird' identifies a category of objects while the relative clause 'that is small, yellow and sings' distinguishes it from other members of the same category. Thus to define a canary we will specify his parts (being birds, canaries have "wings" , "beak" and "feathers"), his functions (they "sings" and "can fly") and his attributes (they are "yellow", "small" and "warm-blooded").

parts are organized by meronymy (i.e. body-wing-feathers) and words expressing attributes are connected by antonymy (i.e. small-little). Then in WordNet the kind of semantic relation a word entertain with other words, depend on the kind of "entity" it denotes and for that reason in it words are organized in different files depending on their syntactical category.

3. Adjectives in WordNet

They constitute a syntactic category with a complex behaviour but very rarely studied if compared to the large amount of research spent on substantives and verbs by lexical semanticist. Semantically, they are considered modifiers, that is their function in natural languages is to modify the meaning of words which are referred; in spite of this, more than any other syntactical category adjectives are *modifiable* in their meaning depending on the nominal head to which they are referred.[8] Thus while being modifier, they are highly modifiable so that it has also been discussed if their meaning can be represented. From a syntactical point of view they present an interesting polymorphic behaviour: linguists use to distinguish between *predicative* and *non-predicative* (or *attributive*) uses. The first ones function as predicates in sentences of the form *NP is Adj* (as in "*The man is tall*") while the second ones are essentially noun modifiers (as in "*The tall man*"). This is an important but complicated and sometimes ambiguous distinction, firstly because all adjectives can be used *attributively* (that is in a *non-predicative* way) but not all can be used *predicatively*[9] and secondly because some adjectives can be both, predicative and non predicative, depending on the context of their use[10].

Anyway, the important fact to understand about it, is that many adjectives cannot be used predicatively and in general non-predicative adjectives hold a number of specific semantic behaviours: they carry out their role of modifier partitioning their head nominal into subclasses (such as *chemical engineer* vs. *non-chemical engineer*) that constitute non-gradable

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[8] Consider i.e. the way the meaning of "*difficult*" change in *a difficult child*, *a difficult book* and in *a difficult exam*.

[9] Thus i.e., while "*my former boyfriend*" is admissible, "*my boyfriend is former*" it is not, because *former* is a non-predicative adjective.

[10] An example given in Gross, Fischer and Miller (1989) is "*dramatic criticism*" that out of context can be referred both to the criticism of a drama or to criticism that is dramatic.

dichotomy and moreover, they cannot be nominalized the way predicative adjectives can.[11]

3.1 Descriptive adjectives, qualities and antonymy in WordNet

In WordNet's structure, the distinction between predicative and non predicative adjectives is reflected on the one between *descriptive* and *relational* adjectives (K.J.Miller,1998:47). In force of their different semantic organization, in WordNet they have been separated in two distinct files. Relational adjectives corresponding to non-predicative adjectives, are essentially "classifiers".[12] *Descriptive* adjectives on the other hand, being predicative adjectives display semantic and syntactical proprieties totally different: their main function, is to ascribe to a noun a value for an attribute; that is, following K.J. Miller's description, "*x is Adj*" presupposes that x contains an attribute A such that "*A(x) = Adj*". In short, an adjective is the value for the function A(x). For example HEIGHT is an attribute that ranges over a continuum of values, so that the sentence "the building is tall" means that the building has an attribute HEIGHT and that HEIGTH(building) = *tall*.

Descriptive adjectives constitute the major part of adjectives and they will be our main concern in what follows. They have a unique semantic organization; for them, there is nothing like a hierarchical structure such as hyponymy for nouns or troponymy for verbs.[13] Their basic relationship is antonymy. As we said, its relevance on adjectival organization is an acknowledged fact in psycholinguistic literature (Deese 1964; Lyons 1977; Cruse 1986; Lehrer & Lehrer 1982; Murphy & Andrew 1993) but what is original of WordNet's representation is the idea that antonymy relationship is *grounded on the ontological structure of proprieties that adjectives express*. That is, the function of predicative adjectives is to express values

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[11] That is i.e., the predicative use of nervous in "*the nervous applicant*" admits constructions like "*the applicant's nervousness*" while his non-predicative use in "*the nervous disorder*" does not.

[12] They are named "relational" because morphologically *related* by derivation to nouns (thus i.e. *electrical* is related to the noun *electricity*). They function as classifiers, i.e. "electrical" in "an electrical guitar" specify a particular kind of guitar.

[13] They cannot be represented as a hierarchical tree, where adjectives are connected each other with variants of the "is- a" relationships (Miller and Fellbaum 1991).

of attributes; given that for the most part attributes have a bipolar structure, antonyms are adjectives that express values at opposite poles of the same attribute.

3.2 Wordnet's adjectival clusters

On their representation of adjectival organization Miller and his colleagues have to explain the fact that many adjectives seem to have no antonym and moreover the fact that when two adjectives have similar meanings they do not necessarily share the same antonym.[14] These two questions are deeply connected to each other, but in particular the latter one raises many problems in WordNet's structure whose basic building block are synsets, because it implies the impossibility to represents adjectival organization as an opposition between synsets. Moreover, given that synsets in WordNet represent concepts, this means that antonymy cannot be considered mainly a relation between concepts, but specifically a relation between word forms.[15] Thus WordNet's model distinguishes between conceptual and lexical opposition assuming that every predicative adjective without direct antonym can be connected by similarity relationships to an adjective that have a direct antonym (Gross, Fischer and Miller 1989). By relation of similarity they intend a kind of specialization such that "the class of nouns that can be modified by *ponderous*, for example, is included in – is smaller than – the class of nouns that can be modified by *heavy*." (K.J. Miller 1998: 50). Then, in WordNet a same attribute correspond at the linguistic level to a complex cluster of adjectives.

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[14] Miller's example is WEIGHT: "*Ponderous* is often used where *heavy* would also be appropriate, yet *ponderous* has no obvious antonym. And why do *heavy* and *weight*, which are closely similar in meaning, have different antonyms, *light* and *weightless*, respectively?" (Miller and Fellbaum 1991: 210).
[15] "People who know English judge *heavy/light* to be antonymous, and perhaps *weight/weightless*, but they pause and are puzzled when asked whether *heavy/weightless* or *ponderous/airy* are antonyms"; in this latter case "concepts are opposed but the word forms are not familiar pairs" and this depend for WordNet's authors on the fact that "antonymy relation between word forms is not the same as the conceptual opposition between word meanings" (K.J. Miller 1998: 49).
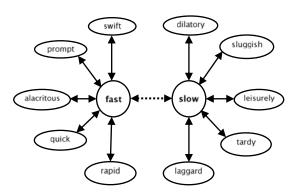
Fig. 1: Bipolar adjective structure for SPEED on WordNet's model

This cluster has a structured internal organization that is essentially bipolar, where each pole is constituted by a number of adjectives that express opposite values for the same attribute. Each half cluster then is internally structured by a focal adjective which is connected to other adjectives by similarity relationships. The important difference between focal and satellite adjectives is that the former can be utilized to modify all members of the noun class that contains that attribute, while the latter cannot as far as the noun class they modify is a specification of the first one.[16] On the whole this complex structure represents the linguistic expression of the underlying propriety or attribute.

5. Discussion of WordNet's treatment of descriptive adjectives

WordNet's main merits for what concerns adjectival semantics are essentially two: firstly, distinguishing between direct and indirect antonymy, it does of oppositeness a general structure of our conceptual system that has its specific linguistic expression in antonymy. Secondly, grounding antonymic organization of adjectives on the structure of attributes, it consents a better understanding of its primitiveness in

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[16] Thus in the case of the adjectival pairs *fast/slow*, *fast* can modify train and horse as containing "SPEED" as attribute, while *rapid* being similar to *fast* can modify train but not horse.

language acquisition and of its pervasiveness in our experience: all our experience in fact is intrinsically experience of the qualitative structure of the world that surrounds us. If oppositeness is grounded on bipolar structure of qualities, then it has to have a pervasive role in the organization of our experience, not only at the linguistic level. On the other hand there are several aspects of adjectival semantics that rest out of WordNet's representation.

5.1 Gradation

One of them is gradation. Its role organizing adjectives in natural languages has been largely recognized in psycholinguistic literature (Lyons 1977; Bierwisch 1989). Not all but many attributes can assume different values.[17] Thus at the lexical level it is possible to individuate ordered strings of adjectives each one expressing a different value for a same attribute.[18] Nevertheless in English only few proprieties allow lexicalized gradation; for the most part gradation is not lexicalized and its expression is accomplished in other ways, by means of adverbs of degree (such as *very, extremely, rather, quite…*) or morphological rules for comparative and superlative degrees. For that reason, despite its relevance from a phenomenological point of view, gradation has not been coded in WordNet (K.J. Miller 1998) and its bipolar structure articulated on direct and indirect antonyms do not consent to collocate in some intermediate place between the two opposite half clusters, gradate adjectives.

5.2 Markedness

A most relevant aspect of the adjectival semantic not represented in WordNet is the distinction internal to the antonymic pair between primary and secondary term: a fact well-known in linguistic literature as the "markedness problem". Attributes can be conceived as dimensions of a

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[17] Are not gradable that proprieties that like GENDER are dichotomous and whose values (*male/female*) from a logical point of view are contradictories.
[18] This is the case of the TEMPERATURE attribute for which we have *torrid, hot, warm, tepid, cool, cold* and *frigid* and in which *hot/cold* constitute the antonymic pairs and *tepid* the intermediary value.

hyperspace where one end of each dimension is anchored at the point of origin of the space: the origin corresponds to the expected value while deviations from it merit comment, thus are called "marked values". Markedness is a phenomenon that characterizes nearly all direct antonyms and permits to individuate for each one the primary term as the unmarked one; this one constitutes the attribute's default value, the value that is assumed in absence of contrary information.[19] Notwithstanding its relevance, WordNet does not represent it arguing that for the most part in English the marked term is morphologically stressed by negative prefixes.[20] Anyway morphological criteria are not enough for many pairs of adjectives, especially for what concerns attributes connected with our perceptual experience that generally are not stressed from this point of view (*big/little*, *deep/shallow* and so on). For them is impossible understand in WordNet which term of the antonymic pair is the primary one.

5.3 Adjectival Polysemy

Another problematic aspect in WordNet is its representation of adjectival polysemy. As we said, adjectives are considered modifiers but at the same time they are extremely modifiable by the head noun they modify.[21] This relevance of noun context for adjectival meaning has been put forth by Murphy and Andrew (1993): they have shown that i.e., the adjective *fresh* can acquire different meanings depending on its context of use.[22] Moreover they stress that depending on its meaning *fresh* acquires different antonyms: when referred to idea its antonym is *old* while it is opposed to *frozen* when associated to fishes and to *dirty* when referred to shirts. In WordNet different meanings for the same word are stored as separated synsets, thus it is not surprising in it that each of them has its own

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[19] The unmarked term is the more frequently used, the more customary and prototypic and also quite often morphologically connected to the name of the attribute (*long* → LENGTH).
[20] Such as *un-pleasant, im-patient, il-legal* and so on (Miller 1998).
[21] Justeson and Katz (1993) have shown that different senses of polysemous adjectives occur with specific nouns: i.e., *old* referred to hyponyms of person (such as *man*) means "not young" while referred to hyponyms of artefact (such as *car*) means "not new".
[22] When referred to a shirt *fresh* suggest that it has been recently washed; when combined to fishes, it indicate that they have been recently caught and when referred to ideas, it suggest a kind of new rather than old ideas (Murphy and Andrew, 1993).

antonym.[23] Nevertheless, they argue, the fact that subjects make judgements of antonyms about un-associated pairs of adjectives on the base of their meaning show that antonymy is a relationship between word meanings (1993: p. 316) and not a lexical one as WordNet assumes.

All these remarks are extremely punctual in respect to WordNet's treatment of adjectival polysemy but differently from Murphy and Andrew, we think that their critics do not directly imply a conceptual description of antonymy. As we noted also conceptual descriptions of antonymy present many problems: thus following Murphy and Andrew's account we cannot distinguish between semantic and lexical manifestation of oppositeness in adjectives and thus we lose the lexical specificity of direct antonymy as a relation that pertains only to selected pairs of adjectives and that cannot be maintained changing one of them with its synonym.[24] Moreover these last remarks points out the need of a better description of the polysemic structure of adjectives that probably will imply a reconsideration of synset's structure at least for what concerns adjectival semantics.

6. Grounding the adjectival semantic in perception

All aspects listed in these previous paragraphs, can give us an idea of the adjectival semantic complexity and of the role that antonymy plays in it. In what follows we will argue that this complexity can not only be considered a linguistic matter, in that it has to be connected to the complexity that characterizes the organization and identity of qualities at the perceptual level. In WordNet the semantic organization of descriptive adjectives (mostly articulated on similarity and contrastive structures) is

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[23] As Murphy and Andrew observe, this representation of polysemy suggest a conception of the adjective-noun interaction as a matter of "selecting a previously existing sense, to which an antonym is already associated" (Murphy and Andrew, 1993: p. 309) that is extremely problematic: firstly, there is little agreement between lexical semanticists on whether distinct meanings can be considered different senses associated with a same lexical entry or simply different uses of a more general meaning connected with that word (and in the case of *fresh* or of *old*, their multiple senses are highly related); secondly, considering each sense of a same adjective as separated and independent from the others, WordNet multiply drastically the number of synsets[23] and thus, the number of relationship that have to be stored in our semantic memory, so that "a reasonable question is how a language user might identify and store all these relations" (1993, p. 317).

grounded upon the ontological organization of qualities. But if adjectives are investigated from a linguistic point of view, qualities are the principal object of the psychology of perception as far as at this level, all our perception consists of bunches of qualitative aspects developed inside a multidimensional space. Thus, any account of the structure of qualities reflected by the adjectival lexicon, has to begin from their perceptive phenomenology. This we believe is true despite the fact that, in WordNet as well as in the most part of psycholinguistic literature on semantic structure of adjectives, there is a lack of references to recent experimental research on the structure of qualities at the perceptual level. But many of WordNet's assumptions about the organization and internal structure of qualities, if not compared with and grounded on experimental investigations of their perceptual organization, risk to remain "mere assumptions".

In what follows, we will briefly present some recent findings of experimental phenomenology concerning the perceptual structure of oppositeness (Savardi and Bianchi 1997; 2000; 2003) that could contribute to suggest empirical answers to the issues presented above as un-resolved features of WordNet. The general hypothesis of Savardi and Bianchi's research project is that opposition is a *basic perceptual relationship*, just like other kinds of directly perceived relationships. In this paper we will focalize essentially on their findings concerning the way contrariety organizes our perceptual experience of space (Savardi and Bianchi 2000, 2003); we think they are particularly relevant here because of their concern with the perceptual identity of the main dimensions that structure our spatial experience.[25] In this specific respect, there are essentially four aspects that merit to be mentioned:

- Polarization of spatial experience. They found that from a phenomenological point of view, our perception of space is highly polarized; when asked to identify the spatial proprieties available in the ecological space, subjects gave proprieties all connected to pairs of contraries (such as long/short, wide/narrow, large/small, regular/irregular, straight/bent and so on). A detailed qualitative and quantitative study of the internal structure of each spatial dimension was proposed (Savardi, Bianchi 2000; Bianchi, Savardi, Tacchella,

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[25] We will not give here a detailed description of their experimental procedures and results, for which we recommend the papers mentioned; we want to just give an idea of some of their empirical findings that we think would be relevant for the grounding and refinement on empirical bases of the WordNet's model of adjectival organization.

2002); it investigates the extension and the qualitative characterization of both poles of the dimensions and of the intermediate region, in terms of range of experiences or single experience. This analysis revealed that our perception of spatial properties is generally composed not only by contrary qualities but also of intermediate ones (despite the fact that natural languages rarely lexicalize intermediate experiences). However, even with significant differences between different dimensions, the extensions of the two polarized properties was usually bigger than the range of states perceived as intermediate ones.

▪ Anisotropy of polarization. Another characteristic emerging from different experimental tasks is the asymmetry (or anisotropy) of the two contrary properties. This aspect emerged:

a) from the analysis of the internal structure of spatial properties mentioned in point 1. They found in fact that the 37 spatial dimensions underlined 6 different structures defined by different kinds of anisotropy: poles consisting of bounded ranges of properties (e.g. short) vs. poles consisting of unbounded ranges (e.g. long); poles consisting of single properties (e.g. close) vs. poles consisting of ranges of properties (e.g. open); poles of the same qualitative kind (e.g. both bounded ranges) but having different extensions (e.g. acute-obtuse).

b) from production and recognition tasks, using simple geometric figures (Savardi, Bianchi, 2000; Bianchi, Savardi, 2006) where single transformations of size, surface, orientation and form turned out to give rise to different perceptions of contrariety when applied to the two opposite directions. For instance, changing the size from small to large and *viceversa*, or changing the surface from filled-in to empty and *viceversa*, does not make recognizable the same amount of 'oppositeness' (adequacy of the quality) neither does it require with the same strength a change of the propriety to make the figure opposite (requiredness of the property towards transformation into the opposite property).

▪ Non uni-dimensionality of dimensions. One of the questions that must be empirically solved is if contrary properties should be considered parts of a same dimension (lying on two opposite sides of it) or not, and if is possible to consider each of them the "inverted property"of the other. Results form a first set of data (Burro, Bianchi, Savardi, 2006), referred to the 4 pairs *high/low, small/big, large/narrow, long/short*, did not confirm the uni-dimensionality of these opposites. On the base

of metrics constructed by means of the recognition of degree of a certain property in a sample of different objects, it was found that each opposite cannot be considered exactly the "reverse" of the other; that is, they do not represent the extremes of a single spatial dimension: i.e. in the case of *large/small* the perception of smallness belongs to a different scale and a different dimension with respect to that of largeness, even though it cannot be excluded that they are interconnected.

- Multidimensionality of proprieties. Another aspect that strongly emerged from their research, is the multidimensional structure of proprieties. Searching the perceptual interconnections between multiple contraries that were produced by subjects for a same quality (Savardi and Bianchi 2000, 2003) when connected to different objects/events of which it can pertain, they found that while at the lexical level the contraries given for a same quality seem to be object/event specific, when analyzed at the perceptive level their phenomenological identities show many aspects of invariance.[26] Furthermore in a different task, asking participants to define the congruency, incongruency or independence of each of the 74 analyzed spatial properties to the others, it was found that for less than 8% of these comparisons the two compared properties were described to be independent. In other words, the identity of each quality turned out to be not atomistic, revealing instead a multidimensional identity (e.g. "In front" was said to be congruent with open, wide, near and far, high, divergent and convergent etc. while "behind" was described as congruent with small, close, narrow, downhill, near, convergent and so on).

Conclusions

These findings show that the most relevant aspects of adjectival semantics are themselves expression at the lexical level of features that pertain to the phenomenological identity and structure of qualities at the perceptive level (such as polarization, gradation, anisotropy and multidimensionality). On the connection between language and perception

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[26] Thus i.e., they found that the "open" was opposed to "close" when referred to a door, while it was opposed to "sealed" when referred to a letter (Savardi and Bianchi 2003).

there is a vast literature, especially for what concerns the effort to ground language organization on the most relevant structures of our perceptual experience.[27] Nevertheless as we have seen, for what concerns adjective semantics, this grounding has remained only assumed but not systematically investigated.[28] On the other hand what follows from these empirical findings is that the perceptual structure of attributes is much more complex than WordNet's account: all its assumptions about the bipolar structure of dimensions, so determinant for adjectival semantics, remain too general and vague with respect to the effective organization of this polarity and need to be refined in the light of empirical research. When investigated at the perceptive level, attributes seem to be constituted by the interconnection and overlapping of multiple dimensions that are separated but notwithstanding related, following complex configurations; their identification needs further research and besides of being of interest for the psychology of perception, will likely be very insightful for a deeper understanding of the adjectival semantic.

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[27] The distinctive feature of the wide range of theories and research that pertains to Cognitive Semantics is the assumption that to understand the meaning of linguistic expressions implies to investigate the ways in which they are connected to and generated from our non-linguistic experiences (Miller and Johnson-Laird 1976; Talmy 1983; Jackendoff 1983; Langacker 1987).

[28] For what concerns the connection between adjectives and qualities there is research but it is mainly limited to color adjectives (Berlin and Kay 1969).

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149

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