

THE RELATION OF ANTONYMY IN THE TERMINOLOGY FROM THE DOMAIN OF BIOMEDICAL ENGINEERING

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***Résumé :** La relation lexico-sémantique de l'antonymie occupe une place importante dans l'organisation mentale du vocabulaire, ce qui la rend extrêmement importante pour l'étude de la terminologie. Elle crée des relations d'opposition entre les concepts et, respectivement, les termes qui les désignent, nous aidant à les replacer dans les systèmes conceptuel et terminologique d'un domaine particulier. Le présent article vise à étudier la relation de l'antonymie dans la terminologie du domaine du génie biomédical en anglais et en roumain, en se concentrant sur l'identification et la classification des paires antonymiques sur la base d'un corpus comparable de textes originaux.*

***Mots clés :** relation lexico-sémantique, antonymie, terminologie, génie biomédical*

1. The lexico-semantic relation of antonymy

Antonymy is a phenomenon that has been studied from several perspectives. In the specialized literature antonymy is recognized as the most robust of lexico-semantic relations being important both for the mental organization of the vocabulary and for the organization of coherent discourse (Paradis, Willners, 2006 : 1051). Given that antonymy is, according to David Alan Cruse, the only semantic relation directly lexically recognized in everyday language, we might expect to see a robust classification system. However, although antonymy has been subjected to continuous linguistic study, not all researchers have reached the same conclusions. It is true that most classify pairs of antonyms according to largely similar criteria, but the terminology used to describe these categories is not at all standardized. Moreover, an adequate definition of antonymy has not yet been adopted. According to Steven Jones, antonymy is a phenomenon better suited for exemplification than definition. However, he argues that there are two perspectives from which attempts have been made to define this phenomenon, namely the semantic and the structural ones.

Thus, Steven Jones argues that any definition of antonymy must be both lexical and semantic. Antonyms must have opposition of meaning, but they must also have a strong and well-established lexical relationship. Word pairs that meet both criteria are known as "prototypical" or "canonical" antonyms, and those word pairs that meet the first criterion, but not the second, have been termed as "peripheral" or "non-canonical" (terminology provided by David Alan Cruse and M. Lynne Murphy respectively). These labels refer, in essence, to those lexically established pairs (e.g., *hard / soft*) and those pairs that are not (e.g. *malleable / rigid*), currently paying particular attention in research to canonical antonyms (Jones, 2002 : 9-11). A high degree of canonicity means a high degree of lexico-semantic connection in memory and conventionalization in text and discourse. The lexical aspect of canonicity refers to the location of word pairs on a scale from the most suitable to the least suitable, and the semantic aspect focuses on why some pairs could be considered more suitable oppositions compared to others (Paradis, Willners, Jones, 2009 : 381).

Herrmann et al. define antonymy in terms of four relational elements. The first element aims at clarifying the dimension on which the pairs of antonyms is based. Their assumption is that the clearer the dimension, the stronger the antonymic relation (for example, *good / bad*, as opposed to *holy / bad*). Second, the dimension must be predominantly denotative rather than predominantly connotative. The third element is concerned with the position occupied by the meaning of the word on the scale. To be suitable antonyms word pairs should occupy the opposite sides of the midpoint (e.g., *hot / cold*) and not the same side (e.g., *cool / cold*). Finally, the distance from the midpoint must be equal (Kostić, 2016 : 2-3).

According to Steven Jones, M. Lynne Murphy, Carita Paradis and Caroline Willners, antonymy occupies a unique position because it represents a binary relation compared to other lexico-semantic relations (Jones, Murphy, Paradis, Willners, 2012 : 1). Thus, there is a minimum difference between the members of the antonym pairs in terms of content and maximum in terms of configuration. They denote the same semantic feature, but occupy opposite poles of the same structure. For example, adjectives such as *long / short*, *good / bad* and *dead / alive* are considered typical members of the category and denote features in semantic spaces length, merit and existence, respectively (Paradis, Willners, 2013 : 289).

It has been established that, unlike other types of relations, members of a linguistic community have a strong intuition that various types of opposition relations fall into the general category of antonyms, an idea supported by Roger Chaffin and Douglas Herrmann, and antonym relations are mastered earlier in our metalinguistic development than synonym relations, according to Patricia Heidenheimer. M. Lynne Murphy even claims that antonymy is "arguably the archetypical lexico-semantic relation". It is not surprising, then, that the emergence of corpus linguistics has inspired a number of publications on antonyms and the antonym relation (Jones, Murphy, Paradis, Willners, 2012 : 1-2). Corpus linguistics is inherently a distributive discipline, and the study of corpus-based lexical semantics is no exception : corpora do not offer meanings or functions that can be easily extracted and compared, but only the distributions of morphosyntactic and lexical formal elements (and, depending on the corpus, sometimes phonological or orthographic elements), so meanings and functions must be deduced from the formal distribution (elements) in their contexts (Gries, Otani, 2010 : 122).

Thus, Caroline Willners in her research on antonyms in context starts from the hypotheses suggested by Walter G. Charles and George A. Miller, one of which is that a

pair of adjectives can be considered antonyms because they appear in the same context at a higher frequency (Willners, 2001 : 62). The hypothesis underlying the co-occurrence based approach is that the distributional characteristics of using an element revealed many of its semantic and functional features and purposes (Gries, Otani, 2010 : 122). Caroline Willners concludes that the frequency of co-occurrence of antonym pairs and the parallelism of the context are signs that can facilitate the identification of antonym relations between words (Willners, 2001 : 161). The same view is held by John S. Justeson and Slava M. Katz who show that the co-occurrence of antonyms is a common phenomenon and that they occur in prominent patterns, these features providing an explanation of why these words have specific links with each other. These connections together with the opposition of the meanings create the relation of antonymy (Justeson, Katz, 1992 : 180). Steven Jones, in turn, argues that in addition to logical distinctions, pairs of antonyms can be classified according to their textual functions. The data show that the two most common text-based antonymy classes are coordinated antonymy (in which antonyms are joined by *and* / *or* and express completeness or inclusiveness) and auxiliary antonymy (in which antonyms act as a lexical signal expressing a contrasting relationship) (Jones, 2001 : 309).

Lesley Jeffries in her research on opposition relations in discourse studies the antonyms created by textual circumstances called constructed, created, or unconventional oppositions, examining them initially from a formal and functional perspective, and then through a series of case studies focusing on the implications of this phenomenon on the ideological and aesthetic meaning in texts and the contexts of production and reception (Jeffries, 2010 : 1).

Taking into account these new research perspectives, M. Lynne Murphy in her work on antonyms as lexical constructions argues that antonym pairs are more than just bimember semantic paradigms, studying the problem of how antonymy relations are represented in linguistic theory so that it captures both their paradigmatic and syntagmatic properties. In the tradition of structural semantics, an approach supported by such researchers as Adrienne Lehrer, John Lyons or David Alan Cruse, antonymic relations are represented in a paradigmatically organized lexicon. However, such a perspective is too simplistic because (a) it does not distinguish between (lexical) relations between words and (semantic) relations between meanings and (b) it cannot (without the existence of a high degree of polysemy) explain that pairs of antonyms are context-dependent, an idea supported by Gregory L. Murphy and Jane M. Andrew. This observation has led to the opinion that opposition relations are generated pragmatically, but some pairs of antonyms are conventionally associated (Murphy, 2006 : 2-3).

Carita Paradis and Caroline Willners also mention that even if the lexico-semantic relations were in the centre of attention of the paradigmatically oriented structuralists, their research failed to explain the essence of these phenomena. However, with the advent of the cognitive approach in the study of meaning and the development of corpus methodologies, experimental techniques and computational technologies, the basis of research on the meaning of words and lexico-semantic relations has changed radically. The scope of word meaning analysis in general and lexico-semantic relations has expanded to include aspects of construction, text and discourse, as well as aspects of memory and thinking. Language in natural communicative situations has come to occupy an important place in cognitive linguistic research, and the combination of theoretical and empirical developments has led to a new interest in studying lexico-semantic relations and their functions in language and thinking (Paradis, Willners, 2011 : 373). Carita Paradis and

Caroline Willners study antonyms through the prism of the cognitive approach to meaning in which concepts form the ontological basis of lexical knowledge that includes both encyclopedic and linguistic knowledge. The meaning of a lexical unit is its potential for use in conceptual space. The conceptual space is structured in relation to two types of ontological domains : the domain of content and the domain of representation. The domains of the content imply the meaning itself, and the domain of representation offers various configuration patterns on which the meanings are interpreted, e.g. limits and size. Both areas are conceptual in nature and reflect our perception of the world. In addition to the conceptual domain, there is an operating system consisting of different types of constructions that are imposed on the domains by the speakers at the time of use. In the model used in research antonymy is treated as a construction that uses limits and size to structure various content domains (Paradis, Willners, 2006 : 1053-1054).

Regarding antonymy in terminology, Anne-Marie Gagné and Marie-Claude L'Homme mention that very few terminologists have described the opposition relationship in specialized resources, giving two reasons for this state of affairs. This can be partly explained by the fact that the emphasis has been on nouns and very often on nouns denoting entities, while prototypical antonymy is formed between adjectives and less prototypical forms of opposition between verbs. In terminology pairs that could have been defined as opposites were examined more naturally from the perspective of co-hyponyms (Gagné, L'Homme, 2016 : 3-4). Thus, researchers define opposition as a two-way relationship of incompatibility between two terms in a specialized field. In other words, there are opposite relationships between terms that display semantic features that cannot be present simultaneously. This binary and symmetric exclusion relation can be summarized with the logical proposition : if it is X, it is not Y and if it is not X, it is Y. However, incompatibility alone is not enough to fully explain the relations of opposition and antonymy. In a narrow sense the opposition arises, paradoxically, from a semantic resemblance within which a single strong semantic dimension differentiates two terms. The semantic similarity that characterizes opposite relationships implies that pairs are usually defined between terms that belong to the same part of speech and the same semantic class (Gagné, L'Homme, 2016 : 6-7).

2. Antonymy in the terminology from the domain of biomedical engineering

To study the phenomenon of antonymy in the terminology from the domain of biomedical engineering we used the classification of antonymy proposed by Steven Jones who chose to categorize antonyms in terms of their function based on their co-occurrence in context, unlike semanticists who classified antonyms based on logical properties.

Steven Jones distinguishes the following categories of antonymy :

1. ancillary antonymy – involves the use of a pair of antonyms to create or highlight a secondary contrast in the sentence / speech ;
2. coordinated antonymy – the distinction between the two opposite terms is neutralized, usually made through coordination (hence the name for this category), but not all cases of antonyms in which the terms are connected by coordinating conjunction can be placed in this category and not all cases of coordinated antonymy involve a conjunction ;

3. comparative antonymy – involves establishing a comparison between antonyms ;
4. distinguished antonymy – draws attention to the inherent distinction between members of the pair of antonyms ;
5. transitional antonymy – expresses a movement or change from one location, activity or state to another ;
6. negated antonymy – highlights a member of the pair of antonyms using it with the negation of the other member ;
7. extreme antonymy – resembles coordinated antonymy in neutralizing the differences between the two antonyms, but, unlike coordinated antonymy, it unites the extremes of a scale ;
8. idiomatic antonymy – any cases of co-occurrence of antonyms that would be recognized as an idiom, proverb or cliché ;
9. residual antonymy – cases in which the members of the pair of antonyms were clearly intended to contrast, but did not fall into one of the categories mentioned above ;
10. interrogative antonymy – involves a choice between the two members of the pair of antonyms (Murphy, Paradis, Willners, Jones, 2009 : 2160-2161).

In order to create the terminological corpus which served as the basis of the practical research we used as an English source the book "Medical Devices and Human Engineering" written by Joseph D. Bronzino and Donald R. Peterson, and as a source for Romanian terminology the book "Instrumentație Biomedicală" by Anatolie Iavorschi, Călin-Petru Corciovă and Victor Șontea.

Studying the examples of antonyms extracted from the English terminology source, we can conclude that most antonym pairs fall into the category of coordinated antonyms, one of the two major categories proposed by Steven Jones. In this case the antonyms are connected by conjunctions *and* and *or* :

- *biomedical sensing – nonbiomedical sensing ;*
- *diffusible indicators – nondiffusible indicators ;*
- *nontransvenous electrode – transvenous electrode ;*
- *transmitter – receiver ;*
- *faradaic processes – nonfaradaic processes ;*
- *human systems – artificial systems ;*
- *solid metal devices – liquid metal devices ;*
- *transmitted signals – received signals ;*
- *coagulation profile of blood – dissolution profile of blood ;*
- *specific nuclei acid sequences – unspecific nuclei acid sequences ;*
- *natural convection – forced convection ;*
- *on-line blood gas analysis – off-line blood gas analysis ;*
- *inorganic materials – organic materials ;*
- *rapid shallow breathing – slow deep breathing ;*
- *noninverting input – inverting input ;*
- *ex vivo – in vivo.*

The absolute majority of the extracted terms are compound terms having the same head, the antonymy relation being established based on the modifier of the compound. Therefore, it has often been found in context that the head of the compound appears only together with the modifier of the second term of the pair of antonyms :

E.g. Other notable exceptions to this similarity of sensors for measuring physical quantities in *biological* and *nonbiological systems* are the sensors used for fluidic measurements such as pressure and flow (Bronzino, Peterson, 2017 : 2-1).

But there are also derived terms where the relation of antonymy can be established by the opposition between the derivational elements such as the prefixes in the following example :

- *under-* and *overinfusion*.

The next type of antonymy present within the studied terms is the distinguished antonymy signaled lexically in context by the expression *the difference between ... and ...*. Representative for this category of antonyms are the following examples :

- *input signal – output signal* ;
- *normal tissue – pathological tissue / cancerous tissue* ;
- *macroshock – microshock* ;
- *high-voltage electrodes – low-voltage electrodes*.

The other studied examples fall into the category of residual antonymy, being characterized by semantic contrast and co-occurrence in context :

- *invasive sensor – noninvasive sensor* ;
- *polarized electrodes – nonpolarized electrodes* ;
- *spectral methods – nonspectral methods* ;
- *cardiac signals – noncardiac signal* ;
- *steroid – nonsteroid* ;
- *contact coagulation – noncontact coagulation* ;
- *conductive material – nonconductive material* ;
- *contact mode imaging – noncontact mode imaging* ;
- *oxidation – reduction* ;
- *fibrillation – defibrillation* ;
- *scattering – absorption* ;
- *vascular – avascular* ;
- *endogenous – exogenous* ;
- *soluble – insoluble* ;
- *organic – inorganic*.

From a lexical point of view, most of the researched antonyms are formed by derivation with the help of prefixes that express negation and privative prefixes which facilitated the identification of the antonym pairs in context.

Speaking about the relation of antonymy in Romanian terminology, the extracted examples reveal the existence of a wider spectrum of categories than those in English. However, as in English, most examples of pairs of antonymic terms fall into the category of coordinated antonymy signaled in context by comma or by the conjunction *and* in most examples, and in fewer examples by the conjunction *or*. Thus, the pairs of terms where the relation of coordinated antonymy was established are :

- *cation – anion* ;
- *mediu intracelular – mediu extracelular* ;
- *canale transmembranare lente - canale transmembranare rapide* ;
- *polarizare – depolarizare* ;
- *repolarizarea lentă – repolarizarea rapidă* ;
- *semnale biologice periodice – semnale biologice aperiodice* ;
- *intrarea inversoare – intrarea neinversoare* ;
- *tensiune pozitivă – tensiune negativă* ;
- *șgomote intrinseci – șgomote extrinseci* ;
- *filtru pasiv – filtru activ* ;
- *metode invazive / directe – metode neinvazive / indirecte* ;
- *apa intracelulară – apa extracelulară*.

The next type of antonymy representative for Romanian terminology is the residual antonymy. Just like in English, this category of antonyms includes the biggest number of examples following the category of coordinated antonyms :

- *amplificator inversor – amplificator neinversor* ;
- *amplificator de intrare – amplificator de ieșire* ;
- *electrod rece / indiferent – electrod cald / activ* ;
- *procese staționare – procese nestaționare* ;
- *radiații ionizante – radiații neionizante* ;
- *șgomot aleator – șgomot nealeator*.

The last type of antonymy established in the terminology studied in both languages is the distinguished antonymy although in English it has a more prolific presence than in Romanian where the only example extracted were signaled in context by the word *invers*, which expresses the inherent distinction between the two components of the antonym pair :

- *semnale staționar aleatoare – semnale nestaționar aleatoare*.

E.g. *Semnălele staționar aleatoare* sunt semnale al căror spectru de frecvență rămâne constant în timp. *Invers*, *semnalele nestaționar aleatoare* au spectrul de frecvență variabil în timp (Iavorschi, Corciovă, Șontea, 2017 : 22).

The other types of antonyms that have been determined in Romanian terminology are extreme antonymy and ancillary antonymy although we cannot say that they would change the typological configuration much compared to the one in English terminology, because only one example was determined for each type. Thus, the extreme antonymy is represented by the following example in which the elements of the antonym pair are extreme parts of a scale :

- *tensiunea arterială sistolică – tensiunea arterială diastolică.*

E.g. *Tensiunea arterială sistolică* (Pas – valoarea cea mai mare) reprezintă cea mai mare tensiune în cadrul unui ciclu cardiac [...] *Tensiunea arterială diastolică* (Pad – valoarea cea mai mică) reprezintă cea mai mică tensiune în cadrul unui ciclu cardiac (Iavorschi, Corciovă, Şontea, 2017 : 143).

Lastly, we have the ancillary antonymy where the pair of antonyms *curent continuu ascendent – curent continuu descendent* was used to highlight a secondary contrast in the sentence :

E.g. Intensitatea curentului poate varia *crescând* de la valoarea zero până la o anumită valoare – caz în care poartă denumirea de *curent continuu ascendent* sau *decreşte* de la o valoare dată până la zero – caz în care poartă denumirea de *curent continuu descendent* (Iavorschi, Corciovă, Şontea, 2017 : 188).

As in English, most terms in Romanian are compound terms, the relation of antonymy being determined based on the opposition established between the modifiers of the antonym pair. From a lexical point of view, many terms were created using prefixes that express the negation *a-*, *ne-*, or the privative prefix *de-*, but there are also many terms that were not created through prefixing, the relation of antonymy being established predominantly by examining the context in which terms were used.

Conclusions

Although antonymy has been subjected to a continuous linguistic research from various perspectives, in terminology it has not been studied so closely, often being considered a specific case of co-hyponymy. However, studying the terminology in the domain of biomedical engineering in English and Romanian, we have found that the phenomenon of antonymy has a wide presence creating opposition relations between concepts and, respectively, the terms designating them. This leads us to conclude that antonymy as a lexico-semantic relation occupies an important place in the mental organization of vocabulary which makes it, in our opinion, extremely significant for the study of terminology.

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