The semantic relation of meronymy in the terminology from the domain of biomedical engineering

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Abstract: Meronymy is a semantic relation of major importance for structuring concepts in the conceptual system of a particular field by establishing part-whole relationships that are formed between the concepts and, respectively, the terms that designate these concepts. The present paper aims to study how the relation of meronymy was treated as an object of linguistic investigations as well as the representation of this relation in the terminology from the domain of biomedical engineering in English and Romanian, focusing on the identification and classification of meronym pairs based on a comparable corpus of original texts.
Keywords: *semantic relation, meronymy, terminology, biomedical engineering.*

Introduction

This paper aims to study the way in which the relation of meronymy has been treated as an object of linguistic investigations by reviewing the various approaches that have placed this relation at the centre of theoretical research and the representation of this relation in the terminology form the domain of biomedical engineering by conducting a practical study that focuses on identifying and classifying pairs of meronyms based on a comparable corpus of original texts created in English and Romanian.

Theoretical background

First used by David Alan Cruse in the work "Lexical Semantics", the term *meronymy* indicates the part-whole relation. In order to explain what the meronymy relation implies, the linguist starts from the definition of the concept of *part* outlining its characteristics by comparing it with the notion of *piece*. Thus, he states that a typical part of a whole is differentiated by three basic features: autonomy, non-arbitrary limits (delimitation of other component parts by a certain relative discontinuity) and determined function. David Alan Cruse points out, however, that although there is a close link between the extra-linguistic part-whole hierarchy and the corresponding lexical hierarchy, the two are distinct and should not be confused, as in many cases they are not isomorphic [Cruse, 1986: 157-160]. The

same opinion is supported by the linguist John Lyons. According to him, the fact that an entity can be described as part of another entity does not mean that there is a part-whole relation between the lexemes used in the vocabulary to refer to these entities [Lyons, 1977: 312].

Roxana Girju, Adriana Badulescu and Dan Moldovan state that, historically, the part-whole relation has played an important role in linguistics, philosophy and psychology largely due to the fact that a clear understanding of this relation requires a close interaction between logic, semantics and pragmatics. The part-whole relation has been considered a fundamental ontological relation since the time of the atomists, they being the first to provide a systematic characterization of the parts and the whole, the relationship between them and the inherent features of this relationship. However, most research on the part-whole relation has been conducted since the early twentieth century.

The research in the field of logic and philosophy has been concerned with formal theories about parts (meronymy), the whole and their relationship in the context of formal ontology. This approach supports the idea of a unique, universal and transitive part-whole relation used to model various spheres such as time and space.

Studies in linguistics and cognitive psychology focus on different part-whole relations and their role as semantic primitives. Because there are several ways to express these relations, many researchers have argued that meronymy should be considered as a set of relations [Gîrju, Bădulescu, Moldovan2006: 85-86].

According to Nick Riemer, the definition of meronymy based on the part-whole relation is not without its shortcomings. Typically, meronymy is considered a transitive relation: if A is a meronym of B and B is a meronym of C, then A is also a meronym of C. However, the use of the notion of *part* in language does not always follow the transitive logical character expressed by the relation of meronymy [Riemer, 2010: 141]. An example cited by many authors when discussing the issue of transitivity is the one given by John Lyons. A certain object x that we can refer to as a *handle* can also be part of an object y that we can refer to as a *door* and can be part of another object z that we can refer to as a *house*. X is part of z (by virtue of the transitive character of the part-whole relation existing between physical entities). However, a statement like "The house has/ does not have a handle" sounds quite bizarre or an expression like "the handle of the house" is absolutely unacceptable [Lyons, 1977: 312-313]. John Lyons suggests that, in fact, there are several types of meronyms in the language. Based on this idea, Madelyn Anne Iris, Bonnie Litowitz and Matha Evens developed a classification of meronymic relations that includes four types depending on the relationship between:

- the functional component and its whole: heart – body, engine – car;
- segment and the pre-existing whole: slice – cake;
- member and the collection or element and set: sheep – flock;
- subset – set (usually considered a hyponymic relation): fruit – food.

Transitivity holds forthe subset and segmented wholestypes of meronymy, but not for the other types [Riemer, 2010: 141].

Another classification of meronyms is the one developed by Morton E. Winston, Roger Chaffin and Douglas Herrmann who identified six types of meronymic relations. The differences between those types are marked by the value of three elements that summarize the characteristic features of these relations and are expressed in three basic ways: functionality, similarity between the parts and the possibility of separating the parts. The taxonomy developed by them looks includes the following types:

- component / integral object: handle – cup;
- member / collection: tree – forest;
- portion / mass: grain – salt;
- stuff / object: steel – bike;
- feature / activity: paying – shopping;
- place / area: oasis – desert [Winston, Chaffin, Herrmann, 1987: 420-421].

Researching the part-whole relations, Alessandro Artale, Enrico Franconi, Nicola Guarino and Luca Pazzi mention that the differentiation of the six types of meronyms presented above offers the authors the opportunity to justify the lack of transitivity in some part-whole relations. They claim that if we consider the concept of part as having the same meaning we can keep the transitive character; problems regarding transitivity appear only when we approach a mix of types of meronymic relations.

Although the study by Morton E. Winston, Roger Chaffin, and Douglas Herrmann is an important first contribution to understanding the cognitive nature of part-whole relations, there have been some criticisms of this approach. To begin with, although the proposed approach seems to exclude the idea of the existence of a single party-whole relation that is supposed to be transitive, several authors have pointed out that the typology introduced by Morton E. Winston, Roger Chaffin and Douglas Herrmann can be seen as specializations of a single meronymy relation that satisfies the basic axioms of meronymy. This feature of different part-whole relations could be dependent on the ontological character of both the whole (including the notion of integrity) and the part.

Another critique of this approach is motivated by the fact that it is based on linguistic examples whose interpretation may be ambiguous and, therefore, some distinctions proposed by the authors (which are not supported by formal evidence) may be obscure or debatable, hence the proposal of Madelyn Anne Iris, Bonnie Litowitz and Matha Evens to reduce the classification of part-whole relations to four main types. Peter Gerstl and Simone Pribbe now go further in researching this phenomenon by isolating three types of wholes based on their compositional structure, namely: mass, collection and complex (whose parts are respectively called quantities, members and components) and two subsequent ways isolation of their parts based on intrinsic characteristics (portions) and external schemes (segments) [Artale, Franconi, Guarino, Pazzi, 1996: 5].

Researching the works of John Lyons and David Alan Cruse, M. Lynne Murphy mentions that at another level meronyms can be divided into two types: necessary and optional (according to John Lyons) or canonical and facilitative (according to David Alan Cruse). In addition to the criterion of necessity, David Alan Cruse identifies four other dimensions that he uses to distinguish between prototypical and non-prototypical meronym relations, arguing that the most prototypical meronyms are necessary, integral, discrete, motivated, and congruent [Murphy 2009: 540].

Speaking about the place that meronymy occupies in the context of other semantic relations, William Croft and David Alan Cruse in their study of cognitive linguistics state that like any other semantic relation meronymy is seen as a relation between contextually interpreted meanings (or, more precisely, a relationship formed by pre-meanings created by the limits of interpretation). However, this relation is less direct than hyponymy, as it is not easy to select an optimal way to express it. The problem is that the basic part-whole relation is not formed between classes of elements, but between individual elements belonging to these classes. Also, the relation itself is subject to interpretation, unlike the relation of hyponymy between classes. As for hyponymy, its very definition is sufficient to determine its existence, without the need for a separate interpretation. However, in the case of meronymy, the part-whole relation between the elements is an interpretation subject to a range of conventional and contextual constraints. Thus, the relation of meronymy is outlined by the existence of an indeterminate meaning adding a series of interpretations of pre-meanings that bring us closer and closer to the target interpretation, but in many cases the part-whole relation cannot be deduced until we reach the level of the individual referent [Croft, Cruse, 2004: 159-162]. Examining this parallel in terms of knowledge organization, Barbara Tversky and Kathleen Hemenway claim that taxonomic relations serve to organize many classes of entities and allow inferences from larger sets of entities to those included in them. In contrast, part-whole relations serve to separate entities into their structural components. The informative character of the basic level can be created by the existence of the inference from the structure to the function at this level [Tversky, Hemenway, 1984: 169].

Corpus and methodological approach

For the practical study of the relation of meronymy in the terminology from the domain of biomedical engineering we used two original works in English and Romanian. The work that served to extract the terms for the corpus in English is *Medical Devices and Human Engineering* written by Joseph D. Bronzino and Donald R. Peterson [2017], and for the Romanian language we used the work *Instrumentaţie Biomedicală* by Anatolie Iavorschi, Călin-Petru Corciovă and Victor Şontea [2017].

To identify the examples of terms between which meronymic relations were established, we used the method proposed by Roxana Gîrju, Adriana Bădulescu and Dan Moldovan in their study on the identification of meronymic

relations. According to them, there are a variety of lexico-syntactic structures that can express the semantic relation of meronymy. In English there are unambiguous lexical expressions such as *consists of, is made of, is a member of* (their Romanian equivalents being *constă din*, *este format din*, *este membru al*), whose simple detection can be used to identify the relation of meronymy. On the other hand, there are many ambiguous expressions that express the relation of meronymy only in some contexts. In this case, its identification is based on extracting the semantic features of the constituent elements and verifying whether these features match the classification rules [Gîrju, Bădulescu, Moldovan, 2006: 87-88].

Meronymy in the terminology from the domain of biomedical engineering

First we are going to present some examples of terms in English where the relation of meronymy was identified using the expression *consists of* in all of its grammatical forms. The first term is the holonym (the whole), and the other terms listed through a forward slash are the identified meronyms (parts):

- *Inductive-capacitive resonant circuit – inductor / capacitor / coil;*
- *Sensor – LC circuit;*
- *DNA – nucleic acid;*
- *ICD system – generator / leads;*
- *Implantable joint angle transducer (IJAT) – magnet / magnetic sensor;*
- *Intravenous delivery system – fluid reservoir / catheter system;*
- *Conductor – electrode;*
- *Photomultiplier tube – photosensitive cathode;*
- *Outer ear – pinna / ear canal;*
- *Electronic hearing aid – microphone / amplifier electronic / speaker.*

In the process of identifying the examples we noticed that even if *consists of* is considered an unambiguous expression, it cannot always serve as a specific feature of marking the relation of meronymy in context. There are also cases where the relation established between the identified terms was the one of hyponymy, for example: *frequency range – ultraviolet range*. An identified contextual lexical marker that could clarify the differentiation between meronymy and hyponymy without the need to resort to extracting the semantic features of the constituent elements is the word *components* that, in many cases, follows the expression *consists of*, which automatically places the pairs meronym – holonym in the component – integral object type of meronymy (according to the classification proposed by Morton E. Winston, Roger Chaffin and Douglas Herrmann):

E.g. An intravenous delivery system typically *consists of* three major *components*: (1) fluid or drug reservoir, (2) catheter system for transferring the fluid or drug from the

reservoir into the vasculature through a venipuncture, and (3) device for regulation and/or generating flow [Bronzino, Peterson, 2017: 25-1].

The next lexical expression proposed by Roxana Gîrju, Adriana Bădulescu and Dan Moldovan to identify the relation of meronymy is *made of*. Some examples of terms identified using these expression are:

- *Linear variable differential transformer (LVDT) – ferromagnetic material;*
- *Nanometer – iron oxide (magnetite);*
- *ABICAP filter – polyethylene;*
- *Mass-changing pH-responsive polymer – acrylic acid iso-octyl acrylate;*
- *Electrode – metal;*
- *Membrane – silicone;*
- *Prism – quartz;*
- *Scintillating crystal – sodium iodide / thalium.*

Analysing the above examples, we can conclude that the relation of meronymy which is marked by the expression *made of* is placed within the stuff/ object type. Another contextual lexical marker identified in some cases is represented by the word *materials* which excludes any ambiguity of classification of the analysed pairs of terms as well as the need to resort to the extraction of the semantic features of the constituent elements.

> E.g. Electrodes are *made of* corrosion resistant *materials*, such as noble metals (platinum or iridium) and their alloys [Bronzino, Peterson, 2017: 16-7]. – The relation of has been established between the terms *electrode* (holonym) și *platinum / iridium* (meronym).

The use of the expression *is a member of* to identify the semantic relation of meronymy did not give satisfactory results, so in the context of current research we cannot say that it represents a relevant lexical marker.

In addition to the expressions used above to identify examples of meronymy, we can argue that the expression *part of* present in context could be a sign which would help us detect the terms connected by the relation of meronymy taking into account the definition and the very essence of this semantic relation. Thus, some of the identified examples would be:

- *Preamplifier – amplifier;*
- *Electrode – impedance-measuring system;*
- *R-wave – EGM (electrogram);*
- *Epineural stimulating electrode – implant;*
- *Filament – Wheatstone bridge circuit;*
- *Torque motor – sensor.*

Following this attempt to identify meronymic relations using the expression *part of*, we can conclude that it gave the least relevant results. This can be explained by the different ways in which the word *part* can be used (as mentioned by Anna Wierzbicka [Wierzbicka, 1996: 60]), not all of which expressing a meronymic relation. A factor that differentiates these examples from those identified above is the positioning of the elements of the meronymic pairs in the context. Here they are placed in the order meronym (part) – holonym (whole).

> E.g. The *preamplifier* represents the most critical *partof* the *amplifier* itself as it sets the stage for the quality of the biosignal [Bronzino, Peterson, 2017:9-3].

Other lexico-syntactic structures that can express the semantic relation of meronymy can be derived using the synonyms of those mentioned by Roxana Girju, Adriana Badulescu and Dan Moldovan. Thus, in the source used for extracting the examples in English, we noticed the use of the verb *to incorporate*both in active and passive voice, which could suggest the existence of a relation of meronymy, especially if we consider the definition of this verb given by Oxford English Dictionary: to include something as part of a whole [Waite, 2012: 367]. Thisrelation of meronymy can be placedwithin the type component / integral object. Some identified examples (in order part-whole) would be:

- *LVDT sensor – implant / tocodynamometer;*
- *RFID tag – retinal prosphetic;*
- *LC tank sensor – stent device;*
- *Two-plate capacitor – LC circuit;*
- *Magnetic marker – portable measuring istrument;*
- *Functional membrane – active electrode;*
- *Rate-limiting circuit – timing circuit;*
- *Enzymatic catalyst – biomedical enzymatic sensor.*

Another verb that could mark the relation of meronymy is the verb *to contain* used in different grammatical forms. Although few such examples have been detected, their typology is quite diverse: component / integral object, portion / mass, stuff / object. The presence of this verb automaticly places the terms in the order holonym (whole) – meronym (part). Some identified examples would be:

- *Spirometer – CO_2 absorber;*
- *Blood – hemoglobin;*
- *Abbott Diabetes Care Sof-Tact meter – vacuum pump / lacing device / test strip;*
- *Polyurethane/polyurea compositions – silicon.*

In order to extract the examples in Romanian, we followed the same method, identifying the relations of meronymy with the help of the lexico-syntactic structures that mark these relations in context. For this purpose, we used the

Romanian equivalents of the English ones proposed by Roxana Gîrju, Adriana Bădulescu and Dan Moldovan, as well as others represented by their synonyms that were discovered in the process of extracting the relevant terms. All the examples below can be divided into two types from those proposed by Morton E. Winston, Roger Chaffin and Douglas Herrmann: component / integral object, identified in most pairs of terms, while several others can be classified as belonging to the type of stuff/object, these being differentiated by lexico-semantic structures that suggest this type of meronymy.

Thus, using the expression *constă din* we identified the following examples of terms where the type of meronymy component / integral object was established, present in context in the order whole-part (the majority of examples):

- *Dispozitiv de determinare SpO2 – circuit de comutație;*
- *Traductor piezorezistiv – punte tensiometrică;*

este format din:
- *Membrana celulară – lipide;*
- *Semnale periodice – semnale sinuzale / componente sinusoidale;*
- *Biosenzor – receptor biologic activ / traductor;*
- *Receptor biologic activ – enzime / anticorpi / microorganisme / ADN / țesuturi umane;*
- *Sistemul nervos central – neuroni / celule gliale;*

ca element fiind:
- *Senzor potențiometric – electrod de pH / electrod ion selectiv;*

conține:
- *Traductor – cameră de compresie;*
- *Marca tensometrică – fir rezistiv / lamelă;*
- *Senzor optic – sistem de transmisie cu fibră optică;*
- *Amplificator operațional integrat – transzistoare / diode / rezistoare / condensatoare;*
- *Amplificator de instrumentație – amplificator operațional / amplificator diferențial;*
- *Circuit integrat – convertor;*
- *Semnal ECG – unda P / complexul QRS / unda T / unda U / segmentul PQ / segmentul ST / triunghiul Einthoven;*
- *Electrod – conductor / amplificator;*

este alcătuit din:
- *Circuit echivalent – element liniar;*
- *Filtre pasive – rezistori / bobine / condensatori;*
- *Bloc de alimentare – transformator de rețea / bloc redresor / bloc stabilizator / bloc convertor de tensiune / circuit astabil;*
- *Pneumotahografie – traductor de viteză;*

- *Neuron – corp celular / axon / dendrite;*

este constituit din:
- *Traductor de tip Clark – electrod / soluție de electrolit / membrană de difuzie;*
- *Tub catodic – tun electronic;*
- *Spirometru – chimograf;*

este compus din:
- *Sistem de culegere – electrozi / conductori electrici;*

este dotat cu:
- *Electroencefalograf – sistem de culegere / sistem de amplificare / sistem de etalonare;*

componente sunt:
- *Înregistrator grafic – traductor;*
- *Osciloscop – circuit de intrare / preamplificator pentru deflexia pe verticală / aplificator simetric de sincronzare / circuit formator de semnal / circuit poartă / bloc generator de tensiune liniar variabilă / circuit de reținere / circuit de sincronizare automată / amplificatorul semnalului;*
- *Tensiune de polarizare – tensiune ohmică / tensiune de concentrație / tensiune de descompunere.*

The following examples are pairs of terms where the type of meronymy component / integral object was established, present in context in the order part-whole, using the expression *se include / este inclus în:*
- *Dispozitiv traductor – circuit punte;*

formează:
- *Celule de electroliză – sistem biosenzorial.*

Only a few examples of pairs of terms have been identified as belonging to the type stuff/ object marked by lexico-semantic structures *confecționat din / din*, these being (in order whole-part):
- *Electrod de hidrogen – platină / hidrogen;*
- *Electrod cu joncțiune lichidă – argint;*
- *Microelectrod – oțel inoxidabil / platină / argint / aur / tungsten / sticlă.*

Conclusions
Meronymy is a semantic relation of major importance for structuring concepts in the conceptual system of a particular field by establishing part-whole relations that are formed between them and, respectively, the terms that designate these concepts. Although there are debates about the transitive nature of meronymy,

attempts have been made to solve the problem of transitivity by developing various classifications that specify the nature of each type of meronymy relation. Following the practical research of the examples in English and Romanian extracted from the terminological resources, we found that the suitable method to identify the pairs of terms between which the relation of meronymy is established is with the help of certain lexico-semantic structures such as *consists of, is made of, is a part of, incorporate* in English, and *constă din, este format din, este constitut din, este inclus în, componentele sunt* in Romania, and their synonyms, the pairs of terms being present in context both in the order part-whole, as well as whole-part, depending on the contextual lexico-semantic marking. Regarding the typology, in both languages the type of meronymy component / integral object predominates with few detected examples of stuff / object and only one example in English of type portion / mass type.

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