Languages for Special Purposes in a Multilingual, Transcultural World

Proceedings of the 19th European Symposium on Languages for Special Purposes, 8-10 July 2013, Vienna, Austria

The depiction of terminological variation in medical images: Can you see the difference?

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Abstract. Denominative variants for terms arise as a result of the different situated ways in which we conceptualize the world. Individuals learn new concepts by "simulating experiences" of the members of the same conceptual category. Due to the multidimensional nature and high degree of embodiment of medical concepts, variation, as lexical-semantic phenomenon, is not infrequent in naming medical realities. For this reason, terminological databases should account for variation taking place in specialized communication scenarios. Prior research in the field of knowledge visualization has shown that images are useful to represent relations among concepts, and that visual resources should be selected on the basis of the image-schemas underlying the concept depicted.

In this paper, we argue for the inclusion of images in a terminographical database in order to provide a consistent, meaningful, graphical description of variants for terms referring to DISEASE, SIGN/SYMPTOM and BODY PART. By integrating images in a principled way in a terminological database, we intend to clarify how images can evoke different variants of a single medical term by depicting the cognitive (semantic) or communicative (pragmatic) features which often give rise to terminological variation in Medicine.

Keywords. Concept depiction, image-schemas, specialized knowledge visualization, termbases, terminological variation.

1. Introduction

Terminological resources are becoming more and more necessary in today's knowledge society. Terminologists are aware that for knowledge resources to be useful and meet the information needs of users, they must include different data categories (definitions, contexts, terms, grammatical information, images, reliability marks, etc.). There are several reasons to think that the inclusion of diverse types of information in terminological knowledge bases (conceptual, linguistic and visual) should be done in a principled way, that is to say, on the basis of a consistent set of criteria so as to achieve internal coherence within the term entry (Faber et al. 2007; Prieto and López 2009).

Although most lexicographical resources (either general or domain-specific) now tend to include images, they doesn't seem to pay close attention to how images are selected and the way they should be integrated in term entries for the sake of consistency. Frame-based Terminology (FbT), a recent cognitive approach to the study of specialized language, accounts for the multidimensional and multimodal representation of concepts in terminological resources. For this purpose, FbT is trying to identify objective cognition-based guidelines for image selection which are believed to be based on the degree of specialization of images and their level of representativeness. Within FbT, a new theory explaining the graphic representation of concepts is being developed. Specialized knowledge visualization, as this theoretical approach is known, aims at describing the cognitive criteria which underlie the depiction of concepts.

Specialized knowledge visualization is currently being implemented within the project VariMed, an investigation into denominative variation in specialized language. In this project, we are building a new terminological database of lexical variants for terms designating diseases, signs and symptoms. The challenge now is to use images to distinguish between two very similar

terms which differ at a cognitive or communicative level; thus images must visually convey the differences between close terms (reflux, heartburn, gastro-oesophageal reflux disease or GERD).

In this paper, we explore the visual representation of medical concepts with special attention to the notion of representativeness. We also present the research we are conducting in order to assess usability and usefulness of visual resources in terminological databases and to be able to evaluate what users judge as representative by testing general users and experts from the healthcare sector.

In section 2, we discuss the relationship between Terminology and Cognition and explain in more detail the approach known as Frame-based Terminology. Section 3 presents the use of visual resources in terminological databases focusing on the Specialized Knowledge Visualization account and the VariMed project. In section 4, we describe the principles which lie behind the depiction of medical terms and propose an experiment to analyze the representativeness of images from the point of view of potential users. Finally, we offer some concluding remarks.

2. Terminology and Cognition

For the last two decades, terminology theories have evolved towards more cognitive trends; examples can be found in the Communicative theory of terminology (Cabré 1993); Sociocognitive terminology (Temmermann 2000); Termontography (Temmermann and Kerremans 2003); Ontoterminology (Roche et al. 2009); Frame-based Terminology (Faber 2012).

Most of these approaches are descriptive paradigms of specialized languages and their aim is not just standardization, but to explain the behavior of terms and the linguistic phenomena behind them. Since language processes are rooted in cognitive operations ruling the human concept system, they approach cognition from different perspectives: the communicative purpose of terminological units; the social influence on the use of terms; and the use of ontologies to represent concepts.

2.1. Frame-based Terminology

In this framework, FbT is a cognitive theory of terminology which describes terms thanks to three separate micro-theories (Faber 2013): semantic, syntactic, and pragmatic. The semantic micro-theory is used to describe (a) the internal representation of concepts by means of definitions, and (b) the external representation of concepts by means of a linguistically-based ontology which evokes interconceptual relations. The syntactic micro-theory, in turn, contributes to a better interpretation of multi-word terminological units described by a slot-filling mechanism which is based on predicate-argument structures and the notion of valency. Finally, the pragmatic micro-theory describes the influence exerted by larger situational, linguistic, and cultural contexts on the use of terms, which can be constrained by contextual variation across disciplines, cultures, and communicative situations.

Faber (2009) states the theoretical premises of FBT as follows:

- ○ The general function of specialized language texts is the transmission of knowledge.

- ○ Terms are words, and their behavior can be described through the extraction of syntactic and semantic information through corpus analysis.

- ○ The underlying category structure of specialized domains may be represented, in accordance with Fillmore's Frames, by templates for the processes and entities participating in the specialized field.

- ○ Specialized knowledge acquisition is encouraged by multimodal representations of concepts which highlight our interaction and experience of the world.

In fact, one of the most interesting aspects of FbT is its focus on the cognitive processing of

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specialized terms from a dynamic view, as opposed to other theories which only deal with the communicative aspects of terms regardless how concepts are acquired and processed. The processing and acquisition of specialized concepts is approached by FbT, from the embodied cognition viewpoint. Embodied cognition accounts for the relationship between the real world we perceive through our sensorimotor experiences and the internal representations we use to process and communicate our knowledge about the world (Prieto and Tercedor forthcoming). For FbT, embodiment plays a crucial role in knowledge acquisition, representation and transfer, since they are the foundations of communication and social interaction.

Methodologically, FbT argues for process-oriented terminology management. This methodology advocates a knowledge-based description of specialized domains to determine how concepts interact within a coherent category structure by means of semantic relations.

FbT proposes to analyze multimodality in specialized texts, that is, observing the different types of information implied by different types of semiotic modalities, particularly linguistic and visual. The main objective is to obtain plenty of relevant information from textual corpora in order to be able to facilitate specialized knowledge acquisition. Accordingly, it is our assertion that the knowledge encoded in texts (definitions, contexts, concordances) should mesh with the visual information in images in order to provide a deeper understanding of dynamic domains (Prieto 2013).

3. Terminology and visual resources

Although the ISO standard 704 (2000: 23) concretizes that images in terminographical resources can be iconic, abstract, statistical diagrams, or mixed figures, it merely mentions that "a graphic representation serves its purpose well if it illustrates the characteristics of a given concept and/ or its relations to other concepts." The reviewed ISO standard 704 (2009: 46) offers a more detailed explanation of the role of images in terminological databases, as they are considered to be a kind of ostensive definitions. However, it only includes a subtle reference to the notion of multimodality:

> Also known as a demonstrative definition, [an ostensive definition] is one that defines by exhibiting non-lexical representations of the concept (such as a drawing, an illustration, a video, a sound clip, a computer animation, etc.) or even by pointing to an object. With the increased availability of multimedia technology, ostensive definitions may use any form of multimedia that allows one to exhibit non-lexical representations of the concept. However, rather than being used on their own, ostensive definitions are best employed as complements to intensional definitions or concept descriptions, since it is not always clear what is being referred to or how far to generalize from the particular object exhibited. Furthermore, it may prove difficult to deduce the superordinate concept from an ostensive definition." ISO 704 (2009: 46).

3.1. Specialized Knowledge Visualization

Specialized Knowledge Visualization (SKV) deals with the study of textual corpora in order to identify the cognitive structures underlying a given concept and look for images which consistently depict the embodied experience evoked by such structures with a view to their inclusion in terminological databases. The relation between images and scientific and technical texts was previously studied by Prieto (2008, 2013). Consequently, SKV does not conceive the inclusion of images in terminological databases as completely detached from other representations. Images are just one among several possible devices for concept representation which need to be fully integrated into terminological databases in accordance with the information provided by other kinds of definitions: intensional definitions and knowledge-rich contexts.

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3.2. The VariMed project

Such a methodology is currently being applied to a research project known as VariMed, a terminological database of medical terms and term variants. It is our aim to identify the cognitive and communicative motivations for terminological variation and study the causes for different designations of a single concept in the field of Medicine. Denominative variation is a key element in medical communication both at the intralinguistic level (*amigdalitis*-sore throat) and at the interlinguistic level (keyhole surgery--*laparoscopia*). The objectives of VariMed are: (1) to create a corpus of medical texts in English and Spanish multimodal communication contexts; (ii) to register and classify terminology proper lexical variants in English and Spanish and study their semantic and pragmatic features from the perspective of situated cognition; (iii) to carry out a series of experimental tasks to gain insight into the phenomenon of variation in relation to the cognitive processes of lexical production and comprehension; (iv) to generate a multifunctional and reusable resource with image support for linguistic research, translation and technical writing for knowledge dissemination (varimed.ugr.es).

4. Depicting term variants

Terminological variation is a cognitive and communicative phenomenon which implies the coexistence of several designations for a single concept. Sometimes, term variants arise as a consequence of (1) different ways of perceiving real entities and processes, (2) focusing on different attributes (material, purpose, origin, etc.), or (3) different situational contexts involving heterogeneous recipients.

For instance, there are several lexical options to denominate the disease caused by stomach acid coming up from the stomach into the esophagus: *gastroesophageal reflux disease, gastro-oesophageal reflux, reflux, acid reflux, heartburn, GERD*, etc. These terms are not synonyms insofar as they are not completely interchangeable in all possible contexts. Then, doctors in the UK would probably use *GERD* to communicate with other healthcare providers, or *gastro-oesophageal reflux disease* when telling a patient a diagnosis, whereas in the US they would use *gastroesophageal reflux*. Patients, on the other hand, would prefer to tell a doctor the main symptoms they suffer from using *heartburn* instead. Acid reflux can be used to specify what type of fluid is the cause of their discomfort.

Although all variants represent linguistically the same concept and convey the same meaning in essence, a single concept is lexicalized with different connotations, and images could also help to visually represent these cognitive and communicative differences thus complementing the definition. Nevertheless, definitions, depending on how they are written, can focus on different facets of the concept thanks to the principle of multidimensionality.

Previous studies (Prieto and López 2009; Prieto and Faber 2012) have shown that there are images more or less specialized than others, and more or less representative than others. Tab. 1 shows two different visual representations or ostensive definitions for the concept GASTROESOPHAGEAL REFLUX DISEASE.

It is our hypothesis that the image to the left would not just be less representative, but rather judged less depictive by doctors, since it focuses on the burning sensation felt by patients. In contrast, the image to the right would be deemed more appropriate by healthcare providers because it shows gastric content coming up to the esophagus due to a malfunctioning of the esophageal sphincter regardless of the symptoms, which could be considered rather opaque to patients.

In order to assess these issues related to the notion of representativeness, we have designed an experiment to be conducted within VariMed, as described in the following section.
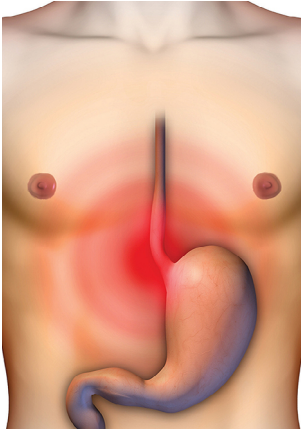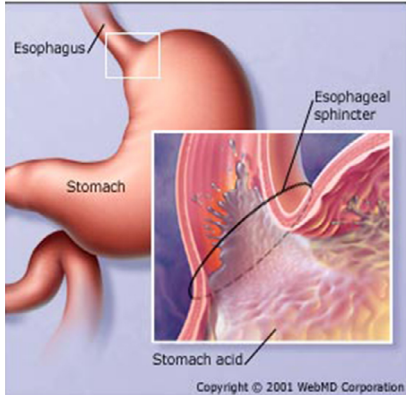
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GASTROESOPHAGEAL REFLUX DISEASE	
(a) heartburn	(b) acid reflux
Source: http://chiropractorrichmondhill. com/wp-content/uploads/2013/03/heartburn. jpg	Source: http://www.webmd.com/heartburn-gerd/heartbrun-and-gerd

Table 1: Ostensive definitions for GASTROESOPHAGEAL REFLUX DISEASE

5. Exploring image representativeness

The study consists of four experimental surveys aimed at English-speaking healthcare providers and non-experts, on the one hand, and Spanish-speaking healthcare providers and non-experts, on the other.

The overall aim is to test whether the criteria currently used when including images in the VariMed termbase lead to the selection of the most representative images both for experts and non-experts. For this purpose, respondents must complete a 50-item questionnaire where they have to choose among four different images depicting the term/s underlined in the preceding short excerpt. Only one of the four images reflected the image schema underlying the concept definition; according with our hypothesis, this image should be considered the most representative by respondents to the detriment of the other three.

So far, the study is under completion and only one of the surveys has already offered significant results with regard to the representativeness of medical images in the opinion of English-speaking non-experts.

5.1. Preliminary results

The survey was responded by 55 subjects. Given a chance performance of 0.25, the proportion of 0.38 selecting the image-schema based option is highly significant. Even if we would say that chance performance is .33, the .38 proportion would still be statistically better than chance. There does not seem to be a notable difference between images depicting informal term variants (heartburn) and high-register formal variants (*gastro-esophageal reflux disease* or *GERD*). Image-schema based options were considered equally significant in the case of informal variants 0.372, and in the case of formal variants 0.393. This means that register variants do not have an influence in the kind of visual representation used to depict concepts. In other words, definitions (images) and images (ostensive) work at a conceptual level by conveying, either linguistically or visually, a set conceptual features, whereas terms are used in communication and need to adapt to contexts and recipients.

6. Conclusion

The evolution of terminological theories towards cognitive paradigms has contributed to a deeper study of the human conceptual system and cognitive operations related to knowledge representation and acquisition. FbT has shed some light into so-far little known issues by exploring the semantic, syntactic and pragmatic component of specialized languages.

Within this framework, the investigation carried out in the project VariMed has paved the way to new multimodal approaches to the representation of concepts in the field of Medicine. SKV is paying attention to the depiction of medical concepts in terminological databases with a focus on representativeness and specialization, two key concepts for embodied cognition.

A study is being implemented in order to find out an unambiguous set of clear criteria leading to the appropriate selection of images depicting medical concepts based on their degree of specialization (register variation) and representativeness. Preliminary results shows that (1) images are conceptual representations (ostensive definitions) receiving no influence from terms (designation); (2) images reflecting the image-schemas underlying specialized concepts are considered to be more representative by English-speaking non-experts.

However, in order to draw clearer conclusions, we need to test English-speaking healthcare providers and Spanish-speaking non-experts and health-care providers. This way we will be able to explain whether there are any cultural/linguistic differences between English and Spanish, and between experts and non-experts.

7. Acknowledgements

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