Using Argument Structure to Disambiguate Verb Meaning

Miriam Buendía Castro, Beatriz Sánchez Cárdenas
University of Castilla-La Mancha, University of Granada
e-mail: miriam.buendia@uclm.es, bsc@ugr.es

Abstract

This study proposes a methodology to disambiguate verb meaning in terminographic resources. To this end, the underlying approach used for verb entries description in the environmental knowledge base EcoLexicon has been applied (Buendía, Montero and Faber 2014; Faber and Buendía 2014). The description is based on three parameters: (i) the nuclear meaning of the verb (i.e. its lexical domain, as proposed by the Lexical Grammar Model (Faber & Mairal 1999); (ii) its meaning dimension (i.e. the lexical subdomain); (iii) its predicate-argument structure highlighting the semantic categories of the arguments. Our study proves that a verb can activate different meaning dimensions in different lexical domains, depending on the semantic categories, or different roles (Van Valin 2005) of its arguments. This way of describing verb meaning according to lexical domains and subdomains, semantic roles and semantic categories helps to disambiguate verbs and represent their meaning in specialized resources.

Keywords: verbs; disambiguation; specialized resources

1 Introduction

For anyone interested in the study of language, meaning disambiguation is a main concern. Disambiguation is necessary not only for nouns and adjectives, but also for verbs, which are a challenge because they provide the semantic framework for sentences.

In the first half of the 20th century, most linguistic theories envisaged the subcategorization of verbs primarily from a syntactic perspective (Chomsky 1957). Little by little, semantics acquired a more important role within linguistics to the extent that today almost all current linguistics theories share the idea that there is a direct relation between syntax, semantics, and pragmatics. In other words, syntax is no longer conceived as separate from meaning and context. On the contrary, sentence structure is usually studied by taking into account the meaning of the words in the sentence as well as the situational context.

This study proposes a methodology to disambiguate verb entries in the environmental knowledge base EcoLexicon using the verb 'burst' to illustrate the process. As shall be seen, it is our assertion that the meaning of a verb constrains the semantic roles and categories of the arguments that can combine with it. For this reason, verbs within the same area of meaning tend to have similar argument structure, and thus have a similar semantic and syntactic behaviour (Sánchez & Buendía 2012). However, what is also true is that at the same time, the semantic nature of the arguments constrains the meaning of the verb. This is especially evident in specialized language when the arguments are technical or scientific terms.

2 Theories of Argument Structure

Generally speaking, the linguistic theories of argument structure that can be applied to the study of phraseology in Terminology are the following: (i) formal linguistic approaches; (ii) functional linguistic approaches; (iii) functional-cognitive linguistic approaches. This section briefly describes those whose premises were particularly useful for our study. It also mentions the most significant lexical resources which contain verb information within their entries. The final aim is to describe the theoretical foundations of our verb analysis.

2.1 Formal theories

Apart from Chomsky's Generative Grammar (Chomsky 1957), the Lexicon-Grammar approach (Harris 1968, 1970; Gross 1975), the Lexical Syntax approach (Subirats 2001), as well as the Linking Rules approach (Levin 1993; Levin and Rappaport 1995; Rappaport and Levin 1998) are currently the most influential formal approaches. Of all of them, the Linking Rules approach was especially useful for this study since our research focuses on semantics.

According to Carter (1988) and Levin and Rappaport (1995: 1), linking regularities are arguments with specific semantic roles, which are regularly associated with specific syntactic structures. The rules responsible for these associations are linking rules. The basic hypothesis of the linking rules approach is that the syntactic properties of verbs are a direct reflection of their underlying meaning. Levin (1993) initially proposed a classification of English verbs on the basis of both intuitive semantic grouping and syntactic alternations. She claimed that verbs sharing the same meaning also coincide in their grammatical properties. This assumption made it possible to predict the behaviour of a verb, based on its semantic class. Levin's taxonomy provides a classification of 3,024 verbs (4,186 senses) into 48 classes and 192 subclasses according to their participation in 79 alternations involving NP and PP complements. In the course of her work, Levin evolved towards a lexical semantic representation based on the formulation of rules that determine argument structure as well as the syntactic projection of these arguments (Levin & Rappaport 1995; Rappaport & Levin 1998). 'Burst', the verb under analysis in this paper, is considered to be primarily a verb of appearance under Levin's classification (Levin 1993: 258), although she also includes it within the verbs of change of state (Levin 1993: 28). As shall be seen, we also consider 'burst' to be a destroy verb if we were to use Levin's classes. In any case, the common alternation that underlies the three classes of verbs is the *causative alternation*. More concretely, the *causative/inchoative alternation* is present in verbs of change of state (Levin 1993: 240).

In our opinion, Levin and Rappaport's linking rule approach is very valuable in that it shows the interdependence of syntax and semantics. We thus agree with some of its basic premises, such as the fact that verbs having the same meaning will presumably have similar grammatical properties. This signifies that it may be possible to predict behaviour based on semantic classes. However, within Levin and Rappaport's approach, argument behaviour depends mostly on the verb. No distinction is made between the arguments provided by the verb and the arguments supplied by the construction in which it is inserted. It is true that verbs are meaningful in themselves, but as shall be seen, the construction in which a predicate is inserted can also contribute to the activation of a particular meaning.

Baker and Ruppenhofer (2002) compare Levin's classification of verbs with the classification in FrameNet (§2.3.1). They observed that although in the linking rule approach, there is a link between syntactic and semantic alternations, reliance on syntactic alternations as a main criterion strongly

conditions Levin's classification and makes it impossible to account for similar lexemes or on the contrary, link different ones. Although the whole thesis of Levin's work is that grouping words according to alternations tends to produce semantically coherent classes, it can also split words that are close in meaning, or lump semantically different words (Baker & Ruppenhofer 2002: 30).

2.2 Functional theories

The objective of functional theories is to describe the use of language in real communicative situations. Some of the most influential functional models were developed at the end of the 70s and beginning of 80s. The two most relevant for our purposes are the Lexical Grammar Model (2.2.1) and Role and Reference Grammar (2.2.2).

2.2.1 Lexical grammar model

The Lexical Grammar Model (LGM) (Faber & Mairal 1999), previously called the Functional Lexematic Model (FLM) (Martín-Mingorance 1998) was conceived by Mingorance in the 1980s and further developed by Faber and Mairal (1999). The Lexical Constructional Model (Ruiz de Mendoza & Mairal 2008) has also partially incorporated the theoretical and methodological premises of the LGM.

The LGM organizes the lexicon in semantic hierarchies which form lexical domains and subdomains. A lexical domain is defined as: "the set of lexemes which together lexicalize all or part of a conceptual domain" (Faber & Mairal 1999: 59). In other words, hierarchies of lexemes, all of which share the same nuclear meaning and syntax, form a lexical domain. According to the LGM, the lexicon is divided into twelve lexical domains (Faber & Mairal 1999: 88), namely, EXISTENCE, CHANGE, POSSESSION, SPEECH, EMOTION, ACTION, MANIPULATION, COGNITION/MENTAL PERCEPTION, MOVEMENT, GENERAL PERCEPTION, SENSE PERCEPTION, and POSITION. Each domain has one or two generic terms or superordinates, in terms of which all the members of the domain are directly or indirectly defined. In this sense, the genus or nuclear term of the definition of each lexeme marks the semantic territory covered by a specific domain or subdomain, and thus is the factor that determines lexical domain membership. The differentiae comprise the semantic information in the meaning of a lexeme which distinguishes it from others in the same lexical domain or part of a domain. It is our assertion that each verb in the lexicon belongs to one of these categories, or in the case of polysemous verbs, they could even activate different domains. Their membership depends on the most prototypically activated semantic features.

2.2.2 Role and reference grammar

Role and Reference Grammar (Van Valin & LaPolla 1997; Van Valin 2005), henceforth RRG, was conceived with the objective of describing the interaction of syntax, semantics and pragmatics in different grammatical systems (Van Valin 2005: 1). RRG establishes semantic roles at two different levels: (i) thematic roles, which are directly related to the type of predicate that they occur with (e.g. PERCEIVER, STIMULUS, COGNIZER, CONTENT); (ii) macroroles, which are generalized semantic functions (e.g. ACTOR and UNDERGOER). As shall be seen, the verb entry description proposed in this research also includes semantic roles in line with RRG.

2.3 Functional-cognitive theories

Functionalist approaches tried to provide the answer to issues that more syntactically-oriented theories were unable to address. However, there were phenomena that functionalists could not

describe either, such as the unexpected differences in argument structure between apparently similar verbs, or on the contrary, coincidences between verbs belonging to different lexical domains. This led to the emergence of functional-cognitive approaches in linguistics, such as Cognitive Grammar (Langacker 1987, 1991), Frame Semantics (Fillmore 1977, 1982, 1985; Fillmore & Atkins 1992), Construction Grammar (Goldberg 1995, 2006), and the Lexical Constructional Model (Ruiz de Mendoza & Mairal 2008: 355). Our study especially uses insights both from Frame Semantics and Construction Grammar.

2.3.1 Frame semantics and FrameNet

The basic premise of Frame Semantics (Fillmore 1977, 1982, 1985; Fillmore & Atkins 1992) is that word meanings should be described within the context of conceptual scenarios, referred to as *frames*. The practical application of Frame Semantics is FrameNet[1]. As is well known, FrameNet is a large database that provides very valuable information for any linguist. The inventory of semantic roles in this thesis coincides with the most general roles in FrameNet. However, instead of the FrameNet conception of roles as frame elements, we have opted for the thematic relations within RRG, and established a further categorization in terms of semantic categories.

Apart from the open-ended number of FEs or roles, FrameNet also has other limitations as pointed out by Jiménez (2008), which are the following: (i) some frames provide all the senses for a predicate, but others only include more peripheral ones; (ii) there is no explanation of how lexical-semantic information can condition the syntactic realization of a predicate; (iii) there is no proposal of a metalanguage, which would enhance its consistency.

2.3.2 Construction grammar

Construction Grammar is a theory closely related to Fillmore's Frame Semantics (§2.3.1). It was initially proposed by Fillmore (Fillmore & Kay 1993) and subsequently developed by Goldberg (1995, 2006). Croft (2001) also proposed an approach to Construction Grammar, known as Radical Construction Grammar.

Construction Grammar rejects a strict division between syntax and semantics. Even though lexical and syntactic constructions differ in internal complexity, both pair form and meaning. It also rejects a division between semantics and pragmatics. Its basic premise is that constructions are considered to be the basic units of language. Constructions are defined as form-meaning correspondences that exist independently of particular verbs. In other words, constructions are thought to carry meaning in themselves, independently of the words in the sentence (Goldberg 1995: 1).

Therefore, in a constructional approach to argument structure, systematic differences in meaning between the same verb in different constructions are attributed directly to the particular constructions (Goldberg 1995: 4). Nevertheless, even though constructions are regarded as having meaning independently of verbs, Goldberg (1995: 1) highlights the fact that grammars do not work entirely top-down, with constructions simply imposing their meaning on verbs, but rather that the analysis must be both top-down and bottom-up. In this sense, Goldberg (1995: 49-50) states that constructions must specify in which ways verbs combine with them; and constructions need to be able to constrain the class of verbs that can be integrated with them and specify the way in which the event type designated by the verb is integrated into the event type designated by the construction.

[1] https://framenet.icsi.berkeley.edu/fndrupal/ [07/02/2016].

2.4 Argument structure as codified in lexical resources

Some of the most representative English and Spanish resources that include the description of verbs within their entries and that have been specially helpful for our verb entry proposal are FrameNet (§2.3.1), WordNet (Fellbaum 2006), VerbNet (Kipper 2005), Proposition Bank or PropBank (Palmer, Gildea & Kingsbury 2005), and the Spanish resources, ADESSE (Vaamonde, González, and García 2010: 1907) and SenSem (Fernández & Vázquez 2012: 158). PropBank, VerbNet, WordNet, and FrameNet are currently being integrated into a project referred to as SemLink, which is in the process of linking different meaning-based resources by mappings in order to enhance inferring as well as semi-automatic extraction tasks, among others.

3 In Search of Disambiguation

For our analysis, we used the English corpus of texts on natural disasters compiled in Buendía, Montero & Faber (2014). The corpus was analyzed in line with the premises in Buendía, Montero & Faber (2014). As such, first, the verb 'burst' was retrieved from the corpus with the term extractor, TermoStat[2], (Drouin 2003). Then, the verb 'burst' was classified in lexical domains by studying its activation in texts as reflected in concordances. More specifically, both arguments and predicates were identified and analysed. As such, we annotated each argument with what we have referred to as *semantic category*.

Semantic categories are generalizations for a set of terms that are assumed to share a similar semantic and syntactic behaviour. In this sense, arguments belonging to a semantic category not only have a common nuclear meaning but also similar syntactic projections (Buendía, Montero & Faber 2014: 75). It is important to mention that only arguments that correspond to terms or nouns/ noun phrases and which therefore are realized as subj obj in the sentence have been assigned a semantic category. Arguments that indicate PATH, LOCATION, TIME, etc. and which are optional have not been assigned any semantic category.

The semantic categories identified for the specialized field of natural disasters were the following: NATURAL DISASTER, ATMOSPHERIC AGENT, WATER AGENT, ATMOSPHERIC CONDITION, MATERIAL ENTITY, AREA, CONSTRUCTION, ENERGY, HUMAN BEING, LANDFORM, WATER COURSE, DEATH, DAMAGE, LOSS OF LIFE/PROPERTY, PLANT, and EXPLOSIVE (Buendía, Montero & Faber 2014: 75). As shall be seen in Table 1, those arguments that are obligatory in the construction appear in bold, i.e. lexically profiled roles using Golberg's terminology (Goldberg 2006: 39). Those that are optional and not necessary for the understanding of the construction come up in normal font. Subsequently, the semantic roles were assigned. As previously mentioned, the set of semantic roles in our study largely coincides with the most general thematic relations provided by Role and Reference Grammar (Van Valin & LaPolla 1997). The inventory used was the following: AGENT, NATURAL FORCE, DESTINATION, EXPERIENCER, FREQUENCY, GEOGRAPHICAL LOCATION, MANNER, PATH, PATIENT, SITUATION/ EXPERIENCE, ORIGIN, THEME, TIME, and RESULT.

3.1 The example of the verb 'burst' in the context of natural disasters

Our study shows that a verb can activate different meaning dimensions in different lexical domains, depending on the semantic categories, or different roles (Van Valin 2005) of its arguments. For example, 'burst' can have three senses within the context of natural disaster: (i) 'burst1', to move

[2] http://termostat.ling.umontreal.ca/ [07/02/2016].

forcefully (especially of wind events), within the lexical domain of MOVEMENT; (ii) 'burst2', to begin to exist (especially of volcanic events), within EXISTENCE; (iii) 'burst3', to cause to come apart, (especially of construction entities) within ACTION.
In the first sense, 'burst1' takes a first argument designating a NATURAL DISASTER restricted to wind events, and a second argument designating PATH (e.g. 'the hurricane burst through the city's levees'). In the second sense, 'burst2' takes a first argument designating a NATURAL DISASTER restricted to volcanic events, and optional arguments designating GEOGRAPHICAL LOCATION, TIME or MANNER (e.g. 'the volcano burst out fiercely in the Isle of Palma'). In the third sense, 'burst3' takes a first argument designating a construction entity with the role of PATIENT and a second optional argument with the role of SITUATION/EXPERIENCE (e.g. 'the dam burst in torrential rain'). When the construction is causative, the first argument is a NATURAL DISASTER usually associated with wind events with the role of NATURAL FORCE, whereas the second argument is a PATIENT which designates a CONSTRUCTION ARTEFACT (e.g. 'the typhoon burst a dike in Kaohsiung'). As such, the dictionary entry for 'burst' would be the following (Table 1):

MOVEMENT			
Lexical subdomain: to move forcefully (especially of wind events)			
Semantic role	THEME	*burst*	PATH
Semantic category	NATURAL DISASTER *(wind events)*		
'The hurricane burst through the city's levees'			
EXISTENCE			
Lexical subdomain: to begin to exist (especially of volcanic events)			
Semantic role	THEME	*burst*	LOCATION, TIME, MANNER
Semantic category	NATURAL DISASTER *(volcanic events)*		
'The volcano burst out fiercely in the Isle of Palma'			
ACTION			
Lexical subdomain: to come apart (of construction artefacts)			
Semantic role	PATIENT	*burst*	SITUATION/EXPERIENCE
Semantic category	CONSTRUCTION ARTEFACT		
'The dam burst in torrential rain'			
ACTION			
Lexical subdomain: to cause to come apart (of construction artefacts)			
Semantic role	NATURAL FORCE	*burst*	PATIENT
Semantic category	NATURAL DISASTER *(wind events)*		CONSTRUCTION ARTEFACT
'The typhoon burst a dike in Kaohsiung'			

Table 1: Verb entry proposal for 'burst'.

4 Conclusion

The description and analysis of verbs in terminology has still not been adequately addressed when paradoxically verbs are the most important lexical and syntactic category of language (Fellbaum 1990: 278). There are still few terminographic resources which account for verb entries and those who do include verb information within their lemmas sometimes lack of systematicity. As such, terminographers, linguists, or anyone who consults a specialized dictionary in search of verb disambiguation in case of polysemous verbs rarely finds the answer to their questions since the resource far from dispelling their doubts, raises more.

This paper offers a way to describe and represent verb entries in specialized resources which will help to handle polysemy. As shown, the description takes into account verb argument structure. It is our assertion that both verbs and the constructions in which they are inserted convey meaning. As such, our verb entry proposal for verb disambiguation takes into account the lexical domain activated by the verb (Faber & Mairal 1999), and the semantic roles and semantic categories activated by the arguments. Our analysis has been applied to the specialized domain of the environment, but its premises could be extended to any other domain. This way of representing verb entries proves to be helpful when it has to do with a verb with several senses.

5 References

Baker, C.F. & Ruppenhofer, J. (2002). FrameNet's Frames Vs. Levin's Verb Classes. In *Proceedings of the 28th Annual Meeting of the Berkeley Linguistics Society*. Berkeley, California: UC Linguistics Department, pp. 27-38.

Buendía Castro, M., S. Montero Martínez & P. Faber (2014). Verb collocations and phraseology in EcoLexicon. In K. Kuiper (ed.) *Yearbook of Phraseology.* Berlin: De Gruyter Mouton, pp. 57-94.

Carter, R. (1988). Compositionality and Polysemy. In B. Levin & C. Tenny (eds.) *On Linking: Papers by Richard Carter.* Cambridge: Center for Cognitive Science, MIT, pp. 167-204.

Chomsky, N. (1957). *Syntactic Structures*. The Hague: Janua Linguarum 4.

Croft, W. (2001). *Radical Constructional Grammar. Syntactic Theory in Typological Perspective*. Oxford: Oxford University Press.

Drouin, P. (2003). Term Extraction Using Non-technical Corpora as a Point of Leverage. In *Terminology* 9(1), pp. 99–117.

Faber, P. & Buendía Castro, M. (2014) EcoLexicon. In A. Abel, C. Vettori & N. Ralli (eds.) *Proceedings of the XVI EURALEX International Congress*. Bolzano: EURALEX, pp. 601-607.

Faber, P. & Mairal, R. (1999). *Constructing a Lexicon of English Verbs*. Berlin/New York: Mouton de Gruyter.

Fellbaum, C. (2006). WordNet and Wordnets. In K. Brown et al. (eds.) *Encyclopedia of Language and Linguistics*. Oxford: Elsevier, pp. 665-670.

Fellbaum, C. (1990). English Verbs as a Semantic Net. In *International Journal of Lexicography* 3(4), pp. 279-301.

Fernández, A. & Vázquez, G. (2012). Análisis Cuantitativo Del Corpus SenSem. In I. Elorza, O. Carbonell, R. Albarrán, B. García & M. Pérez (eds.) *Empiricism and Analytical Tools for 21st Century Applied Linguistics*. Salamanca: Ediciones de la Universidad de Salamanca, pp. 157-170.

Fillmore, C.J. (1977). Scenes and Frame Semantics. In A. Zampolli (ed.) *Linguistic Structures Processing*. Amsterdam: North Holland Publishing Company, pp. 55-83.

Fillmore, C.J. (1982). Frame Semantics. In The Linguistic Society of Korea (ed.) *Linguistics in the Morning Calm*. Seoul: Hanshin, pp. 111–137.

Fillmore, C.J.. (1985). Frames and the Semantics of Understanding. In *Quaderni Di Semantica* 6, pp. 222-254.

Fillmore, C.J. & Atkins, B.T.S. (1992). Toward a Frame-based Lexicon: The Semantics of RISK and its Neighbors. In A. Lehrer & E. Kittay (eds.) *Frames, Fields and Contrasts: New Essays in Semantic and Lexical Organization*. Hillsdale: Erlbaum, pp. 75-102.

Fillmore, C.J. & Kay, P. (1993). *Construction Grammar. Unpublished Manuscript*. Berkeley: University of California.

Goldberg, A. (1995). *Constructions. A Construction Grammar Approach to Argument Structure*. Chicago: University of Chicago Press.

Goldberg, A. (2006). *Constructions at Work: The Nature of Generalization in Language*. Oxford: Oxford University Press.

Gross, M. (1975). *Méthodes En Syntaxe*. Paris: Hermann.

Harris, Z. (1968). *Mathematical Structures of Language*. New York: John Wiley and Son.

Harris, Z. (1970). *Papers in Structural and Transformational Linguistics*. Dordrecht: D. Reidel.

Jiménez, R. (2008). Los Metalenguajes y Las Representaciones Léxico-semánticas: Una Propuesta Desde El Modelo Léxico-Construccional. In A. Moreno (ed.) *Actas Del VIII Congreso De Lingüística General*. Madrid: Universidad Autónoma de Madrid. Accessed at: http://www.lllf.uam.es/clg8/actas/pdf/paperCLG58.pdf [15/01/2016].

Kipper, K. (2005). VerbNet: a Broad-coverage, Comprehensive Verb Lexicon. Ph.D Thesis. University of Pennsylvania. Accessed at: http://verbs.colorado. edu/~kipper/Papers/ dissertation.pdf [24/05/2015].

Langacker, R.W. (1987). *Foundations of Cognitive Grammar: Theoretical Prerequisits*. Vol.1. Stanford: Stanford University Press.

Langacker, R.W. (1991). *Foundations of Cognitive Grammar: Descriptive Application*. Vol. 2. Stanford: Stanford University Press.

Levin, B. (1993). *English Verb Class and Alternations: A Preliminary Investigation*. Chicago: University of Chicago Press.

Levin, B. & Rappaport Hovav, M. (1995). *Unaccusativity: At the Syntax-Lexical Semantics Interface*. Cambridge: MIT Press.

Martín-Mingorance, L. (1998). *El Modelo Lexemático-funcional: El Legado Lingüístico De Leocadio Martín Mingorance. (The Functional Lexematic Model: The Linguistic Legacy of Leocadio Martín Mingorance).* Ed. Amalia Marín Rubiales. Granada: University of Granada.

Palmer, M., Gildea, D. & Kingsbury P. (2005). The Proposition Bank: An Annotated Corpus of Semantic Roles. In Computational Linguistics 31(1), pp. 71-105.

Rappaport Hovav, M. & Levin, B. (1998). Building Verb Meaning. In M.Butt & W. Geuder (eds.) *The Projection of Arguments. Lexical and Compositional Factors*. California: CSLI Publications Stanford, pp. 96–124.

Ruiz de Mendoza, F.J. & Mairal, R. (2008). Levels of Description and Constraining Factors in Meaning Construction: An Introduction to the Lexical Constructional Model. In *Folia Lingüística* 42(2), pp. 355-400.

Sánchez Cárdenas, B. & Buendía Castro, M. (2012) Inclusion of Verbal Syntagmatic Patterns in Specialized Dictionaries: The Case of EcoLexicon. In R. Vatvedt Fjeld & J. Matilde Torjusen (eds) *Proceedings of the 15th EURALEX International Congress*. Oslo: EURALEX, pp. 554-562.

Subirats, C. (2001). *Introducción a La Sintaxis Léxica Del Español*. Madrid: Vervuert.

Vaamonde, G., González, F. & García, J.Mª. (2010). ADESSE. A Database with Syntactic and Semantic Annotation of a Corpus of Spanish. In N. Calzolari, K.Choukr, T. Declerc, M.U. Doğan, B. Maegaard, J. Mariani, J. Odijk & S. Piperidis (eds.) *Proceedings of the Eight International Conference on Language Resources and Evaluation (LREC'12)*, Istanbul (Turkey), pp. 1903-1910.

Van Valin, R.D.Jr. (2005). *The Syntax-semantics-pragmatics Interface: An Introduction to Role and Reference Grammar.* Cambridge: Cambridge University Press.

Van Valin, R.D.Jr. & LaPolla R. (1997). *Syntax: Structure, Meaning and Function*. Cambridge:

Cambridge University Press.

Acknowledgements

This research was carried out within the framework of project FF2014-52740-P, Cognitive and Neurological Bases for Terminology-enhanced Translation (CONTENT) funded by the Spanish Ministry of Economy and Competitiveness.