

Understanding Meaning and Knowledge Representation

Understanding Meaning and Knowledge Representation:

*From Theoretical and
Cognitive Linguistics to Natural
Language Processing*

Edited by

Carlos Periñán-Pascual
and Eva M. Mestre-Mestre

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TABLE OF CONTENTS

Index of Tables	xiii
Index of Figures	xvii
Introduction.....	xxi

Part One: Meaning and Knowledge Representation

Chapter One	3
Causal Relata and Event Chains in the Concepts Transfer, Let/Allow and Permission in Modern Irish	
Brian Nolan	
1. Introduction	3
2. Transfer Constructions	5
3. GIVE_PERMISSION Constructions.....	7
4. GET_PERMISSION to Achieve a Particular PURPOSE	12
5. LET_ALLOW Constructions.....	13
6. PERMIT Constructions	16
7. Discussion	17
8. References	21
Chapter Two	25
Causative <i>Lassen</i> Constructions in German: Syntax, Argument Structure, Meaning Variants and the Impact of Cultural Knowledge in Disambiguation	
Elke Diedrichsen	
1. Introduction	25
2. Other Construction Types with <i>Lassen</i> in German	26
2.1. Collocations with <i>Lassen</i>	26
2.2. <i>Lassen</i> in Middle Constructions (Fagan 1992).....	27
2.3. Full Verb Uses of <i>Lassen</i>	27
2.4. Adhortative Constructions.....	27
3. Syntax and Semantics.....	27
3.1. The Argument Structure of the <i>Lassen</i> Construction	27
3.2. The Syntax of the <i>Lassen</i> Construction.....	29

3.3. Meaning Variants and Disambiguation by Cultural Knowledge.....	32
3.4. A Scale of Causativity for the German <i>Lassen</i> Construction ..	38
4. Summary and Conclusion	44
5. References	46
Chapter Three	49
Towards the Meaning and Realization of Māori Neuter Verbs	
Aoife Finn	
1. Introduction	49
2. A Brief Introduction to Māori	49
2.1. Transitive Verbs	50
2.2. Neuter Verbs in Māori.....	52
3. Aktionsart Classes in Role and Reference Grammar	56
3.1. Aktionsart Classes and Their Features	57
3.2. Testing for Aktionsart Classes	61
4. Neuter verbs, Transitive verbs and Aktionsart tests in Role and Reference Grammar.....	69
4.1. Neuter verbs, Transitive verbs and Test 1 – Progressive aspect.....	69
4.2. Neuter verbs, Transitive verbs and Test 2 – Dynamic adverbs and Test 3 – Pace adverbs	73
4.3. Neuter verbs, Transitive verbs and Test 4 – Duration adposition	75
4.4. Neuter verbs, Transitive verbs and Test 5 – Completion adposition	76
4.5. Neuter verbs, Transitive verbs and Test 6 – Stative Modifier.....	77
4.6. Neuter verbs, Transitive verbs and Test 7 – Causative Paraphrase.....	78
5. Conclusion.....	79
6. List of Abbreviations.....	79
7. References	80
Chapter Four	83
Creation of the Substantive Core of the Polysemantic Verb of Partial Relations “part->whole”	
Svetlana Kiseleva and Nelly Trofimova	
1. Preliminaries	83
2. Prototype Theory: The Underlining Theory for Prototype Structures.....	84

3. The Substantive Core of a Word	88
4. The Invariant as a Meaningful Core of a Polysemantic Word	91
5. The Definition of the Meaningful Kernel of the Partitive Verb “to compose”	98
6. Conclusions	103
7. List of References	104
8. Sources and Authorized Abbreviations	107
 Chapter Five	 109
A Polysemy Account of Turkish Spatial Noun ‘Üst’ in Dative Case Marker	
Aysun Balkan	
1. Introduction	109
2. Literature Review	110
3. Objective of Study	114
4. Research Hypothesis and Questions	115
4.1. Typological Sketch of Turkish	115
5. Methodology	119
6. Data	119
7. Analysis	119
8. Results	121
9. Discussion	159
10. Conclusion	161
11. Bibliography	161
 Chapter Six	 165
Interpretation of Coreferential Chains in Czech	
Alena Poncarová	
1. Introduction	165
2. Theoretical Background	166
2.1. Information Structure in Czech	166
2.2. Sentence Structure in Czech	168
2.3. Coreference in Czech	169
2.4. Centering Theory	169
3. Survey Design	172
3.1. Tested Hypotheses	172
3.2. Testing Conditions	173
3.3. Prague Dependency Treebank	173
3.4. Questionnaire	176
3.5. Results	186
4. Conclusion	189

5. List of Abbreviations.....	190
5.1. Text	189
5.2. Notation.....	190
6. References	191
Chapter Seven.....	193
A Hypothesis about the Origin of Meta-Symbols and Superordinate Categorization	
Ciro Antunes de Medeiros	
1. Introduction	193
2. Superordinate Categorization and Human Language	195
3. Language before Syntax and Basic-Level Categorization.....	197
4. The Hypothesis.....	199
5. Discussion: Targeting possible Future Experiments	204
6. References	205
Chapter Eight.....	209
An Iconic and a Systematic Feature of “Irregular” Forms in English	
Elena Even-Simkin	
1. Introduction	209
2. “Irregular” versus “Regular” Forms.....	211
3. The Nominal IVA System in Old and Modern English	213
4. The IVA Past Tense System in Old and Modern English	216
5. Five “Weak” Verbs as a Further Evidence of the Phonological System of the IVA.....	222
6. Discussion and Conclusions.....	225
7. References	228
Part Two: Theoretical Linguistics and NLP	
Chapter Nine.....	235
What can Theoretical Linguistics do for Natural Language Processing Research?	
Brian Nolan	
1. Introduction	235
2. What do Contemporary Linguists use in their Work?	238
3. The Role of Theoretical Adequacy in our Models and Linguistic Realism.....	240
4. Convergence.....	241
5. The Next Generation of Linguistically Motivated Language Software.....	242

6. Conclusions	243
7. References	247
Chapter Ten	249
Does NLP need Theoretical Linguistics?	
Elke Diedrichsen	
1. Introduction	249
2. Personal Devices	250
3. NLP for Research and Industry	253
4. Summary and Outlook	255
5. References	256
 Part Three: A Linguistically Aware and Cognitively Plausible NLP Project	
Chapter Eleven	261
A Hybrid Evaluation Procedure for Automatic Term Extraction	
Carlos Perinián-Pascual and Eva M. Mestre-Mestre	
1. Introduction	261
2. SRC: A Metric for Term Extraction	263
2.1. Termhood in SRC: Saliency	264
2.2. Termhood in SRC: Relevance	265
2.3. Unithood in SRC: Cohesion	266
3. Dictionaries and Thesauri as Reference Lists	267
4. Evaluation Procedure	268
4.1. Experiment	268
4.2. Results	271
4.3. Discussion of results	273
5. Conclusions	278
6. Acknowledgement	279
7. References	279
Chapter Twelve	283
Developing Parsing Rules within ARTEMIS: The Case of DO Auxiliary insertion	
Ana Díaz Galán and María del Carmen Fumero Pérez	
1. Introduction	283
2. ARTEMIS, FunGramKB and RRG	284
3. Formal Description of DO Operator	287
4. DO Operator in RRG	291
5. DO Operator in ARTEMIS	295

5.1. AVMs and Lexical Rules	296
5.2. Syntactic Rules	300
6. Conclusion	302
7. References	302
Chapter Thirteen	305
Coreference Resolution with FunGramKB	
María José Ruiz Frutos	
1. Coreference Resolution	306
2. Corpus and Methodology	306
3. FunGramKB for Coreference Resolution	307
3.1. Linguistic Information	307
3.2. Conceptual Knowledge	308
3.3. Extending Semantic Knowledge	312
4. Conclusions	313
5. References	314
Chapter Fourteen	319
The Integration of the Concept +CRIME_00 in FunGramKB and the Conceptualization or Hierarchization Problems Involved	
Ángela Alameda Hernández and Ángel Felices Lago	
1. Introduction	319
2. Theoretical Background of the Functional Grammar Knowledge Base (FunGramKB) and the <i>Globalcrimeterm</i> Subontology	320
3. The Concept +CRIME_00: Conceptualization and Hierarchization	326
4. The Case of +CUCKOO_SMURFING_00	332
5. Conclusions	336
6. References	337
Chapter Fifteen	341
Assisting the Process of Building a Satellite Ontology of Mental Disorders in FunGramKB using a Latent Semantic Analysis-based Tool	
Ismael Iván Teomiro García and María Beatriz Pérez Cabello de Alba	
1. Introduction	341
2. Creating a Subontology in FunGramKB	342
3. Creating a Subontology of Mental Disorders in FunGramKB	346
4. Latent Semantic Analysis	347
5. A Proposal for the Creation of a Subontology of Mental Disorders	349
5.1. Procedure	349

5.2. Knowledge Modelling	351
6. Conclusion and Future Lines of Research	360
7. References	361
Biodata	363

INDEX OF TABLES

Causal relata and event chains in the concepts transfer, let/allow and permission in Modern Irish	3
Causative <i>lassen</i> constructions in German: Syntax, argument structure, meaning variants and the impact of cultural knowledge in disambiguation	25
Towards the meaning and realization of Māori neuter verbs	49
Table 1. Typical transitive verbs	51
Table 2. Typical mutu verbs	54
Table 3. Typical ora verbs	55
Table 4. Typical haere verbs	56
Table 5. Aktionsart classes and English examples	57
Table 6. Basic Aktionsart classes and their features	61
Table 7. Expected results of each Aktionsart test	68
Table 8. The progressive particles	71
Creation of the substantive core of the polysemantic verb of partial relations “part->whole”	83
A Polysemy Account of Turkish Spatial Noun ‘Üst’ in Dative Case Marker	109
Table 1. Turkish Nominal Case Markers	116
Table 2. Grammaticalized Spatial Systems of Turkish and English	118
Table 3. Frequency Percentages of the Protoscene and Distinct Senses for ‘Üst + DAT’	125
Interpretation of coreferential chains in Czech	165
Table 1. Thematic progressions	167
Table 2. Subject vs. Object	169
Table 3. Types of Transitions	170
Table 4. PDT results – information structure	175
Table 5. PDT results – constituent structure	175
Table 6. Variants of contexts	180
Table 7. Pre-testing results	181
Table 8. Questionnaire results – information structure	187

Table 9. Questionnaire results – information structure hypotheses ...	188
Table 10. Questionnaire results – constituent structure	188
Table 11. Questionnaire results – constituent structure hypotheses...	189
A hypothesis about the origin of meta-symbols and superordinate categorization.....	193
An iconic and a systematic feature of “irregular” forms in English.....	209
Table 1. Phonological Fronting Process of IVA	215
Table 2. Seven Classes of “Strong” Verbs in OE	216
Table 3. The IVA Systems of the OE “Strong” Verbs	218
Table 4. Backing Process of IVA.....	220
Table 5. Backing Process of the IVA in the Originally “Weak” and/or “Strong” Verbs with the Additional Marker of Past Tense	222
Table 6. Backing Process in Modal Forms	226
What can theoretical linguistics do for natural language processing research?	235
Table 1. Industry-specific challenges and needs for language-aware technologies	244
Does NLP need theoretical linguistics?	249
A hybrid evaluation procedure for automatic term extraction	261
Table 1. Composition of the corpus.	268
Table 2. Relational tables for IATE data.	270
Table 3. Relational tables for DEXTER ngrams	270
Table 4. Precision in the Type-A evaluation of unigrams.....	271
Table 5. Precision in the Type-B evaluation of unigrams.....	271
Table 6. Precision in the Type-A evaluation of bigrams.....	272
Table 7. Precision in the Type-B evaluation of bigrams.....	272
Table 8. Precision in the Type-A evaluation of trigrams.	272
Table 9. Precision in the Type-B evaluation of trigrams.	272
Table 10. Precision increase after type-B evaluation	273
Table 11. A sample of bigrams: C-value and position in the candidates list.	278
Table 12. A sample of bigrams: C score and position in the candidates list.	278

Developing parsing rules within ARTEMIS: the case of DO auxiliary insertion	283
Table 1. Patterns of DO operator insertion in simple sentences according to formal grammars	291
Coreference resolution with FunGramKB	305
The integration of the concept +CRIME_00 in FunGramKB and the conceptualization or hierarchization problems involved.	319
Assisting the process of building a satellite ontology of mental disorders in FunGramKB using a Latent Semantic Analysis-based tool.....	341
Table 1. List of semantic neighbours of “trastornos mentales”	350
Table 2. List of semantic neighbours of “enfermedad”	353
Table 3. List of semantic neighbours of “enfermedades”	353
Table 4. List of semantic neighbours of “síntoma”	356
Table 5. List of semantic neighbours of “síntomas”	356
Table 6. List of semantic neighbours of “trastorno”	358
Table 7. List of semantic neighbours of “trastorno mental”	359

INDEX OF FIGURES

Causal relata and event chains in the concepts transfer, let/allow and permission in Modern Irish	3
Causative <i>lassen</i> constructions in German: Syntax, argument structure, meaning variants and the impact of cultural knowledge in disambiguation	25
Figure 1. Scale of causativity with causative <i>lassen</i> constructions in German.....	39
Figure 2. Causative construction with inanimate causee/causer	41
Figure 3. Constructional Schema for the German causative <i>lassen</i> construction	42
Towards the meaning and realization of Māori neuter verbs	49
Creation of the substantive core of the polysemantic verb of partial relations “part->whole”	83
A Polysemy Account of Turkish Spatial Noun ‘Üst’ in Dative Case Marker.....	109
Figure 1. I put the book on top of / onto the table.....	117
Figure 2. The book is on / on top of the table	117
Figure 3. I took the book from top of the table.....	117
Figure 4. Protoscene of Turkish Spatial Noun ‘üst’	122
Figure 5. PROTO-Goal Sense of Turkish ‘üst + DATIVE’	123
Figure 6. (S)he put his/her hands on top of / onto the table.	124
Figure 7. The Semantic Network of ‘üst + Dat’ within the Principled Polysemy’ Model	126
Figure 8. Up Cluster.....	127
Figure 9. Additive Sense.....	129
Figure 10. Successive Sense	130
Figure 11. Base Sense	131
Figure 12. Superior Sense	132
Figure 13. Control Sense.....	133
Figure 14. Responsible Sense	135
Figure 15. Preference Sense.....	136
Figure 16. Forward Cluster	136

Figure 17. Intrusive Sense.....	138
Figure 18. Target Sense	139
Figure 19. Above-and-Beyond Sense	141
Figure 20. Transfer Sense	142
Figure 21. Persistent Sense	144
Figure 22. Surface Cluster	144
Figure 23. Figure Sense	147
Figure 24. Top Sense	148
Figure 25. Outfit Sense	150
Figure 26. Focus-of-Attention Sense	152
Figure 27. Emphasis Sense	153
Figure 28. Covering Sense.....	154
Figure 29. Revealing Sense.....	156
Figure 30. Psychological State Sense.....	157
Figure 31. Background Sense	158
Figure 32. Reflexive Sense	159
Interpretation of coreferential chains in Czech.....	165
A hypothesis about the origin of meta-symbols and superordinate categorization.....	193
An iconic and a systematic feature of “irregular” forms in English.....	209
Figure 1. The Ratio of +Backing versus –Backing Modern English IVA Verbal Forms.....	226
What can theoretical linguistics do for natural language processing research?.....	235
Figure 1. The scope of linguistically motivated Human Language Technology.....	243
Does NLP need theoretical linguistics?	249
A hybrid evaluation procedure for automatic term extraction	261
Developing parsing rules within ARTEMIS: the case of DO auxiliary insertion	283
Figure 1. Enhanced model of LSC (unrefined tree)	285
Figure 2. Instance of AUX in a syntactic RRG template	292
Figure 3. Example of DO auxiliary in an RRG syntactic template	292
Figure 4. Layered structure of the clause with operator projection....	293

Figure 5. DO insertion and RRG levels	295
Figure 6. Example of reorganization of ARTEMIS AUX category...	299
Figure 7. ARTEMIS editor	299
Coreference resolution with FunGramKB	305
The integration of the concept +CRIME_00 in FunGramKB and the conceptualization or hierarchization problems involved.	319
Figure 1. FunGramKB modules.....	322
Figure 2. Corpus database.....	324
Figure 3. Main menu of FunGramKB Term Extractor	325
Figure 4. Representation of the concept +CRIME_00 in the FunGramKB editor.....	328
Assisting the process of building a satellite ontology of mental disorders in FunGramKB using a Latent Semantic Analysis-based tool.....	341
Figure 1. FunGramKB modules (Periñán-Pascual and Arcas-Túnez, 2011: 3).	343

INTRODUCTION

The purpose of the book is to examine and discuss recent work in meaning and knowledge representation within theoretical linguistics and cognitive linguistics, particularly that research which can be reused to model natural language processing (NLP) applications. Today there is a need to develop NLP systems from a linguistically aware approach. Although there are many NLP applications that can work without taking into account any linguistic theory, this type of systems can only be described as “deceptively intelligent”. On the other hand, those computer programs requiring some language comprehension capability should be grounded in a robust linguistic model if we want them to display the expected behaviour. Therefore, this book is concerned with the in-depth study not only of the multiple dimensions of language, e.g. morphology, syntax, semantics, pragmatics, concept formation, lexicon, and many others, but also of the interfaces between the components of the architecture of the language system and the processes underlying language comprehension and production under varying circumstances and situations. The new insights from this type of research can undoubtedly help model more robust NLP systems. This book is divided into three thematic parts.

From functionalist and/or cognitivist approaches, PART 1 deals with various theoretical linguistic issues that have the potential to enhance NLP systems. For example, Role and Reference Grammar (Van Valin 2005) plays an important role in the first three chapters of the book. In chapter one, Brian Nolan explores the causal relations underpinning the concepts of transfer, let/allow and permission and their argument realization in Modern Irish (Nolan 2012, 2013). In this regard, he examines a number of syntactic construction patterns associated with the argument realization, considering factors such as control and volition (Dixon 2010) in causal event chaining. In chapter two, Elke Diedrichsen describes the *lassen* (‘let’) construction in German, whose semantics can vary within a spectrum of meanings involving direct causation, permission and non-intervention. The syntax and semantics of the construction are discussed extensively, being represented in a Constructional Schema that displays its features. In chapter three, Aoife Finn studies if the meaning of transitive verbs in Māori is actually the same as that of neuter verbs, as proposed in

traditional grammars (Harlow 2007). It seems that, although neuter verbs and transitive verbs have similar meanings, the syntactic realization of these two types of verbs is quite different. Given their different syntactic realizations, this chapter preliminarily considers the logical structure of neuter verbs via Aktionsart tests. Thus, the findings in chapters one, two and three may be very valuable, for example, for machine translation in general and for word sense disambiguation in particular. On the other hand, and from the cognitive realm, the analysis of lexical polysemy has a special treatment in the next two chapters. In chapter four, Svetlana Kiseleva and Nelly Trofimova examine the mechanisms of meaning extension in the polysemous English verbs of part-whole relation. Their theory is based on the idea that the meaning of any word can be explained by means of an exact paraphrase composed of simpler, more intelligible lexical components than the original (Wierzbicka 1972). Thus, their main statement is that every complex word has a substantial core, being the essential basis that provides its semantic integrity. In chapter five, Aysun Balkan analyses the applicability of the Principled Polysemy model (Tyler and Evans 2003) to the Turkish *üst* construction ('on' and 'over') including spatial nouns suffixed with dative case marker. Despite the fact that Turkish and English are typologically distinct languages and express spatial relations using very different linguistic elements, the current study shows a surprising amount of overlap with the primary and extended senses found in the polysemy networks of 'üst + Dative' and English 'over'. Again, a treatment of polysemy such as the ones proposed in these two chapters can help machines solve lexical ambiguity. Likewise, chapter six can be very relevant for anaphora resolution, where Alana Poncarová presents various methods of reconstructing the meaning of co-referential chains in Czech from the perspective of Centering Theory (Brennan, Friedman and Pollard 1987; Grosz, Joshi and Weinstein 1995). Her research shows that the information structure (Topic-Focus articulation) and the constituent structure (Subject-Object function) are key factors in this process. Moreover, in chapter seven, Ciro Antunes de Medeiros describes the human ability to produce superordinate categories in the context of the relationship between conceptual organization and lexical acquisition, a cognitive modelling topic which can be of interest to researchers in ontology development. Finally, in chapter eight, Elena Even-Simkin describes an iconic phono-morphological analysis of the internal-vowel-alternation phenomenon in plural nouns and past tense forms in English based on the theory of Phonology as Human Behavior (Diver 1979; Tobin 2009). The findings presented in this chapter may have

implications in the field of Web search engines or in human-robot interaction.

PART 2 consists of two chapters that intend to demonstrate the reader about the need for NLP research groups to have linguists collaborating with computer engineers. To a layman, this could be a non-issue, since at first sight computational linguistics is deemed as a sub-discipline of applied linguistics. However, theoretical linguistics has usually played a remarkably minor role in this field of research. Indeed, Wilks (2005) noted that the links between NLP and linguistics have not been either so numerous or so productive as we could imagine. Based on the authors' vast experience in this field, chapters nine and ten portray this situation from a contemporary view. In chapter nine, Brian Nolan examines the question 'What can theoretical linguistics do for NLP research?' from a number of perspectives, including linguistics, informatics and engineering. He explores the work practices and goals of contemporary linguists today and the tools they use in that work. This chapter also describes the contribution of linguistic theory (generative, constructional and functional) to linguistic realism to achieve descriptive, explanatory and computational adequacy while managing issues with linguistic and computational complexity. The functionality of many future NLP applications is not yet known; however, language-aware human cognitive technologies can point us in a very interesting direction. He concludes that the future is bright for linguists, especially those with some software skills, and that linguistic theory has a significant contribution to make to NLP. On the other hand, in chapter ten, Elke Diedrichsen supports the idea that NLP can benefit from scholars and researchers who work in theoretical linguistics, in particular functional models of grammar. The breadth of language-aware products available today is indicative of the way the IT industry is growing globally. We live in a multilingual world, and all these languages need to be properly characterized for the benefit of the customers of these products. The way to achieve this is to take on board the knowledge and insights provided by theoretical linguistics. The potential for 'next generation' IT products, arising from synergistic efforts of linguists, computer scientists and engineers working together, is huge. This chapter discusses some of the new language-aware products and applications that have recently emerged from leading IT companies.

PART 3 serves to illustrate how a linguistically aware and cognitively plausible approach to human-like processing through FunGramKB Suite can contribute to the development of enhanced knowledge engineering and NLP projects. FunGramKB Suite (Periñán-Pascual 2012, 2013) is a user-friendly environment for the semi-automatic construction of FunGramKB,

a lexical-conceptual knowledge base particularly designed for natural language understanding systems, and for the development of tools for the automatic processing of language (cf. Perrián-Pascual and Arcas-Túnez 2014b). In this regard, in chapter eleven, Carlos Perrián-Pascual and Eva M. Mestre- Mestre accurately describe a hybrid approach to the evaluation of automatic term extraction systems, which have been traditionally evaluated by means of one of two methods, i.e. gold-standard reference lists or validation based on experts' judgements (Pazienza, Pennacchiotti and Zanzotto 2005). In particular, these authors explore the way that the IATE thesaurus together with a specialized dictionary can be semi-automatically integrated with the human validation of term candidates. The experiment was performed with DEXTER, an open-access platform for data mining and terminology management that can export specialized terms to FunGramKB. In chapter twelve, Ana Díaz Galán and María del Carmen Fumero Pérez contribute to ARTEMIS, a grammar development environment that outputs the parse tree of a text based on the Layered Structure of the Clause in Role and Reference Grammar. In particular, they study the grammatical phenomenon of the insertion of the DO operator in simple sentences in English. In chapter thirteen, María José Ruiz Frutos explains how the semantic knowledge, common-sense knowledge and world knowledge in FunGramKB can help solve co-reference ambiguity. In chapter fourteen, Ángela Alameda Hernández and Ángel Felices Lago explore the design and development of specialized-knowledge ontologies in the FunGramKB framework. In particular, they describe the methodological problems encountered in the conceptualization of the superordinate concept CRIME and its configuration as an umbrella concept. Finally, the aim of chapter fifteen is to set the basis for the creation of a terminological satellite ontology of mental disorders within FunGramKB. In this work, María Beatriz Pérez Cabello de Alba and Ismael Iván Teomiro García follow Felices-Lago and Ureña Gómez-Moreno's (2012) methodological underpinnings for the construction of terminological subontologies in FunGramKB, as well as Perrián-Pascual and Arcas-Túnez's (2014a) methodology used in the design of a subontology on criminal law in FunGramKB. The authors employ a tool based on Latent Semantic Analysis (Landauer, Foltz and Laham 1998) in order to complete the phases of corpus compilation and term extraction. As can be noted in this third part of the book, linguists play a major role in those NLP systems which exploit FunGramKB as its knowledge base.

This monograph was conceived from the different perspectives of a full gamut of research projects concerned with language understanding

through the prism of theoretical linguistics, cognitive linguistics and computational linguistics. Therefore, the book will be of particular interest to scholars, researchers and postgraduate students who work in these fields of knowledge.

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PART ONE:

**MEANING AND KNOWLEDGE
REPRESENTATION**

CHAPTER ONE

CAUSAL RELATA AND EVENT CHAINS IN THE CONCEPTS TRANSFER, LET/ALLOW AND PERMISSION IN MODERN IRISH

BRIAN NOLAN

INSTITUTE OF TECHNOLOGY BLANCHARDSTOWN, DUBLIN

1. Introduction

We know that the analysis of the causative (Nolan 2012a: 33; Nolan 2015; Nolan, Rawoens and Diedrichsen 2015) intersects with semantics, syntax and morphology and, as such, the causative construction remains one of the primary research areas for many linguists. It has been generally recognised that there are three prototypical types of lexical, morphological and syntactic causative within any consideration of a causative taxonomy. However, as well as these types, a further distinction is made along semantic lines of inquiry between direct causation and indirect causation. That is, languages are known to make a distinction between direct and indirect causation through some language specific means. For example, in order to express direct causation, a language may use a causative construction in which a higher degree of fusion is seen in the expression of cause and effect. Correspondingly, indirect causation will exhibit a lower degree of fusion of cause and effect within the expression.

Many scholars, including Van Valin (2005:42; *n*5) and Song (1996: chapter 1), realise that treating all causatives as having the same ‘CAUSE’ element is a gross oversimplification of the complexities involved. There is essentially a contrast among three basic types of causality, including (i) Direct (Coercive), (ii) Indirect (Non-coercive), and (iii) Permissive. Both direct and indirect causality are represented by ‘CAUSE’, and permissive causality can, for example, be represented by ‘LET’ or ‘ALLOW’ in logical structures. We are concerned in this chapter with causative constructions and the concepts of TRANSFER, LET/ALLOW and PERMISSION within Modern Irish, as shown in (1).

(1) x CAUSES/PERMITS/LETS/ALLOWS y to DO/MAKE/HAVE z-something

In this analysis, we will be mindful of the typology of causation in the work of Dixon (2010: 62), where he proposes the nine semantic parameters in (2), described in Table 1.1, to characterize a typology of causation.

(2) State/action, transitivity, control, volition, affectedness, directness, intention, naturalness and involvement

An important set of considerations is also found in the work of Talmy (2000), where he proposes that the physical-force model maps straightforwardly to the psychological realm, since these same predicates are used to characterise psychosocial as well as physical causal relations. This proposal develops a central theme of cognitive linguistics according to which abstract conceptual content is derived from representations of physical reality. Gärdenfors (2007) similarly extends the Talmy perspective to characterise verbal concepts as patterns of forces:

Even though our cognition may not be built precisely for Newtonian mechanics, it appears that our brains have evolved the capacity for extracting the forces that lie behind different kinds of movements and action... In accordance with this, I submit that *the fundamental cognitive representation of an action consists of the pattern of forces that generates it*.

(Gärdenfors, 2007: 254)

We argue that the appropriate way to understand dynamic events is to consider them as forces: inputs of energy. Such inputs of energy may, or may not, have an effect on the state of affairs; this inherent defeasibility provides the tools necessary to naturally accommodate the problems of the concepts of TRANSFER, LET/ALLOW and PERMISSION. This accommodates Talmy's (2000) insight that component forces are referred to in the meanings of agonist-antagonist lexical items such as *enable*, *prevent*, and so on. The causing event corresponds to a force that is applied to a situation where the resulting stative predicate does not hold such that this force yields a situation where the resulting stative predicate does, or may, hold.