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Perspectives on Abstract Concepts

Cognition, language and communication

Edited by
Marianna Bolognesi
Gerard J. Steen

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There is no abstract art. You must always start with something.
Afterward you can remove all traces of reality. (Pablo Picasso)

Flying starts from the ground.
The more grounded you are, the higher you fly. (J. R. Rim)

Nature makes no leaps. (Leibniz)

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Acknowledgments

The present volume evolved from the symposium *Abstract Concepts: Debating structure, processing, and modeling of abstract concepts*, held in Amsterdam on November 18, 2016 (https://abstractconceptsnet.wordpress.com), organized by the editors of this volume. The symposium was the first international meeting exclusively focused on the structure, processing, and modeling of abstract concepts. The event was generously sponsored by EU Marie Curie Actions (Individual Fellowship awarded to Marianna Bolognesi, CogViM project, n° 629076), The Royal Dutch Academy of Arts and Sciences (KNAW), the Amsterdam Brain and Cognition group (ABC, UvA University Amsterdam, NL), and the Network Institute research center (NI, VU University Amsterdam, NL). We are very thankful to these organizations for supporting the realization of this event, from which this volume evolved.

For their help in organizing and running the symposium, we are indebted to the organizing committee, especially to Gudrun Reijnierse, Laura Aina and Jerrod Maddio. A special thank you goes to the keynote speakers who participated to the event, which are, in alphabetic order: Alessandro Lenci, Max Louwerse, Ken McRae, Diane Pecher, Friedemann Pulvermüller, Gun Semin, Gabriella Vigliocco, and Piek Vossen.

Finally, a frank note. The event that took place in Amsterdam in November 2016 was originally envisioned as a small-scale 1-day symposium, in which the invited speakers would come to Amsterdam to present and discuss with their peers the current views on the nature, structure, and processing of abstract concepts. However, as soon as we started distributing around the program and the invitation to participate, this envisioned small local audience soon became a large group of more than one hundred international delegates from European as well as extra-European countries, who enthusiastically contacted us, asking us to join the event, and take active part, by sharing their own research on this topic. Because the program for the day was already filled with the keynotes' lectures, we decided to set up a poster session, to display a selection of the best current works on abstract concepts carried out at various national and international institutions. This volume is based on a selection of these presentations.

We are grateful to the authors of this volume for their fervent and constructive attitude toward the original symposium and (most of them) toward this current editorial project. As a matter of fact, during the symposium the delegates exchanged academic views as well as methodological advices and contributed actively and constructively to shape the debate that took place during the symposium in the plenary room. After the event, the delegates contacted us to ask whether it was possible to collect all the poster files and create a book of poster presentations, in order to share with one another the research that was presented during the poster session. As editors, we moved beyond that idea, and proposed the authors to collect full papers based on those posters. During the preparation of the volume we received invaluable feedback and extremely detailed and constructive comments from an anonymous reviewer. We are truly grateful to this reviewer, as well as to the HCP series editors, for their collaboration and support. We are now proud to share this volume with the readers and hope to meet their expectations.

Marianna Bolognesi
Gerard J. Steen
Oxford and Amsterdam
November 2018

Introduction

Marianna Bolognesi and Gerard J. Steen

1. Background

Human language is the most powerful communication system that evolution has ever produced. Within this system, we often use words that designate things we can perceive through our senses, such as *cake*, *car*, and *kitten*. These words refer to entities that we can see, touch, smell, hear and taste (to different degrees). However, within the same system we can refer to entities that we cannot directly perceive through our senses, because they are, in different ways, more abstract. We can talk about human-born creations (using words such as *theory*, *debate*), social constructs (e.g., *community*, *organization*), ethical values (e.g., *respect*, *justice*), and internal states (e.g., *ambitiousness*, *enthusiasm*). Moreover, we can talk about concepts that are more general and inclusive than the individual instances that we can see and touch at once. To do so, we use words like *humans* (referring to the generic concept of humankind) or *researchers* (referring to the category of humans that master this profession). These words allow us to talk about categories of entities and are therefore more abstract than words referring to a specific individual within such category (e.g., *Michael*).

Our ability to use and understand abstract concepts remains one of the most intriguing faculties of human cognition. In cognitive science, psychology, and neuroscience the differences between abstract and concrete concepts are backed up by several empirical studies, showing that words designating concrete concepts are more easily processed than words designating abstract ones in a variety of tasks, including word recognition (e.g., Strain et al. 1995), memory tasks (Jefferies et al. 2006; Romani et al. 2008), comprehension tasks (Kounios and Holcomb 1994; Schwanenflugel and Shoben 1983), and production tasks (Goetz et al. 2007; Tyler et al. 2000; Wiemer-Hastings and Xu 2005). In language development, words referring to abstract concepts tend to appear later in children's vocabulary, compared to words that refer to concrete concepts (e.g., Vigliocco et al. 2017). Moreover, neuroscientific evidence shows that the two types of concepts can be specifically impaired in brain damaged patients, because their processing relies on

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overlapping but partly distinct neural systems (e.g., Binder et al. 2009; Hoffman 2016 for literature reviews).

This empirical evidence comes from the fields of cognitive science, psychology, and neuroscience. In linguistics, the difference between words referring to abstract and concrete concepts has also been addressed in a variety of studies. For example, computational linguistic studies show that 70% of the words that we use on a daily basis refer to abstract concepts (Recchia and Jones 2012); that verbs tend to be on average more abstract than nouns, when abstractness is defined in terms of low degrees of imageability (McDonough et al. 2012). Moreover, verbs tend to have a more complex relational structure than nouns, and therefore their meaning tends to rely to a larger extent on phrase structures and associated words, while the meaning of nouns tends to be defined more in terms of internal properties (e.g., Gentner 1982). Words that have a more complex relational structure tend also to be more abstract (e.g., Asmuth and Gentner 2017). It has also been suggested that it is easier to think of a context for words referring to concrete objects than for words referring to abstract ones (cf. Context Availability Hypothesis: Schwanenflugel and Shoben 1983). Schwanenflugel and Shoben found that concrete words are easier to process because in principle there are more available and pertinent linguistic contexts in which these words appear. Conversely, words designating abstract concepts are harder to process because it is more difficult to think about meaningful contexts in which such words can be used.

Starting from these preliminary results, extensive analyses based on large corpora of real language data were conducted in the past ten years, to investigate whether words referring to abstract concepts tend indeed to be less tightly related to a wider array of linguistic contexts, compared to words referring to concrete concepts (Andrews et al. 2009; Griffiths et al. 2007; Jones et al. 2012; Lund and Burgess 1996). These analyses were conducted by means of distributional semantics, a technique that uses lexical co-occurrence statistics to represent the relationships between words in terms of similarity in the contexts in which such words are used (e.g., Landauer and Dumais 1997). For example, Hoffmann and colleagues used distributional semantic methods to formally investigate the degree of contextual variability associated with abstract vs. concrete words (Hoffman et al. 2013). They found, surprisingly, that words designating abstract concepts tend to be used in a wider variety of different contexts than words designating concrete concepts. For example, the concrete word *spinach*, typically occurs in contexts related to cooking and eating, while the abstract word *life* tends to be used in a much wider variety of linguistic contexts. However, because abstract words tend to be used in a wider variety of linguistic contexts, the strength of the connection between abstract words and the linguistic contexts in which they are used is lower than the strength of the connection between concrete words and their related contexts of use. This may explain why it is more difficult to retrieve relevant contexts of use for abstract than for concrete words.

The wider theoretical debate in which the differences between abstract and concrete words are embedded relates to the nature of meaning, and the nature of the semantic representations underlying language processing (Bolognesi and Steen 2018a). This well-known debate sees, traditionally, the supporters of the grounded (and embodied) accounts of cognition on one side, and the supporters of symbolic accounts of cognition on the other side. The debate is extremely lively, and, as pointed out by Louwerse (2018), generated over 1,500 publications and well over 30,000 citations in the past few decades. The theoretical and empirical milestones achieved within this topic are summarized in two notable contributions, which address directly this topic: a collective volume that presents contributions from various fields of research, supporting the embodied vs. symbolic nature of language processing (edited by De Vega, Glenberg, Graessner 2008); and more recently a special issue of Psychonomic Bulletin and Review focused onto the nature of concepts (August 2016), edited by Bradford Mahon and Gregory Hickok. The structure and processing of abstract concepts constitutes a crucial point of discussion within this greater debate: if language processing is embodied and supposedly activates neural substrates usually dedicated to processing perceptual and motoric experience, what happens when we process words that do not have referents that can be perceived through our bodies? In this regard, a variety of proposals has been advanced by researchers in various fields, pointing out the role played by metaphor and metonymy, the role played by emotions, and the role played by instances of perceptual and communicative experiences in grounding abstract concepts (see Bolognesi and Steen 2018b for a review).

The reader might argue that these theoretical issues are presented in a strictly binary fashion: abstract concepts are opposed to concrete concepts, and embodied theories of meaning are opposed to symbolic theories of meaning. In fact, the more the scientific knowledge around these issues advances, the more the strictly binary distinctions are challenged. On the one hand, conceptual concreteness cannot be conceived as a strictly binary variable, because (1) different definitions of abstract and concrete concepts have been advanced, as was exemplified in the first paragraph of this introduction, and it is not clear yet what are the interconnections and correlations between these different definitions; (2) empirical studies in which concreteness scores are elicited from participants (based on different definitions of concreteness) show that the concreteness scores attributed to given words tend to cover all the points of the (Likert) scale, rather than being polarized on the two extremes (e.g., Brysbaert et al. 2014); this suggests that concreteness is a gradual, rather than a binary, property. On the other hand, the dichotomy between supporters of the grounded and embodied accounts of cognition and supporters of the symbolic and amodal accounts has been recently challenged by an increasing number of studies in which scholars suggest that language processing can be both, embodied and symbolic. The different type of processing would depend on the context in which the words are presented and the timeframe in which the processing is measured: first, a shallow, symbolic linguistic processing takes place, and then, given the correct configuration of a series of still debated parameters, a deep processing that involves embodied simulations would follow (e.g., Barsalou et al. 2008; Louwerse 2011; Dove 2016). These observations led to the emergence of a new generation of theoretical accounts, the so-called 'hybrid' accounts of cognition, in which grounded and symbolic accounts of cognition may complement one another in processes related to conceptual abstraction. Barsalou summarizes this perspective by stating:

> as researchers have become increasingly convinced that concepts are grounded, they have simultaneously become increasingly aware of how extensively abstraction is associated with conceptual processing. Indeed, abstraction appears to be a hallmark of human cognition and an important source of its computational power. Thus, a current challenge is explaining how grounding and abstraction emerge together. (Barsalou 2016: 1132)

In order to advance our scientific knowledge on abstract concepts, it is necessary to break through classic binary oppositions and focus on how and when the two types of processing take place, and how they affect the way we understand and represent abstract concepts. Given the tremendously complex nature of this topic, it is desirable to adopt a multidisciplinary set of methods, and to investigate these issues from a multilingual perspective, to gain insight into how words referring to abstract concepts function in different languages, given the fact that most of the work conducted in the past decades is biased toward the study of abstract words in the English language, and that research shows that different languages categorize experience in different ways (e.g., Winawer et al. 2007; Boroditsky 2001).

The chapters that constitute this collective volume work in these directions. The contributions in this volume vary in focus, methods, and languages addressed. Such variability is counterbalanced by the fact that all chapters address the same general questions:

1. On which dimensions of meaning do abstract concepts and concrete concepts differ?
2. How does perceptual experience affect abstract concept processing and representation?
3. What is the role of language in shaping and indexing the content of abstract versus concrete concepts?
4. How and in which contexts are abstract concepts understood through metaphor?

2. Contributions to the volume

The chapters address three general aspects related to abstract concepts, which relate to the way these concepts are processed and grounded in the mind, the way they are represented and structured in language, and the way they are used in natural communication settings. The book is therefore divided in three sections, each addressing one of the three dimensions of abstract concepts meaning.

The first section opens up with **Chapter 1**, in which Felix R. Dreyer and Friedemann Pulvermüller argue that the apparent lack of empirical evidence for a grounding of abstract words stems, at least in part, from an erroneous treatment of abstract words as one monolithic semantic category, rather than taking into account specific abstract word types and sub-categories. The authors review classical and recent empirical evidence from neuropsychological, neuroimaging and behavioral approaches, demonstrating the necessity to consider specific semantic meaning types when investigating a possible grounding of concrete and abstract concepts, for both theoretical and methodological reasons. They conclude that motor systems in semantic processing may play a role not only during the processing of concrete words, but also during the processing of some abstract 'mental' symbols, previously thought to be 'disembodied'.

In **Chapter 2**, Claudia Mazzuca and Anna Maria Borghi report and discuss the results of an experiment that seems to support the Words As social Tools (WAT) theory (Borghi and Cimatti 2009; Borghi and Binkofski 2014). This theory was proposed as an alternative view to explain the grounding of abstract concepts, since the role of the sensorimotor system seems to be unable to offer a comprehensive account. WAT suggests that abstract concepts are grounded in linguistic and social experience and, as a consequence, linguistically conveyed information plays a major role in the processing of abstract words. In the chapter the authors show that the simulation of abstract word meaning, compared to the simulation of concrete word meaning, involves a significantly stronger activation of the mouth. This specific body part, according to the authors, allows to ground abstract concepts in the human body.

Chapter 3 provides a theoretical discussion of recent empirical evidence showing different results in relation to the activation of the visual cortex during the processing of abstract words. The author, Fabrizio Calzavarini, starts by arguing that the ability to use words includes both the ability to relate words to the external world, typically accessed through vision (in referential tasks), and the ability to relate words to other words (e.g., word-word matching), in inferential tasks (Marconi 1997). In recent empirical studies, some authors showed that neural regions typically involved in processing visual input are engaged also in purely inferential tasks. This has been interpreted as a proof for the activation of mental simulations. Calzavarini shows that whereas for words related to concrete concepts the visual cortex is active during inferential tasks, this is not the case with words referring to abstract concepts. The results are discussed in relation with the difference between referential and inferential processing.

Chapter 4 explores the role of bodily mimesis, defined as the use of the body for representational means (Donald 1991; Zlatev 2008), for the development of abstract concepts. Anna Jelec argues that mimetic behavior in children may constitute the link between the abstract concept and physical experience. The chapter reports a case study focused on the development of abstract concepts in a congenitally blind Polish child, and illustrates the strategies adopted by the child to express abstract concepts through mimetic behavior that she could not have possibly learnt through vision. The author illustrates and discusses several examples of mimetic behavior observed in the young participant, and shows, in a longitudinal perspective, how this behavior tends to disappear around the age of 10, and to be replaced by verbal descriptions of the meaning of abstract concepts, which does not need the support of mimesis.

The first section of the volume is concluded with **Chapter 5**, in which additional empirical evidence in support of the WAT theory (see Chapter 2) is provided. Elisa Scerrati, Luisa Lugli, Roberto Nicoletti, and Anna Maria Borghi argue that the linguistic network is activated more by abstract than by concrete concepts given that the mode of acquisition of abstract concepts relies more on language. The authors support this view by showing that the acoustic modality, used to decode words, is heavily involved during the processing of abstract concepts. The authors interpret the results by arguing that when we process abstract words we re-enact the experience of their acquisition and/or explain to ourselves their meaning. In this perspective, the experiences re-enacted during the processing of abstract and concrete concepts differ: while concrete concepts rely on the re-enactment of (mainly) *perceptual* experiences, abstract ones would rely on the re-enactment of *linguistic* experiences.

The second section of the volume focuses on abstract concepts in language and analyses the semantic and syntactic structure of words denoting abstract concepts. In **Chapter 6**, Lettica Hustinx and Wilbert Spooren address the notions of abstract vs. concrete language and identify the specific dimensions of meaning that can account for this distinction. The chapter reports two studies in Dutch: the first investigates the determinants of concreteness and abstractness using a rating task and shows that sensory perceptibility is an important component of concreteness, and that the determinants ‘specificity’ and ‘drawability/filmability’ vary together with word class types. The second study builds on insights derived from study 1 and shows that when texts are manipulated, in order to vary the degree of concreteness of specific words, there seems to be no effect on how the texts are comprehended, and no effect on how they are perceived to be persuasive. The studies raise issues about the validity of the writing guideline according to which effective language (i.e., comprehensible and persuasive) shall be as concrete as possible.

Chapter 7 explores the specific syntactic construction named co-predication, in which two predicates simultaneously apply to the same noun (e.g., *folded educational newspaper*). Elliot Murphy tests the perceived acceptability of such constructions when the predicative construction expresses respectively concrete properties (e.g., *folded* newspaper) and abstract properties (e.g., *educational* newspaper). The results of his experiments demonstrate that the order in which the adjectives (co-predicates) are provided plays a major role in the licensing of all copredication types. Furthermore, the author shows that this licensing incurs acceptability costs based on the semantic category and complexity of the adjectives. The author concludes that while the language system may encode abstract and concrete representations in identical ways, the parsing mechanisms that operate over these representations differ and are affected by the different syntactic structures in which such co-predications are embedded.

Chapter 8 addresses conceptual concreteness from the perspective of countability. Francesca Franzon and Chiara Zanini claim that since concreteness is usually defined as a semantic property related to physical perception (i.e., the presence of boundaries that define where an entity begins and where it ends), then it follows that uncountable terms (e.g., *much cake*), although concrete, shall be perceived as more abstract than countable ones (e.g., *one cake*). The authors argue their perspective with empirical data collected from 58 Italian children. They show through two experiments that syntactic constructions can modulate the degree of countability of given nouns and allows blurring of the boundaries of the denoted objects. This phenomenon increases the perceived abstraction of the linguistic inputs and the related ease of understanding by young children.

Chapter 9 addresses the structure of particle verbs in German in connection with abstraction. The authors, Sylvia Springorum, Hans Kamp and Sabine Schulte im Walde, start by claiming that German verb particles alone, without context, represent unspecified concepts that are based on abstractions of relations derived by human perception of physical space (e.g., gravity). Once such particles are embedded in linguistic contexts, their meaning is then specified via the semantic constraints activated by the grammatical structures. Through a sentence-generation experiment the authors provide a qualitative analysis of the meanings involved in the linguistic combinations of particles and verbs generated by German native speakers. The authors demonstrate that these neologisms evolve in a non-arbitrary way, by combining the constraints provided by the constituents with the constraints provided by the contexts.

In the last chapter of this section, **Chapter 10**, Alessandro Panunzi and Paola Vernillo analyze concrete and abstract senses of action verbs in Italian, used in literal vs. figurative contexts. The authors investigate the cognitive mechanisms that enable concrete action verbs to give birth to new abstract meanings. They present a corpus-based analysis that focuses on the metaphorical variation of a cohesive group of five Italian action verbs codifying a movement along the vertical axis (*alzare*, *abbassare*, *salire, scendere*, *sollevare*, which translate as 'raise', 'lower', 'rise', 'descend', and 'lift'). The results support the claim that a large part of abstract concepts is grounded in the physical and perceptual experience of the world. This seems to confirm the Invariance Principle worked out by Lakoff, in that the metaphorical mapping of an action verb seems to be strictly constrained by the image schemas involved in its core and concrete meaning.

The third and last section of the volume focuses on how abstract concepts and their related words are used in natural communication. **Chapter 11** explores how abstract concepts and words emerge in a developmental perspective. Maria Rosenberg, focuses on the lexical development of a Swedish monolingual girl, and documents the emergence of abstract words, collected throughout a period of time of almost two years. In the case study reported in this chapter the author describes 440 word types, documenting their relative age of acquisition. Each word type is then analyzed and classified as concrete or abstract, as well as in relation with the type of information conveyed, in the contexts in which it was used. Based on the collected data the author discusses how the sensorimotor and the affective information verbally conveyed by the child can account for her ability to abstract away from the perception-based reality.

Chapter 12 focuses on the abstract concepts used in science, and in particular on how the abstract concepts of 'heat energy' and 'heat transfer' are developed, taught and understood by students during secondary (high) school science lessons. The author, Sally Zacharias, provides an account of how these concepts are linguistically expressed in discourse, using a cognitive discursive framework. The chapter focuses on how the perceptual, social, and linguistic experiences may contribute to shape the content of these concepts. By means of a discursive cognitive linguistic analysis carried out on the tape scripts collected by the author, the chapter examines the conceptual structure and linguistic representation of these two specific abstract concepts. It opens new horizons for the development of educational materials to be used in classroom settings, which can support instructors in teaching abstract scientific concepts.

The last chapter of this volume, **Chapter 13**, investigates how the abstract concept of TIME is expressed in natural language, by analyzing 15,000 collocations extracted from various corpora, where the word *time* is used. The author, Ievgeniia Bondarenko, takes an original perspective on this topic, by addressing the difference between two conceptions of time: TIME as a philosophical entity (Hawking 2005), and everyday time, which is 'as concrete as human life' (Heidegger 1996). To achieve this, she uses philosophical/scientific (i.e., non-human centered) corpora, and poetic (i.e., human-centered) corpora of corresponding periods of the English language history (7–21 centuries). Through the construction and comparison of domain matrices, each representing one definition of TIME and all its related dimensions of meaning, the author discusses and distinguishes different degrees of concreteness/abstractness for each of these two conceptualizations.

3. Conclusions

Abstraction is a core property of human cognition that enables humans to build concepts and express meanings beyond the *hic et nunc* of perceptual experiences. Language has a privileged role in expressing abstract concepts: within this powerful communicative system we have words that express abstract, intangible entities, like *arguments*, as well as words that express tangible entities, like *cups*.

The contributions in this volume focus on various aspects involved in the human cognitive processing of abstract concepts: the acknowledgement that there are various types of abstract concepts, and that these can possibly be processed in different ways (Chapter 1); the fact that abstract concepts may involve the activation of different types of experiences, compared to concrete concepts, and in particular linguistic and communicative experiences (Chapter 2; Chapter 5), while the visual cortex, typically involved in the processing of concrete concepts, seems to be less involved (Chapter 3); and, finally, the hypothesis that bodily mimesis could link the development of abstract concepts from concrete ones, to the development of linguistic skills. In terms of semantic and syntactic structures, this volume identifies and explains the semantic determinants that account for abstractness (Chapter 6); the acceptability of concrete and abstract properties (adjectives) used in co-predicative structures (Chapter 7); the linguistic strategies that can be used to increase word abstractness, based on countable vs. uncountable nouns (Chapter 8); the role of the linguistic contexts in modulating the abstractness of verb particles (Chapter 9); and, lastly, the mechanisms of meaning extension that allow to generate abstract meanings of action verbs, starting from concrete ones (Chapter 10). Finally, in relation with the use of words referring to abstract concepts in communication, this volume addresses the spontaneous production of words referring to abstract vs. concrete concepts and the expression of the related perceptual and emotional content in monolingual development (Chapter 1); the development and expression of abstract scientific concepts in a classroom setting

(Chapter 2); and the corpus-based semantic modeling of two definitions of TIME, which differ in concreteness (Chapter 3).

The various aspects and definitions related to abstract concepts are addressed through various methods and investigated in analyses conducted in various languages: Dutch, English, German, Italian, Polish, and Swedish. Even though the results are not directly compared across languages, this linguistic richness, we believe, help us extend the value of the findings on this topic beyond the solely English language. The results and discussions that emerge from these chapters, in relation with the original research questions tackled by this volume, advance our scientific knowledge on the structure and processing of abstract words and concepts, by showing that abstract and concrete concepts differ not only in perceptual strength, but also in the degree with which they activate linguistic and communicative experiences, and neural areas dedicated to processing visual input. Moreover, it is shown that perceptual experiences may contribute to shape the content of *some* types of abstract concepts, but not all of them. For this reason, a fine classification of different types of abstract concepts is badly needed. In addition, what we argue here is that language makes a substantial contribution in shaping and constraining the meaning of abstract concepts, more so than when considering the meaning of concrete concepts. The argument can be made that words referring to abstract concepts tend to emerge later in developing children, compared to words referring to concrete concepts; and that metaphor is a cognitive mechanism used to extend concrete meaning to abstract domains, and express abstract concepts verbally.

The findings described in this volume highlight also new compelling challenges, which arguably will be addressed in the coming years. For example, it remains an open question how and why different languages abstract and extend meaning in different directions and different conceptual and linguistic strategies, starting from the same concrete meanings. In particular, it is still a debated issue what types of abstract concepts appear to be more widely distributed across human languages. Second, human beings share similar bodies, which afford similar ways in which perceptual experiences can be approached. Even though the environment in which humans live offers a great degree of variability, and therefore a great degree of possible experiences, the link between linguistic diversity and experiential variability remains an open issue. Finally, even though there seems to be an agreement on the idea that abstract concepts derive from concrete ones by means of different types of meaning extension, systematic analyses are still missing, to explain and demonstrate what types of cognitive operations motivate the emergence of specific types of abstract concepts from concrete categories. As editors, we hope to have raised the reader's curiosity and scientific interest in these new issues related to abstract concepts and human cognitive processing.

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PART I

Abstract concepts in the mind

Conceptual processing and cognitive grounding of abstract concepts

CHAPTER 1

The relevance of specific semantic categories in investigating the neural bases of abstract and concrete semantics

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Previous research has shown that modality-preferential sensorimotor areas are relevant for processing of words referring to concrete objects or actions. However, whether modality preferential areas also play a role for abstract words is still under debate. In this chapter we will argue that the apparent lack of empirical evidence for a grounding of abstract words stems, at least in part, from the treatment of abstract words as one monolithic semantic category, rather than taking into account specific abstract word types and sub-categories. We will review classical and recent empirical evidence from neuropsychological, neuroimaging and behavioral approaches and demonstrate the necessity of considering specific semantic meaning types when investigating a possible grounding of concrete and abstract concepts, for both theoretical and methodological reasons.

Keywords: abstract semantics, concrete semantics, grounding, semantic sub-categories

1. Introduction

The aim of this chapter is to argue that specific semantic content needs to be considered when investigating the neural basis of processing the semantics of concrete but also of abstract words. This question is of special concern when testing for grounded or embodied approaches towards semantics, both from a methodological and a theoretical perspective. We will first briefly outline the debate on embodied and disembodied approaches, before we summarize evidence from category specific investigations of the neural bases for concrete word semantics which is in favor of embodied accounts. The comparison of these investigations to those that do not consider specific semantic types is subsequently taken as motivation

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to use a more fine-grained classification of abstract words when investigating the contributions of modality preferential systems to semantic processing. We conclude this chapter by summarizing recent evidence for some exemplary subclasses of abstract words: words referring to mathematical concepts, abstract emotional states or abstract mental processes.

2. Disembodied and grounded models of semantics

2.1 Disembodied approaches towards semantics

Motivated by advancements in artificial intelligence and computer science, traditional cognitivist models of semantics assume word meaning to be represented in a homogeneous, uniform format, either in the form of symbol systems, manipulated by syntactic rules (Fodor 1983), or in semantic networks, storing the meaning of words and the semantic relations between words (e.g., Quillian 1969). Semantics was assumed to be handled by a dedicated semantic system, independent from other cognitive modules, like those related to basal sensory or motor processing (Fodor 1983; Ellis and Young 1988). Cognitive modules in general were seen to be encapsulated from another, i.e., when processing inputs from another module, a cognitive module cannot access information that is stored in other modules but has to rely on the information that is stored in itself. Hence, a dysfunction in one module is assumed to have no influence on the quality of representation and processing in another module. It should be noted though that these cognitive theories indeed assume the semantic system to receive input from other, non-semantic modules, like perceptual systems, and to send its output to other systems, like the module for the execution of a response action, once semantic processing is complete; the role of these systems, however, is merely 'subsidiary' to the 'central' semantic system (Fodor 1983).

Yet this view has an important caveat, as pointed out by Harnad (1990) (and acknowledged already by Quillian 1969): based on Searle's Chinese Room Experiment (Searle 1980) it has been demonstrated that a purely symbolic system cannot convey meaning on its own. If a symbol's meaning is exclusively represented via references to other atomic or molecular symbolic meanings, such a system becomes inherently circular, as the respective referenced symbols have their meaning in turn again defined by references to other symbols. This circularity renders purely symbolic systems entirely meaningless, as they fail to relate a symbol (or linguistic sign) to its referent in the world, so that the symbols of a purely symbolic system are in fact not interpretable. It should be noted that amodal symbol systems do not deny in- and output from and to sensory or motor systems, but any mapping of external to central semantic information is assumed to occur in an entirely arbitrary fashion.

2.2 Grounded approaches towards language comprehension

A solution is to ground at least some of those symbols directly in sensory (and by extension also motor) experience. These grounded symbols of semantic representation can then serve as a basis of the grounding of other symbols via combinatorial processes (Harnad 1990). Critically, such a system would contradict the modularity and functional independence of the semantic system from systems for basal perceptual and motoric functions. In contrast to the aforementioned symbolic accounts, grounded or embodied theories propose that semantics is, in part, directly represented and grounded in basal sensory and motor systems (e.g., Barsalou 1999). Here, semantics is thought to be represented in a distributed fashion, rather than in a single separate, distinct and autonomous module. Importantly, semantics are here assumed to be represented in modality specific format, contrasting with the assumed amodality of symbol system approaches. In this view, sensorimotor information is not believed to be "subsidiary", but indeed constitutive for semantic representation. If one assumes cognitive processes in general, or also specifically the processing of semantics, to be in some way realized in the brain, it may appear worthwhile to not only focus on a purely cognitive level but to also investigate the respective underlying neural architecture and mechanisms. This approach allows to derive theories on the neural mechanisms underlying semantics, which can be tested empirically using psycholinguistic and neuroscientific methodology.

Under the assumption that similarities between the neural correlates of cognitive functions are informative about overlaps of the nature of the respective representational formats, grounded and embodied theories on the neural underpinnings of semantics (e.g., Pulvermüller 1999; Glenberg and Gallese 2012) have proposed that semantic processing is, at least in part, realized in brain systems involved in direct sensory perception or motor action. If semantics are indeed represented in a modality specific format, the respective neural correlates should not only involve amodal- or multi-modal systems but also modality specific motor and sensory systems in the brain.

Crucially, the mapping of sensorimotor information to a word is believed to not occur in an arbitrary fashion, but to follow a pattern of sensorimotor somatotopy, involving those modality specific systems that are specifically relevant for a word's meaning. As a consequence, any change in the functional state of a sensorimotor system should be reflected in changes of those semantic representations that are based on the respective sensorimotor representation. At the same time other semantic representations that do not contain any information of said altered sensorimotor system are hypothesized to remain unaffected. As a further consequence of the constitutive role of sensorimotor information for semantic representation, the respective modality specific systems should become active automatically and instantaneously once the semantics of a words are being accessed.

2.3 Hebbian learning and neural cell assemblies

In addition to hypotheses on the spatial properties and temporal dynamics, any neural theory on the nature of semantic representations should also explain, or model, how and why these specific spatio-temporal attributes of the neural correlates of semantic representations come to be. A neurobiological mechanism that would potentially allow a semantic grounding in modality-preferential systems of the brain, as described above, is Hebbian learning. The Hebbian learning principle proposes that cells strengthen their mutual connections when they become active in synchrony (Hebb 1949). This basic principle allows for correlational or associative learning, which would in turn allow to learn the relation between a linguistic sign and its sensory motor referents. In neural terms, this process results in groups of neurons that are strongly connected with excitatory links, called cell assemblies (Hebb 1949; Braitenberg 1978).

For example, when one learns the meaning of the word ‘hammer’, this linguistic sign would be, among others, related to the perceptual sensations of seeing a hammer and the motor activity related to using it. In neural terms this would be reflected in connections between neuronal cell assemblies, representing the word, to neurons handling the respective sensory or motor information. The resulting cell assembly would directly speak against a localistic and encapsulated account of semantics. Given their excitatory mutual connections, activations of only few selected specific cell assembly components can result in widespread ignition, or at least facilitated activation of the entire cell assembly. In the context of the ‘hammer’ example, the perception of the sign ‘hammer’ would result in (facilitated) sensorimotor activity and vice versa sensorimotor experiences related to situations in which the sign ‘hammer’ is used, would result in (facilitated) activations of the sign components in the cell assembly.

However, these physical referents of the sign ‘hammer’ would, at least in a naturalistic setting, vary to a large degree between situations this sign occurs and is used, i.e., due to different people using the hammer, different intentions to use a hammer or simply with different kinds of hammers. This large variety in physical referents would result in a strengthening of connections between word (i.e., sign) cell assemblies and very widespread and heterogeneous sensorimotor referents, as also informational content which is not actually relevant for the meaning of the sign ‘hammer’ is associated with its usage. Such a cell assembly could over time lose a great deal of its entropy (in an information theory sense, i.e., information content) and would make differentiations of semantics between individual signs more difficult (Sejnowski 1977). Therefore, another learning principle must be considered in addition to Hebbian learning, which is Anti-Hebbian learning. According to this learning rule, neurons that fire in a-synchrony weaken their mutual connections (Bienenstock et al. 1982). Both learning rules in concert allow to relate the sign 'hammer' to the sensorimotor experience that is common between situations, informative for its meaning and importantly it also allows to differentiate between meanings of different words. Simulation approaches applying those learning rules under neurobiological constraints indicate that this principle can indeed be successfully applied to model language learning and semantic representations (e.g.,Tomasello et al. 2017).

Once the meaning of a sign (or word) has been learned it can also provide a basis for learning the meaning of novel signs by linguistic description and context alone, using the same principles of Hebbian and Anti-Hebbian learning, as correlated activity between different cell assemblies can modify their mutual connections in a similar vein as previously described to occur within cell assemblies. This mechanism provides means to hand over previously grounded semantics between signs via word-word, rather than just word-world learning (Pulvermüller 2002). Thus, it is possible that some or many word meanings are not grounded directly in experiential references, but via the proxy of a 'grounding kernel' of previously learned word meanings (Pulvermüller 2013).

3. Semantics in the brain

The question whether modality specific knowledge is of relevance for semantic representations, as proposed by embodied and grounded approaches towards semantics and as denied by proponents of entirely amodal symbolic semantic representations, can be addressed empirically using methods established in the fields of psycholinguistics and neuroscience. In order to do so, one first needs to make the assumption that in general the cognitive faculty of semantic representation and processing is realized in neural architecture and biological mechanism in the brain. Furthermore, one needs to assume the localization of the neural underpinnings of semantics (and their correlates) within the brain to be informative about the representational format of semantics, at least to a degree that allows inferring overlaps in representational format from overlaps in neural substrates between cognitive functions.

Advances in neuroimaging methods in the past decades enabled testing the hypothesis of these different models on semantic processing in the brain in vivo on a large number of participants. In recent years a large-scale meta-analysis summarized the results of 120 of those neuroimaging investigations on semantic processing (Binder et al. 2009). This analysis revealed a widespread (modality unspecific) network covering inferior frontal gyrus, the middle temporal and fusiform gyrus, posterior inferior parietal lobe, dorsomedial prefrontal cortex, ventromedial prefrontal cortex and posterior cingulate gyrus, thus speaking against a single area being exclusively involved in semantic processing and representation. A specific contribution of modality-preferential areas, as embodied accounts would predict, was not reported.

However, this latter observation can be attributed to the design of the meta-analysis and the summarized studies, rather than to an absence of sensorimotor area involvement in semantic processing. The majority of the summarized studies used tasks that required an active motor response, which could have masked motor activations caused by perception of linguistic input. Furthermore, the majority of neuroimaging studies included in the meta-analysis presented results on contrasts between meaningful stimuli and stimuli devoid of meaning. Any semantic system however should be capable to achieve more than just telling apart meaningful from meaningless stimuli. Actual word meanings have to be considered too. From a localistic, amodal symbolic perspective on semantics this would not be necessary, as the neural substrates would be assumed to remain homogenous between semantics of different words. In contrast, grounded or embodied frameworks of semantics explicitly predict differential neural substrates, depending on exact word meaning. In case word semantics are not being controlled for, it is likely that those modality specific activations cancel each other out when averaged across all meaning types applied, thus revealing merely the modality unspecific contributors to semantics, as reported in meta-analysis results.

Therefore, approaches that control for explicit semantic content should be considered in order to test hypothesis of grounded approaches towards semantics. This is not to say that Binder and coworkers were not aware of this issue. In fact, they presented also data on a very limited set of 10 studies on a controlled, though broad, semantic categories of 'artifacts' and 'living things'. However, the aforementioned motor response caveat still applied. It is therefore worthwhile to specifically consider those approaches that provide a very fine-grained control of exact word semantics in tasks that do not require overt motor responses in order to test predictions of grounded theories of semantics.

In the following sections we will specifically review those studies which provide a very fine-grained control of exact word semantics, in order to test predictions of grounded neural theories of semantics. In doing so, we will focus predominantly on the contribution of motor systems to action-related semantics, especially as some theoretical approaches (Wittgenstein 1953) in particular highlight the relevance of (social) action contexts of language usage for linguistic meaning.

3.1 Investigations of category specific semantic processing

In a passive reading functional magnetic resonance imaging (fMRI) paradigm that controlled for psycholinguistic differences between semantic word categories, Hauk et al. (2004) could show an involvement of inferior temporal and inferior frontal cortex in addition to precentral motor areas in the processing of action words. Over and above a general involvement of motor systems in processing action-related semantics in a domain general fashion, the exact action word type, i.e., the related effector needed to perform the named action, was reflected in the corresponding activation patterns of the motor system in a somatotopic fashion.

This pattern of effector specific semantic somatotopy in the motor system was replicated in further fMRI studies on single verb (e.g., Rüschemeyer et al. 2007; Moseley and Pulvermüller 2014) and noun stimuli (Rüschemeyer et al. 2010; Carota et al. 2012; Moseley and Pulvermüller 2014). Although some researchers see some of these effects to be difficult to replicate (Postle et al. 2008; Caramazza et al. 2014), systematic comparison of corresponding studies demonstrated good reproducibility (Carota et al. 2012; Kemmerer et al. 2012).

Furthermore, the semantic-specific fMRI activation of extrasylvian areas was shown to be not reduced to the motor system, but to involve primarily sensation related systems as well. Here, nouns that relate to objects with strong auditory semantics were shown to elicit activity also in posterior superior and middle temporal gyri, areas normally involved in actual processing of object related sounds (Kiefer et al. 2008), whereas passive reading of nouns with strong taste related semantics resulted in specific contributions of gustatory systems (Barrós-Loscertales 2012). Likewise, passive reading of nouns strongly associated to smells was reflected in olfactory systems, in addition to activations in classical perisylvian areas (González et al. 2006).

3.2 Investigations of temporal dynamics of sensorimotor involvement in processing semantics

Apart from the question of the spatial properties of semantic processing, answering the question, *where* semantics are being processed, it is furthermore imperative to investigate also the temporal dynamics of sensorimotor area involvement, in order to make precise statements on their role for language processing (Hauk 2016). This is necessary to exclude the possibility that recorded fMRI signals in sensorimotor areas actually merely reflect confounded cognitive processes, like word related imaginary-, episodic memory-, or task related executive processes, secondary to, rather than genuine semantic processing. Any temporal disentanglement of semantic and possibly confounded processes can however not be achieved by fMRI, as it provides just a very limited temporal resolution, ranging in the domain of seconds. In contrast, electrophysiological measures like electroencephalography (EEG) or magnetoencephalography (MEG) allow to make statements on correlates of general cognitive or specific semantic processes with millisecond precision. Here, EEG results by Hauk and Pulvermüller (2004) indicate somatotopic contributions of the motor system for effector specific action verbs in a passive reading paradigm to occur already 250 ms after word presentation. Similar findings were obtained using a MEG mismatch negativity paradigm on words relating to actions performed with different effectors, showing somatotopic effects in motor areas already around 90 ms (Shtyrov et al. 2014) after presentation of word final syllables which define the respective word semantics. As for the aforementioned fMRI findings on the spatial properties of extrasylvian contributions for semantics, such early somatotopic effects were not observed for action words exclusively but were also reported for words with strong sensory semantics (Kiefer et al. 2008).

Despite this early involvement of extrasylvian areas it has been argued that it could still be the case that these contributions are actually secondary to genuine semantic processing, occurring solely in amodal/not modality specific perisylvian areas, as there is no objective time threshold that would rule out the presence of even earlier semantic processes (Mahon and Caramazza 2008). At best, the aforementioned EEG and MEG results can therefore only show that interpretations in terms of non-semantic processes are merely less likely to hold true (Hauk 2016). Despite the plethora of evidence of a somatotopic and early involvement mentioned in this and the above paragraphs, both measures cannot provide direct proof for an actual behavioral relevance of sensorimotor systems for semantic processing.

3.3 Behavioral evidence for an interplay of sensorimotor and conceptual systems

If the aforementioned grounded and embodied approaches towards semantic representations hold true, an influence of sensorimotor activations on semantic processing would be predicted and vice versa an influence of semantic processing on sensorimotor activity. With regards to the former prediction, behavioral evidence presented by Glenberg and Kaschak (2002) indicates a general influence of motor actions on semantic processing. In their study, participants were asked to judge the meaningfulness of sentences, with target sentences describing movements either towards or away from the body. Responses were given either via a movement away or towards the body and reaction times in this setup resulted in specific interference effects in case the necessary response movement did not match the direction of movement described in the target sentence. A direct behavioral demonstration of effector specificity in the interaction between actual movements and semantic processing was provided by Shebani and Pulvermüller (2013), who asked participants to perform complex tapping patterns with their hands or feet while remembering a list of action verbs referring to either hand or face actions. Error patterns showed a cross-over double dissociation between experimental conditions, despite the word categories being matched in terms of their psycholinguistic properties, thus indicating directly a somatotopic overlap of semantic specific memory and motor systems and likewise a causal role of the latter for the former. Furthermore, as in the previous paragraphs, those behavioral findings were not unique to the motor system and its activation by action, but where also observed to occur in the context of sensory stimulation for words related to respective sensory information (Connell et al. 2012).

3.4 Neurostimulation evidence

Neurostimulation methods can be used to affect activity in parts of the brain directly, resulting in either an increase or inhibition of neural activity for short periods of time, thus allowing to infer a causal role of the stimulated area for semantic processing, in case neurostimulation results in semantic specific differences in behavior.

In line with this rationale, Willems et al. (2011) applied constant theta burst TMS on left hemispheric premotor areas, to temporarily inhibit neural activity in these areas thus creating virtual lesions. Results of a subsequent lexical decision paradigm indicated reduction of response speed specifically for manual, hand action-related, but not for non-manual verbs. Results are interpreted in terms of reduced inhibition of primary motor areas (by inhibiting premotor areas) causing facilitation of behavioral performance. These results confirmed earlier observations by Pulvermüller et al. (2005) on a functional role of motor areas for semantic processing. In this study, a different stimulation setup was applied, to facilitate neural activity directly, using single TMS pulses were applied to either the hand or the foot motor cortex while presenting hand or foot related action verbs in a lexical decision paradigm. Here an interaction between TMS stimulation site and action verb semantics was observed in reaction times, again suggesting a somatotopic involvement of motor areas in processing action word semantics. In sum, these experimental paradigms that directly manipulate neural activity of the motor system strongly support a notion of a causal involvement of motor areas in processing of semantics.

Although these different approaches provide consistent conclusions it has been argued by some authors (Mahon and Caramazza 2008; Mahon 2015) that even these findings do not present evidence unambiguously in favor of the motor system actually holding semantic representations of action words. Instead, the reported effects could occur as the result of spreading of the induced neuronal activity back from the motor system into an entirely a- or multimodal semantic system that stores the actual representations of a words meaning and would thus be compatible with entirely disembodied or ungrounded approaches towards semantics. In addition, the effects reported above in this section were only found for response speed and not for response accuracy. This may be merely the result of the non-invasiveness of neurostimulation approaches, which can only induce small changes in neuronal activity and hence also only small behavioral effects; but it also allows the interpretation that merely the processing of semantics was disturbed or facilitated, while the issue of the representational format of semantics remains untouched by those approaches (Mahon 2015).

3.5 Patient evidence

From a theoretical perspective, behavioral impairments in patient populations with neurological lesions however could paint a different picture than the aforementioned neurostimulation studies. In case a patient with lesions in the sensory or motor systems exhibits behavioral deficits in their processing of related action or sense related semantics, any interpretation in terms of (neurostimulation induced surplus) activity spreading back from basal sensory and motor areas to an amodal conceptual system cannot be applied, as in this case brain activity is missing (as a consequence of the lesion) and not induced via external stimulation. Furthermore, the investigations of neurological patients would allow to apply standard inference schemes in neuropsychology, i.e., investigations of single and double dissociations (Crawford et al. 2003), to derive conclusions on the necessity of specific brain areas for specific cognitive functions.

Early evidence on such semantic category specific impairments was presented by Warrington and McCarthy (1983, 1987). In two single patients, each suffering from an infarction of their middle cerebral artery and global aphasic symptoms, performance on manipulable objects was impaired more severely than that for animals, flowers and foods in a range of matching to sample tests. At the same time, a cohort of patients with herpes simplex encephalitis presented the opposite pattern in a similar series of tasks, with animals and foods being impaired while (mostly manipulable) objects being less affected in comparison (Warrington and Shallice 1984). This double dissociation demonstrates that semantic processing is not realized in one unitary semantic system, but different semantics must – at least in part – be realized in differing neural substrates.

3.5.1 *Impairments of the motor system*

In order to make more fine-grained statements of the functional involvement of sensory or motor systems in semantic processing, neurological patients with deficits specifically in their motor or sensory function should be considered. One clinical population that appears to be well suited in this respect is that of motor neurone disease (MND) patients, who show specific impairments of their motor functions. In a study by Bak et al. (2001) a word to picture matching task was performed on a group of six MND patients, who were shown to have task accuracy impairments more pronounced for action verbs than for non-action nouns.

Another disease that is related to specific motor impairment of motor functions is Parkinson's disease (PD). As for MND, also PD patients were shown to exhibit specific impairments for processing action semantics, compared to non-action controls for single verbs (e.g., Boulenger et al. 2008). Strikingly, the processing difference between action verbs and control verbs was observed to disappear during treatment of PD symptoms to restore motor functionality.

In a similar vein, Neininger and Pulvermüller (2001) were able to test one stroke patient with a very focal lesion in the somatosensory, pre- and primary motor cortex who exhibited selective slowing of responses for action verbs in a speeded lexical decision task, compared to matched non-action control nouns. This observation was replicated for lexical decision accuracy in a bigger group of stroke patients with frontal motor lesions, though in this case lesions were often also covering inferior frontal and/or superior temporal lesions.

A different angle to investigate category specific neural substrates in stroke patients was chosen by Arevalo et al. (2012) and Kemmerer et al. (2012; though including also some patients of other lesion etiologies in analysis). Both studies used voxel-based lesion symptom mapping to analyze semantic deficits in large patient groups on a voxel-by-voxel basis and also found lesions in motor areas, in addition to perisylvian systems, to be predictive for impairments on action semantics. Arevalo et al. (2012) tested nouns and verbs of even effector specific action semantics but did not report any somatotopy in their results. Results on stroke patients therefore seem to merely support the domain general contribution of the motor system to sensory motor semantics. This latter observation might be driven by the aforementioned wide-spread lesion nature in stroke patients, covering more than just the motor areas related of one specific effector, as also in voxel-based lesion symptom mapping approaches such confounds in lesion patterns cannot be overcome (Rorden et al. 2009).

4. The issue of abstract concepts

Despite the above evidence in favor of an involvement and even a necessary role of modality specific sensory and motor systems for concrete word processing, grounded approaches still face criticism for their apparent inability to explain representations of abstract words. Whereas abstract symbolic systems do not see any special challenge in abstract words, as concepts, grounded theories appear hard to apply in this case as there is no transparent mapping of sensory or motor information to their semantics (Mahon and Caramazza 2008; Dove 2016). These authors conclude that grounded theories must therefore be inherently limited in their possible scope and could not be applied as a theory for semantic representations in general.

However, even if abstract words were entirely amodal, symbolic approaches would need to account for the general processing differences between abstract and concrete verbs, as represented in the classical concreteness effect (e.g., James 1975). Here, concrete words were shown to have better results in lexical decision paradigms than words of abstract semantics, even when other psycholinguistic features are being controlled for. Similar processing differences between abstract and concrete stimuli were furthermore also highlighted in concreteness effects in comprehension and memory (Moeser 1974; Holmes and Langford 1976).

4.1 Classical accounts to explain differences between abstract and concrete concepts

One of the classical models proposed to explain this concreteness effect is the dual-coding theory (Paivio 1986). This model proposes that concrete words are represented in a verbal code format, thought to be situated in the left hemisphere, and in a sensory image-based format, assumed to extend over the right hemisphere. In contrast, abstract words are assumed to be represented in the verbal code exclusively, without any particular involvement of sensory coded information. Hence, the crucial difference between abstract and concrete words could be attributed to differences in their imageability.

This proposal was put in question by results of Schwanenflugel and Shoben (1983), as well as by Schwanenflugel and Stowe (1989). They demonstrated that the concreteness effect disappears once the associative information of abstract and concrete words has been controlled for. The context availability model (Schwanenflugel and Shoben 1983) consequently proposes that the processing advantage for concrete nouns stems from the fact that they typically have more contextual linguistic or general semantic information available than their abstract counterparts. A distinct sensory code is therefore assumed to be not needed in semantic representation to explain processing differences between abstract and concrete words.

In light of the evidence in favor of grounded models of semantics for concrete words, summarized above, it becomes apparent that neither of these classical approaches (i.e., dual coding or the context availability proposal) appears to be strongly supported. The observed modality-preferential activations for semantic category specific stimuli speak against entirely "verbal", i.e., amodal representations, as proposed by the context availability theory. At the same time, the cortical distribution over left (and right) hemisphere of these contrasts goes against the prediction of exclusive right hemisphere involvement for the representation of modality specific content in the dual coding model.

4.2 Previous investigations on abstract words

Still, these models and the concreteness effect in general are influential also for current research, as they motivate the general principle on how abstract semantics is investigated, i.e., in comparison with concrete words, which one could assume to be of importance in order to answer the question whether or not modality specific representations are also of relevance for abstract concepts. In this context, two recent meta-analyses of neuroimaging investigations of abstract semantics are of special relevance (Binder et al. 2009; Wang et al. 2010). Together, both studies summarized 25 individual PET and fMRI studies on abstract words and sentences and revealed the inferior frontal and medial temporal areas to be activated more strongly to abstract than to concrete stimuli. Modality specific sensorimotor areas however were, at least in the majority of studies, not highlighted. It may appear to be tempting to take these systematic meta-analyses as evidence in favor of disembodied accounts on abstract word semantics, but instead it could also be argued that the individual studies (and hence also the two meta-analyses) do not allow this conclusion by design. Some of the reasons for this are similar to the ones previously mentioned for meta-analyses on concrete words:

1. Many of the studies analyzed required active motor responses from the participants. As for concrete words, this setup makes it likely that task-specific motor activity and its anticipation or preparation masks motor activity that is genuine to semantic processing and representation.
2. Both meta-analyses focus on contrasts of abstract against concrete words or sentences, thus revealing activity that is greater in one condition than in the other. Any activity that is possibly shared between abstract and concrete stimuli however is lost in this comparison. Hence individual contrasts, separately for abstract and concrete stimuli, would be needed to reveal neural substrates that are involved in both kinds of semantics.

3. All of the studies summarized treated abstract words as one monolithic category, without paying tribute to the exact abstract word meanings. Taking the category specificity results for concrete words as an example, it may appear likely that also different subclasses of abstract words are related to different neural substrates, which would cancel each other out when many semantically heterogeneous abstract stimuli are averaged together in analysis. As these category specific activations could potentially involve also modality-preferential sensorimotor areas, their contribution to semantic processing could potentially not be revealed in either meta-analysis by design.

As a consequence, any approach (not only those relying on neuroimaging measures) that tries to answer the question whether or not modality-preferential motor or sensory systems are also involved in handling abstract semantics should not attempt to merely contrast abstract to concrete meanings, but to compare both abstract and concrete words to a common baseline. Furthermore, abstract words should not be treated as one monolithic category, but more fine-grained subclasses of abstract words should be considered instead, to pay tribute to exact semantic content of words under investigation.

5. Identifying different classes of abstract words

Considering the aforementioned research on the grounding of concrete concepts as a model for investigations on abstract words it appears worthwhile to define fine grained abstract subclasses. This does not mean (and the same applies to concrete words as well) that the neural substrates of word meaning processing ought to be organized by those categories, but those subclasses may well represent instances of word meanings that rely on specific sensory, motor, introspective of affective information to a different degree. For example, Della Rosa et al. (2014) assumed a total of five different categories when designing their cognitive test battery of abstract words: Abstract emotion words, cognitions (i.e., abstract mental state words), words referring to abstract actions, traits and social concepts. Evidence on the aforementioned weight differences of specific sensory or motor information between these abstract word subclasses can be seen in the results of Ghio et al. (2013). Here, semantic ratings revealed differential association strengths of hand, face and leg actions between mental state, emotion and mathematics related sentence stimuli. In particular, sentences describing abstract emotional states and processes were shown to have stronger associations to actions conducted with either effector than mathematics or mental state sentences. In contrast, sentences related to mathematics received stronger hand action relatedness than mouth and leg action ratings. Likewise, also abstract mental sentences presented specific dissociations between the effector relatedness strengths, with face/mouth action relatedness receiving stronger ratings than semantic relations to either hand or leg actions. A differentiation of abstract words into specific subclasses therefore seems to be justified, especially in the context of research on a possible grounding of abstract semantics, as different subclasses might be related to different predictions on the contributions of specific modality preferential neural systems. In the following sections we will summarize recent results on the neural bases of some exemplars of those subclasses: Mathematical terms, abstract emotion words and abstract mental words.

5.1 Abstract mathematical terms

In an attempt to investigate the neural substrates of abstract number words, Tschentscher et al. (2012) applied an fMRI silent reading paradigm in which either Arabic number symbols (single digits, 0 to 9), or their word counterparts ("zero" to "nine") were the stimuli of interest for analysis. To assure participants' attention throughout the task, participants were asked to respond with a foot pedal press on rare action cue trials. Subsequent to this reading paradigm, participants conducted a motor localizer task in which active finger movements were required. Results indicated that even in the absence of hand movements those motor areas become involved in digit and number word perception that were shown to be involved in finger movements of the motor localizer task, in addition to anterior parietal cortex. The choice of a foot pedal as a response device allowed to interpret the hand motor activation to be independent of action preparation activity, which would be predicted to occur in more dorsal leg motor areas. Importantly the lateralization of the motor system's contribution to number word or digit processing was revealed to depend on individual counting habits. In case participants reported to use their right hand to start counting or to gesture small numbers (i.e., 1–5), the respective hand motor system contribution was observed to be left-lateralized, whereas participants who tend to start counting with the left hand showed the lateralization to be reversed. The observed motor system involvement in number word processing and the correspondence between individual counting habits and activation lateralization are consistent with a grounding of abstract numerical-mathematical terms in motor action and experience. This result fits well into earlier behavioral evidence on the interplay of motor function and numerical/mathematical processing (e.g., Fischer 2008).

This interplay between motor function and abstract mathematical word processing has been shown to be not reduced to number words, but to extend also to abstract mathematical quantifiers, as presented in an EEG approach by Guan et al.

(2013). Here, quantifiers like “more” or “less” were presented in a short narrative context consisting of several sentences each. During sentence presentation, participants were asked to continuously press a button with one finger and to indicate story comprehension with a switch to another button, positioned either below or above the button pressed during sentence presentation. Results in this paradigm indicated an N400-like component in the mesio-frontal and frontal-lateral cortex, previously identified to be involved in action monitoring, in case the quantifier information was “incongruent” with the respective response movement, i.e., less quantity information and upward movement or higher quantity information and downward movement. This observation was seen to resemble difficulties to integrate the requested response movement into semantic cortex and is hence interpreted in terms of an interaction between motor activation and semantic analysis of abstract mathematical quantifiers. At the same time, the motor potential, elicited by the release of the button pressed during sentence presentation, was also observed to be manipulated by this compatibility of response movement direction with the presented abstract quantifiers. This finding was taken as evidence for the semantic analysis of quantifiers to directly affect motor responses, again pointing to a functional linkage of hand motor systems and abstract quantifier word processing. These studies are by no means meant to be exhaustive for approaches that target this interplay of motor function and mathematical term comprehension, but they should provide examples on how investigations of specific abstract subclasses can provide conclusions on a potential grounding of abstract terms in action that would likely not be possible in case those fine-grained semantics differentiations were not accounted for in stimulus and study design.

5.2 Abstract emotion words

Another set of abstract words recently investigated comprises abstract emotion words, like “love” or “hate”. These words have high affective connotations, but only low concreteness/high abstractness ratings, especially when compared to concrete words with emotional semantics, like “scream” or “smile”. Moseley et al. (2012) investigated the neural bases of words with abstract emotion semantics by presenting them in a passive silent reading fMRI paradigm, together with matched concrete action or emotion related, or non-action control words. The overall design of this study paralleled that of Hauk et al. (2004). Results of abstract emotion words to control conditions (non-action controls and hashmark strings) revealed that the left inferior frontal gyrus as well as precentral hand- and face motor areas were recruited in passively reading these items, in addition to different parts of the limbic system, as the insula, basal ganglia and the anterior cingulate cortex.

As these results were observed in an entirely passive reading paradigm in the absence of overt face or hand movements, and in contrasts with semantically different word categories matched on non-semantic psycholinguistic features, the motor involvement in word processing can be interpreted in terms of a grounding of abstract emotion semantics in face and hand motor areas. Interestingly, especially arms/hands and the face are those effectors that are of particular importance for expressing emotions and perceiving emotions in others (e.g., Ekman et al. 1969; Aviezer et al. 2008). Furthermore, in language learning during infancy, it is especially emotion expression behavior carried out by these effectors (in addition to articulators) that provide means for the parent to infer the emotional state of the infant and chose the respective verbal label accordingly in implicit or explicit language teaching. However, as for the fMRI evidence in favor of a grounding of action or sensory modality related word semantics in the respective modality preferential sensorimotor systems, the results by Moseley et al. (2012) could also be interpreted to entirely resemble post comprehension epiphenomena (see e.g., Mahon and Caramazza 2008). Therefore, investigations on causal contributions of the motor system to processing abstract emotion semantics are needed to rule out any epiphenomenal interpretation.

First evidence in this direction can be seen by work Moseley et al. (2015) on autism spectrum condition patients. Again, using a passive silent word reading task, it could be shown that autism spectrum disorder patients show less activity in hand and face motor areas, as well as in anterior cingulate cortex, for abstract emotion words than healthy controls, whereas there was no difference between both participant groups in psycholinguistically matched, non-emotional, non-action control words (i.e., animal names). The degree of this hypoactivity in the motor system for abstract emotion words was seen to be correlated with scores in standardized diagnostic autism questionnaires. As autism spectrum disorders are not only characterized by emotion recognition and expression deficits, but also by motor impairments (e.g., Jansiewicz et al. 2006), so that results by Moseley et al. (2015) could be interpreted to be in line with the notion of a causal contribution of the motor system to processing abstract emotion semantics.

Even more direct evidence for the functional and necessary role of the motor system for processing abstract emotion semantics can be seen in results by Dreyer et al. (2015). Here, a neurological patient with a focal metastasis in the left supplementary motor area was subject to a speeded lexical decision paradigm. The critical proper noun targets in this paradigm were either hand or face action related (i.e., tools or foods), of abstract emotional nature or non-action related (animal names) which were all meticulously matched on psycholinguistic variables on a lexical and sublexical level. Thanks to this matching, any performance difference between semantic categories can indeed be of semantic nature. Results indicated task accuracy in this patient to be impaired specifically strong for abstract emotional items (at chance level), whereas performance for other noun categories remained more intact. In contrast a cohort of healthy controls did not show any similar semantic category specific performance differences between these categories. At the same time, a second patient, with a very focal lesion directly adjacent to the pyramidal hand motor tracts did not exhibit a similar selectively pronounced deficit for abstract emotion words (but in turn an impairment for tool nouns). Both observations render it unlikely that the observed performance impairment for abstract emotion words following a supplementary motor area lesion resembles merely a generic concreteness effect, independent of the exact lesion site. This observation can therefore be interpreted in terms of a functional and necessary role of the motor cortex in the semantic processing of abstract emotion concepts and therefore suggest that the motor areas previously found active in abstract word processing by Moseley et al. (2012) can serve a meaning-specific necessary role in word recognition.

These observations were made following a lesion in the supplementary motor area, an area that lacks the effector specific somatotopy of primary motor areas. Therefore, this observation cannot be taken as direct evidence for a causal and necessary role of hand and face motor areas specifically for abstract emotion words. However, the category specific nature of the observed performance dissociations still is difficult to reconcile with the idea that sensorimotor systems are somehow peripheral or ‘epiphenomenal’ to meaning and concept processing. Instead, the results of Dreyer et al. (2015) are consistent with the claim that also abstract emotion word semantics are grounded in action and based on distributed action perception circuits reaching into modality-preferential motor areas.

5.3 Abstract mental words

The focus on specific semantic sub-categories when investigating a grounding of abstract word semantics might appear to be a mere methodological trick to avoid the issue of disembodiment (see Dove 2016), by selecting those kinds of the abstract spectrum that are the least abstract. The two exemplar categories described in the previous paragraphs, mathematical/numerical or abstract emotional terms may appear for some to still have easily imaginable and transparent concrete instantiations, like a smile on someone’s face for “joy” or a basket that holds three apples for the word “three”, despite low concreteness/high abstractness ratings. It is therefore worthwhile to turn to another abstract subclass that arguably look more abstract and “disembodied” than those previous examples. Here, abstract mental words seem to be the ideal test case for words that are classically seen to be “disembodied’ and to investigate the limitation of semantic grounding of abstract words (Shallice and Cooper 2013; Dove 2016).

To investigate those abstract mental words in particular, Dreyer and Pulvermüller (2018) conducted a passive reading fMRI paradigm, similar to the one by Moseley et al. (2012). The nouns categories of interest in this paradigm where hand action related tools, face action related foods, of abstract emotional, or abstract mental nature. Again, categories of interest were carefully matched for psycholinguistic features and great care was taken to indeed assure the abstractness of the abstract words. To this end abstract mental words were shown to only have very low scores on relatedness ratings to either hand, face or leg actions, as well as to visual, auditory, olfactory, gustatory or haptic modalities. Importantly, in contrast to abstract emotion items, also the semantic relation to emotions was rated to be only very low. Unbeknownst to the participants (to avoid any bias for motor semantics or motor activity), the reading paradigm was followed by a motor localizer task in the scanner, prompting movements of either hand, leg or face.

Taking into account individual differences in motor areas, as revealed by this motor localizer task, fMRI results in this paradigm indicate activity dissociations between hand and face motor areas on the left hemisphere to be informative for the differentiation within both abstract and concrete semantic subclasses. In particular, an involvement of face over hand motor areas was observed for abstract mental words, whereas their abstract emotional counterparts showed activation in face and hand motor regions to be of equal magnitude, in accordance to observations by Moseley et al. (2012). These results are consistent with brain language theories postulating semantic grounding of concrete and abstract symbols in the sensorimotor system and a set of potentially complementary theoretical explanations for the bases of the grounding of abstract mental terms in face motor areas are provided. These include a direct grounding in basic actions, a grounding in verbal-communicative sequences, semantic learning by verbal explanation, and/or distributional learning of word-word correlations from texts. As abstract mental words appear to be more difficult to relate to concrete objects and actions than concrete words (as confirmed in the semantic ratings), it has been argued by other authors that grounding by verbal explanation might be especially relevant for this word category (see Borghi and Cimatti 2009; Borghi and Binkofski 2014 and Chapter 2 for a detailed discussion of this perspective). All four theoretical accounts share the property that they could, at least in principle, be realized via Hebbian learning derived neural cell assemblies, spreading over modality general und preferential cortical areas (see Pulvermüller 2018, for a recent review).

In the context of abstract mental semantics (but also in context of abstract mathematical and emotional semantics, as presented before), a recent fMRI study by Ghio et al. (2016) should also be mentioned. In this study, short concrete and abstract sentences, relating to mathematical, emotional or mental/cognitive content were presented. Here, differences in perisylvian cortex but not in modality-preferential pre- and post-central gyri were observed when comparing local multi voxel patterns elicited by sentences with abstract arithmetic, emotional and mental meaning. This is in contrast to results on abstract mental nouns of Dreyer and Pulvermüller (2018).

This discrepancy in results to the studies presented in the previous paragraphs however may very well be driven by methodological differences in analysis and task design between approaches. Ghio et al. (2016), applied variable words in their sentence stimuli, most of which are not matched for crucial psycholinguistic factors, thus adding uncertainty to the causes of any sentence-elicited brain activity patterns. Furthermore, lack of control of the predictability of semantically critical words and their cloze probability may add uncertainty regarding the causes of brain activity during sentence processing. The paradigm applied by Dreyer and Pulvermüller (2018) did not face these potential drawbacks, as the different subtypes of abstract words were well-matched for relevant psycholinguistic variables and presented in isolation, to avoid any issues of semantic predictability, while at the same time maintaining a sufficient level of meaning determinacy, as confirmed by semantic ratings.

As for the results of abstract mathematical and abstract emotion semantics, the finding of a specific face motor contribution to abstract mental word processing once more demonstrates the relevance of fine grained semantic categories when investigating the contributions of modality specific neural systems to processing abstract word semantics.

6. Conclusion

As with concrete words, abstract words also appear to show that sensorimotor contributions to their processing are specific for their exact semantics. On the basis of the exemplary abstract subclasses of words referring to abstract mathematical, abstract emotional or abstract mental concepts, we conclude that a role of motor systems in semantic processing may not be restricted to concrete words but may extend at least to some kinds of abstract symbols, even those that were previously thought to be entirely 'disembodied'. These results provide important evidence for grounded rather than entirely ungrounded theories towards the nature of semantic representations in the brain, as they show that grounded models are not necessarily limited in their scope to concrete concepts but can also account for their abstract counterparts.

In order to derive these conclusions however, it is important to take into account exact abstract word semantics, rather than treating abstract words as a monolithic category. This is not to say that previous investigations that did not consider fine-grained abstract (and concrete) categories cannot be interpreted, but we would like to advocate that researchers align the level of semantic detail in stimulus selection with the degree of specificity in theory driven predictions. As grounded approaches towards the neural basis of semantics allow for predictions of the neural substrates of specific semantic categories in finer granularity than their classical "disembodied" counterparts, this issue is of particular importance when investigating contributions of modality preferential neural systems, for processing of concrete, as well as for abstract word semantics.

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CHAPTER 2

Abstract concepts and the activation of mouth-hand effectors

Claudia Mazzuca and Anna Maria Borghi

Embodied and grounded approaches to cognition have compellingly demonstrated that we comprehend concrete words simulating their meaning through our sensorimotor system (Barsalou 2008). Abstract words, i.e., words that do not have a single and concrete referent, are more difficult to account for in a grounded perspective. According to the Words As social Tools (WAT) proposal (Borghi and Binkofski 2014), in the acquisition and representation of abstract words language plays a central role. Abstract words are indeed mainly acquired through linguistic-social experience (Wauters et al. 2003). We report a behavioral experiment showing that the elaboration of abstract words involves the mouth motor system, as embodied counterpart of the activation of linguistic information, and that the involvement of the mouth is flexibly modulated by the task.

Keywords: abstract words, embodiment, grounded cognition, language processing

1. Introduction

The way in which we comprehend and process language is one of the most important issues in cognitive science. For a long time, the dominant paradigm conceived the mind as a computer, performing operations on amodal symbols (Fodor 1983). Nowadays it is generally accepted that cognition is grounded in the sensorimotor system, and that to perform higher cognitive operations like conceptualization and language we reuse mechanisms and structures of the more basic perception and action systems (Anderson 2010; Gallese 2008; Meteyard et al. 2012). In this view, symbols would be multimodal rather than amodal, and conceptualization and word processing would involve a simulation process, consisting of the re-enactment of bodily patterns, emotional and internal states (Barsalou

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2008), helping us to understand the current state of the world and to interact with the environment.

In support of this view, numerous experimental studies have compellingly demonstrated that when we hear a word like 'ball' our sensorimotor system is activated in a way similar to when we perform actions with the referent of the word. This evidence has, however, a limitation. The evidence provided focuses on words that refer to objects or actions (see Pulvermüller 2005), but it is still unclear how this kind of process can take place in the case of abstract words, i.e., of words whose referent is not directly perceivable through our five senses, or of words that do not refer to actions (Tomasino and Rumiati 2013; Pecher et al. 2011).

This chapter will focus on abstract word meanings. We assume that the distinction between abstract and concrete word meanings (from now on words) is not dichotomous, since all words might include both concrete and abstract aspects. For example, the meaning of the word *money* covers both its exchange value (abstract) and the reference to a concrete, specific object, say, a penny. For the words we will consider as abstract ones (e.g., *freedom*, *beauty*, *justice*, *truth*), the abstract aspect is more relevant. With the term *Abstractness* we refer to the property of words that lack a concrete and unique referent, are more complex in meaning and are characterized by higher variability in meaning between participants and within the same participant than concrete words. Different participants are namely more likely to converge on the meaning of a concrete than of an abstract word; furthermore, being less stable than concrete ones, abstract concepts are more likely to change over time. For example, while both the notion of "bottle" and that of "justice" are continuously updated and changed in light of novel experiences, the changes are more prominent in the case of the less stable abstract concept of "justice". Abstract words we will deal with in this chapter are characterized by these properties (for insights on this distinction see Borghi and Binkofski 2014).

1.1 The WAT theory on abstract words and previous evidence on mouth activation

The most prominent novelty in the studies on abstract concepts is the existence of Multiple Representation theories, i.e., of theories according to which the representation of abstract concepts relies on multiple dimensions (see Borghi et al. 2017 for a review; see also Borghi et al., 2018a; Borghi et al., 2018b Bolognesi and Steen 2018). These theories expand the scope of classical embodied views, according to which abstract concepts are grounded in perception-action, similar to concrete concepts. They highlight the difference between concrete and abstract concepts, underlining the role that emotional, linguistic and social experience plays in grounding abstract concepts. They argue either that, compared to concrete concepts, abstract concepts are grounded to a larger extent in the affective and emotional dimension (Affective Embodiment Approach: Kousta et al. 2011; Vigliocco et al. 2014); that they evoke more linguistically conveyed information (Dove 2011, 2014; Borghi and Binkofski 2014; Borghi and Cimatti 2009; Barsalou et al. 2008; Recchia and Jones 2012), or they evoke more social information and they are grounded to a larger extent in social situations, also because in some cases to access their meaning we need to rely on information from parents or experts (Prinz 2002, 2012; Barsalou and Wiemer-Hastings 2005; Harris and Koenig 2006; Borghi and Cimatti 2009; Crutch et al. 2013; Borghi and Binkofski 2014).

Among Multiple Representation theories, two that focus on acquisition: the Affective Embodiment Account and the Words as Social Tools view. The Affective Embodiment Account proposes that because emotional concepts are the first concepts that do not require a concrete referent to be acquired, emotional words would provide a bootstrapping mechanism that helps children to acquire abstract words (Ponari et al. 2017). According to the Words As social Tools (WAT) view (Barca et al. 2017; Borghi and Binkofski 2014; see also Chapter 5 of this volume), because abstract words refer to more diverse and more complex referents, to acquire them we would rely both on sensorimotor information, as with concrete words, but also on the linguistic and social input provided by others. Other people – parents, siblings, experts – can offer us labels, explanations of word meanings etc., which can complement the sensorimotor input and facilitate the understanding and acquisition of new words (Borghi et al. 2018a; Prinz 2002; Shea, 2018). In this view, the role of language is emphasized as a tool that improves and enlarges our cognitive capabilities (Clark 1998; Dove 2015; Lupyan and Bergen 2016).

In the present chapter we focus on the WAT proposal. In particular, we intend to test the prediction deriving from it that when we process abstract words, the activation of linguistically conveyed information leads to the engagement of the mouth motor system. Previous evidence obtained in our lab and in other labs has revealed activation of the mouth during the acquisition and processing of abstract words. In two studies mimicking the acquisition of novel concrete and abstract concepts and words, adult participants were presented either with novel objects to be manipulated or with groups of interacting objects to be observed. In the first study they had to form categories and were then taught the noun referring to the novel category. Results showed that, when performing a subsequent property verification task on both categories, responses with the mouth (using a microphone) were comparatively faster with abstract than with concrete words, while responses with the hand were facilitated more with concrete than with abstract words (Borghi et al. 2011). In a second study, participants who were taught the novel noun earlier were facilitated in mouth responses, confirming an association between acquisition of the linguistic label and engagement of the mouth motor system (Granito et al. 2015). Previous studies performed in Tettamanti's lab (e.g., Ghio et al. 2013) with a rating task in which participants were required to decide whether abstract sentences involved the hand or the mouth showed that abstract sentences of different kinds activated the mouth effector: mental state sentences received high ratings as to the involvement of the mouth, emotional sentences obtained high ratings as to both mouth and hand involvement, while numerical sentences activated mostly the hand, likely due to the finger counting habit (Fischer and Brugger 2011). Granito et al. (2015) also confirmed the association between the mouth effector and abstract concepts in a rating task on abstract and concrete words (not sentences). In sum, studies mimicking conceptual and word acquisition with novel objects/entities revealed a facilitation for abstract words during word processing when the mouth is involved, while ratings studies indicate that participants evaluate abstract sentences and words as involving the mouth more than the hand.

A direct test of the prediction that abstract word processing involves the mouth more than concrete word processing with an implicit task and real words was performed by Borghi and Zarcone (2016). This study is important for the present chapter because it constitutes the basis for the experiment that we performed and that we will describe more extensively. Participants were presented with abstract and concrete definitions on the computer screen, namely definitions that were more general and scientific or definitions characterized by perceptual properties or thematic relations, that were followed by concrete and abstract words (i.e., concrete/abstract definition: "It shapes icebergs or it can be found in cubes or cocktails. / Element formed by water at zero degrees and in the solid state."; concrete word: "ice"; concrete/abstract definition: "A soldier executing the orders accomplishes it."; "Moral law imposing the execution of moral or legal obligations"; abstract word: "duty".) Their task consisted of deciding whether the definition was suitable for the word by pressing a device if that was the case, while if the definition was not appropriate, they had to refrain from responding (Go/No-go task). In one experimental block the device was a key on the keyboard, to be pressed with the hand, in the other block it was a device to hold in the mouth and to be pressed with the teeth. Responses with the hand were overall faster, due to the device. However, the advantage of the hand was less pronounced with abstract than with concrete words, in line with the hypothesis of an activation of the mouth during abstract word processing leading to a facilitation for responses involving the mouth (Kendall's tau-b and Spearman correlations on Average Mouth Ratings and Hand-Mouth difference scores were negatively correlated, $r = -0.400$, $p = .014$; $r = -.585$, $p = .007$, while the positive correlation between Average hand ratings and Hand-Mouth difference scores in RTs did not reach the significance, $r = .292$, $p = .074$; $r = .406$, $p = .075$).

In the study by Borghi and Zarcone, the hand and the mouth were the response effectors. However, the response device was different, slightly limiting the comparability of results obtained with the two effectors. We therefore decided to perform an experiment in which participants always responded with the same effector, the foot, by pressing a pedal.

2. The present study: An overview

Building upon the findings reported in Borghi and Zarcone, we designed the present experiment in which participants held the same device used for the mouth block in Borghi and Zarcone's experiment (see Figure 1), either in the hands or in the mouth, between their teeth (an extended version of this study can be found in Mazzuca et al., 2018).

Figure 1. Button for mouth and hand responses to catchtrials

To render the participants aware of the fact they held the device, they were required to use it when responding to catch-trials. Being specifically conceived to be used with the mouth the device was quite hard to press when responding with the hands, but this was not important since responses to catchtrials were not recorded.

Compared to the experiment by Borghi and Zarcone, another important variation was introduced. Borghi and Zarcone compared only concrete and abstract words. One of the recent developments in the field, however, is an interest in fine-grained distinctions between kinds of concepts (Crutch et al. 2013; Troche et al. 2014; Borghi et al. 2018a; Villani et al., in press; Ghio et al. 2013, Ghio et al. 2016; see also Chapter 1, this vol.). In particular, emotional words are typically rated as more abstract than concrete words, but they have been considered as a third kind of concept, differing both from concrete and from abstract concepts. For these reasons, in the present experiment we decided to include concrete, abstract and emotional words.

Finally, since Borghi and Zarcone found evidence of mouth activation facilitating responses to abstract words with a task requiring in-depth processing, in the present study we decided to use a task that requires a more superficial level of processing, i.e., a lexical decision task, with the intent of investigating whether the mouth effector is always involved in the processing of abstract words or whether the involvement of the mouth is modulated by the task. The lexical decision task was followed by a recognition task.

Thus, we used a button that participants had to hold in the mouth between the teeth or in their hand, depending on the condition, and a pedal they had to press for the majority of the stimuli. This experiment was aimed at investigating if the processing of abstract words is influenced by the fact of keeping a device between the teeth, in the mouth, even when the mouth was not the direct response effector. Our general hypothesis is that the mouth and the hand effectors should be differentially activated with concrete and abstract words. Specifically, we hypothesize that, compared to processing of concrete concepts, processing abstract concepts involves the activation of linguistic information, and that this leads to the activation of the mouth. As a consequence, we predict that keeping a device in the mouth would selectively facilitate responses to abstract words, in terms of reaction times. As for emotional words, we predicted an intermediate pattern of results, due to their ambiguous status.

2.1 Participants

Forty native Italian speakers with age ranging between 20–30 years participated voluntarily. Handedness was assessed using an abridged version of the Edinburgh Inventory (Oldfield 1971). All participants gave written informed consent to participate, and the experimental procedure was approved by the CNR-ISTC ethics committee.

2.2 Materials

Ninety Italian words were selected from the Della Rosa et al. database (Della Rosa et al. 2010) and following the database criteria we selected 30 concrete words, 30 abstract and 30 words that according to the experimenters had high emotional valence. The selected words were balanced in Familiarity. We considered the dimensions of concreteness and abstractness as distinctive for concrete and abstract words, and we chose emotive words by selecting words with values of abstractness and concreteness in the middle.

An online pre-test was accomplished, in order to verify the emotional valence of words: we asked 25 independent participants to judge the emotional value of each word on a Likert scale from 1 to 7 points, where 1 was rated as non-emotional and 7 as completely emotional. The average emotional valence of the selected words was 2.13 for concrete words, 4.54 for emotional words and 3.63 for abstract words. Since in the literature it is debated whether emotional words can be considered a subset of abstract concepts or represent a kind of concept different from both concrete and abstract concepts (Altarriba et al. 1999; Kousta et al. 2011), the pre-test also aimed to clearly distinguish abstract, concrete and emotional words, avoiding overlaps between abstract and emotional words.

From the original 90 words we selected 48 test words from the rated list (16 concrete, 16 abstract, 16 emotive). The three categories (ABSTRACT, CONCRETE and EMOTIONAL) differed in Concreteness (Student *t*-test for independent samples; $p_s < .001$). The abstract and the concrete, the abstract and the emotional, and the emotional and the concrete selected words differed because the first member of each pair was less imageable, activated less contexts, was acquired later and mostly with the linguistic modality, and was more abstract. Abstract and concrete words also slightly differed in Number of Letters ($p < .05$); concrete and emotional words also differed in Familiarity but abstract and emotional words outnumbered concrete words in Frequency, computed following the COLFIS database (Bertinetto et al. 1995).(For an extended version of this study in which all psycholinguistic variables were controlled, please see Mazzuca et al., 2018.)

We subsequently added 48 pseudowords, such as "clavatta", created by modifying one letter at the beginning, in the middle or at the end of concrete, abstract and emotive words in the same proportion as the critical words. Then we created 24 words to be used as catch-trials: they were Italian words with a bold letter at the beginning, in the middle or at the end of the word. Finally, we selected another 48 new words, maintaining the proportion of abstract, concrete and emotional words for the recognition task. Words that can directly activate the hand or mouth (e.g., tools or food related words) were excluded from the list.

The experiment consisted of two tasks, a lexical decision task and a recognition task that were presented in sequence; the lexical decision task always preceded the recognition one. Two separate lists of words were created for the two tasks: for the lexical decision task we had 24 critical words (8 concrete, 8 abstract, 8 emotive), 24 pseudowords and 16 words used as catch-trials. For the recognition task list, we used 24 critical words (8 concrete, 8 abstract and 8 emotive), 24 new words and 12 words used as catch-trials.

2.3 Procedure

Participants were tested individually and were instructed to respond as quickly and accurately as possible to each trial using a response box connected with a pedal and a button. They were given the instructions on the computer screen and were trained at the beginning of every task. In no cases were further instruction from the experimenter needed; she only needed to specify how to use the button for the mouth responses, and she made sure that participants used their dominant hand for hand responses. Testing took place on a PC running EPrime2 Professional software.

Each trial began with a fixation cross for 500 ms, followed by the presentation of the word. Words remained on the screen for maximum of 1.5 seconds. After 1 second the next trial started.

Lexical decision task
The task was divided into two experimental blocks, each preceded by a training block of 16 trials (8 words and 8 catchtrials). Depending on the block, participants kept the button in their dominant hand or mouth, and according to instructions had to press the pedal. The order of the blocks was counterbalanced across participants. Participants were asked to press the pedal if they read an Italian word, and to refrain from responding if they did not. They were also presented with catch-trials, i.e., words with a bold letter, and were required to respond to them by pressing the button with the hand or mouth, depending on the condition. Here the mouth and the hand were not the direct response effectors, and they were occupied during the execution of the task, even if they were not directly active during critical word processing.

Recognition task
The task was divided into two experimental blocks, each preceded by a training block. Depending on the block, participants were required to keep the button in their dominant hand or in the mouth, between the teeth, and according to the instructions they had to press the pedal to respond. A set of 62 words was presented in each block, composed of 24 critical words, 24 new words and 12 catch-trials. The order of the blocks was counterbalanced across participants. Participants were asked to press the pedal when they recognized words on the screen as words already presented in the previous task, or to refrain from responding if they were new words. When catch-trials were presented, they had to respond by pressing the button with the hand or mouth, depending on the block.

3. Results

Lexical decision
Two 3x2x2 ANOVAs on RTs and errors were performed, one with participants and one with items as random factors, with factors Type of Concept (ABS; CNC; EMO) x Effector (Mouth; Hand) x Congruency (Congruent; Incongruent). For the analyses by participants, condition means were obtained by averaging across words, and for the items analyses they were obtained by averaging across participants.

In the analysis of response times, we found a significant main effect of the Type of Concept factor [F_1 (2, 78) = 24.35; MS_e = 3455.11; p < .001, n_p^2 = .384];

[F_2 (2, 44), $p > .05$]. A paired Student *t*-test by participants showed that responses to abstract words were slower than responses to both concrete words and emotional words [t (39) = 5.363; SE = 9.31; $p < .001$; $d = .438$]; [t (39) = 5.940; SE = 10.23; $p < .001$; $d = .521$], while concrete and emotive words did not differ [$p > .05$]. We found no other significant results [$F_s < 2.3$], although the trend of the Interaction between Type of Concept x Effector factors was in line with our hypotheses, showing that responses to abstract words were slower than responses to both concrete and emotional words, but that they had a slight advantage with the mouth, with respect to the hand. Conversely, responses to concrete words were faster when processed with the device in the hand (see Figures 2 and 3).

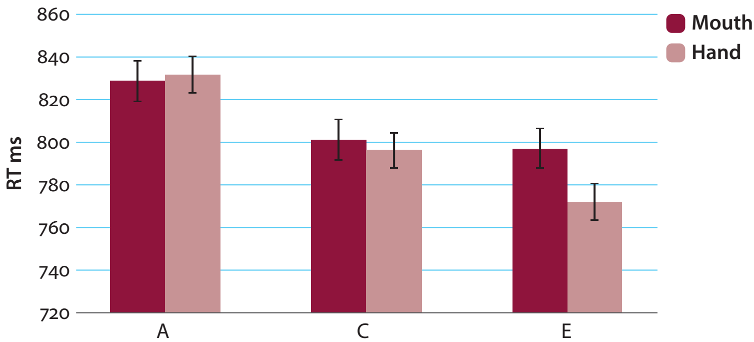

Figure 2. Means of RT in lexical decision

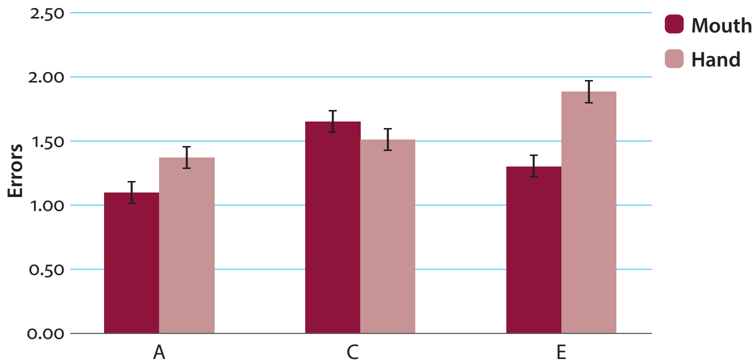

Figure 3. Means of errors in recognition

In the analysis of the accuracy, the main effect of the Effector factor was significant [F_1 (1, 39) = 4.24; $MS_e = 15.33$; $p = .046$; $n_p^2 = .098$]; [F_2 (1, 45) = 5.671; $MS_e = 33.063$; $p = .022$; $n_p^2 = .023$], showing that responses with the mouth were less accurate than those with the hand. No other main effect or interaction resulted as significant [$F_s < .826$]. The findings showed the same trend of concreteness effect of RTs.

Recognition
In the recognition task we focused on the accuracy analysis. Two 3x2x2 ANOVAs on errors were performed, one with participants and one with items as random factors, with factors Type of Concept (ABS; CNC; EMO) x Effector (Mouth; Hand) x Congruency (Congruent; Incongruent). In the analyses of accuracy, the predicted interaction between Type of Concept x Effector was found [F_1 (2, 78) = 4.35; MS_e = 90.258; p = .016; n_p^2 = .100]; [F_2 (2, 45) = 4.35; MS_e = 68.09; p = .019; n_p^2 = .162]. Student *t*-tests showed that when participants responded with the mouth, responses to abstract words tended to be more accurate than responses to concrete [*t* (39) = −1.929; SE = .33; *p* = .06; *d* = .34], while there was no difference with the hand [*t* (39) = −.261; SE = .14; *p* = .8; *d* = −0.03]. Although not significant, the pattern of results is in line with the hypothesized interaction, showing that for abstract and emotional words recognition was facilitated with the mouth, while concrete words were facilitated with the hand.

4. Discussion

Our results clearly show that abstract and concrete words processing was differentially modulated by the effector (hand vs. mouth), even when the effector was occupied and not directly used to provide a response. Furthermore, they show that such modulation was influenced by the kind of task. We will discuss the main results and their theoretical implications below.

Concreteness effect
In the lexical decision task, we confirmed the well-known concreteness effect (Paivio 1986; Schwanenflugel et al. 1992; Barber et al. 2013): concrete words were processed faster than abstract ones (but see Barca et al. 2002; Kousta et al. 2011 for different results). We extended previous results since we showed that this effect occurs even when the abstract words used have higher frequency than the concrete words.

The peculiarity of emotional words
As reported in previous studies, in the lexical decision task emotional words were processed faster than abstract ones, even though the two kinds of words did not differ in frequency [t (30) = −.56, SE = 22.13, *p* > .05, *d* = .19]. Although the set of emotional words we selected was evaluated as more abstract than concrete words, results on the lexical decision task revealed that emotional and abstract concepts did differ in response times, while emotional and concrete words did not. We are aware that null results should be treated with caution. However, our findings

suggest that emotional words represent a specific kind of words, with their own peculiarities, and that they are difficult to assimilate with other abstract concepts – even if participants tend to evaluate them as more abstract than concrete words, their behavior in the lexical decision task is more similar to that of concrete than of abstract words (Altarriba and Bauer 2004; Ghio et al. 2013, 2016; Setti and Caramelli 2005). If we consider the recognition task, instead, emotional words showed more commonalities with abstract than with concrete words as they had an advantage in the mouth compared to the hand condition (see also Ghio et al. 2013; Granito et al. 2015; see Mazzuca et al. 2017; Barca et al. 2017, for discussion on the peculiar role of emotional words compared to both concrete and abstract ones).

Abstract words and the engagement of the mouth motor system

More crucially for our aims, we found that abstract, concrete and emotional words were differentially modulated by the hand and mouth effectors, but that there was a marked influence of the task.

In the Lexical Decision task, the expected interaction between the two factors Type of Concept and Effector was not present. A qualitative analysis of the pattern of data reveals however, in line with our hypothesis, a small advantage for abstract words when processed with the device in the mouth than in the hand. It is possible that the result did not reached significance because the kind of task does not involve deep processing, or because the hand and mouth effects were not the response effectors but were simply occupied in responding to catch-trials. Further research is needed to understand more deeply the reasons underlying these null results.

In the recognition task, the predicted interaction between the two factors Type of Concept and Effector was significant. Responses with the mouth to abstract words were more accurate than those to concrete ones, confirming our hypothesis. The recognition task involves a deeper level of processing than the lexical decision task, and this task might thus require the activation of inner speech to facilitate comprehension and recognition of abstract words.

5. Conclusion

In general, our study reveals that abstract words seem more difficult to process, producing longer RTs in the lexical decision task, but that in the mouth condition they show an advantage in recognition compared to concrete words that instead have an advantage in the hand condition.

In keeping with the WAT proposal, we found that recognition of abstract words was better when the mouth effector was involved. Importantly, the effect was found even if the mouth was not the response effector, but responses were provided with the foot. The higher activation of the mouth with abstract compared to concrete concepts suggests that linguistically conveyed information is engaged in the representation and processing of abstract meanings, through an embodied medium. This study suggests that such mouth activation occurs in tasks implying a deep level of processing.

Further research is needed, to better capture the possible mechanisms underlying such mouth activation with abstract concepts, possibly understanding whether there are distinctions or not between abstract and emotional concepts. The mouth could be involved in conceptual processing for multiple reasons. First, it could be involved because abstract concepts imply the re-enactment of the linguistic acquisition modality (Borghi and Cimatti 2009; Wauters et al. 2003; Bergelson and Swingley 2013). Second, it could be engaged because we re-explain the word meaning to ourselves through inner speech (Vygotsky 1986; Borghi and Zarcone 2016), or because we would be aware of the inadequacies of our concepts and we would need to ask information and help to others (Borghi et al. 2018a). This would occur particularly in tasks that involve deep processing level, such as the recognition task.

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CHAPTER 3

Inferential processing with concrete vs. abstract words and visual cortex

Fabrizio Calzavarini

In this chapter, I discuss the neuroscientific evidence concerning the role of the visual cortex for inferential semantic processing of concrete vs. abstract words. Results of my review suggest that visual cortex activity not only systematically accompanies inferential processing of concrete words, but it is also an active (facilitating) component of it. This is consistent with the Simulation or Embodied accounts of lexical semantic competence, according to which language understanding in general just consists in imagery/simulation processes underpinned by dedicated areas of the brain (e.g., the visual cortex). However, I show that this is not the case for words referring to abstract concepts: inferential processing of abstract words does not seem to involve visual cortex. The theoretical consequences of this phenomenon are also discussed.

Keywords: abstract words, lexical competence, inferential processing, visual cortex

1. Lexical inferential competence and visual-related cortex

Lexical semantic competence, i.e., knowledge of word meaning, is traditionally assessed by means of a variety of verbal semantic tasks, both in production and in comprehension. Some reflections in the philosophy of language (Marconi 1997) have suggested a distinction between two different classes of verbal semantic tasks, i.e., referential and inferential tasks (Marconi et al. 2013; see also Calzavarini 2017). Referential tasks involve the language–world relation as mediated by perception, particularly by vision (e.g., picture naming, word-picture matching), whilst inferential tasks require the ability to deal with semantic relations among words. Examples of inferential tasks are the word-word matching task, in which subject have to select which word among various alternatives is more related in meaning to a probe word, and the definition naming task, in which subjects are asked to

https://doi.org/10.1075/hcp.65.04cal

recover a target word from a definition. Sentence verification, sentence completion, and semantic relatedness decision can be considered as inferential tasks as well (Calzavarini 2017). From a lexical semantic point of view, the defining characteristic of inferential tasks is that, in order to accomplish them, a speaker has to possess a body of knowledge about the network of connections existing between the words of a natural language (*inferential knowledge*, cf. Figure 1 for a visualization of the cognitive processes involved in inferential tasks). Inferential knowledge can be directly conceived as a set of relations between items in the mental lexicon, i.e., the set of mental representations of words themselves (e.g., Landauer 1997). Traditionally, however, it is conceived as a mental catalogue of propositional, quasi-linguistic conceptual representations that is distinct from the mental lexicon. Optimal organization of such inferential knowledge in the cognitive system, together with the ability to access it in an appropriate manner, seems to be a necessary prerequisite for good performances on inferential tasks (Marconi 1997).

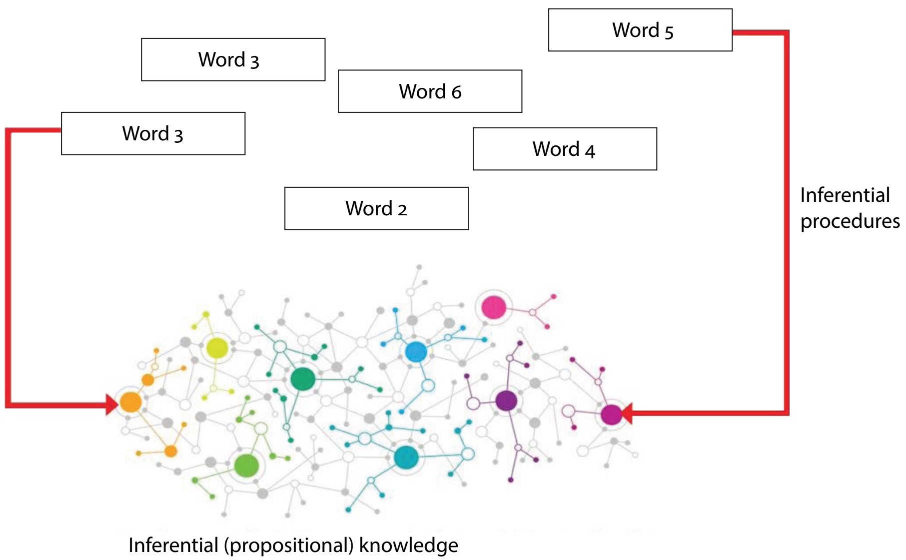

Figure 1. An intuitive characterization of the cognitive semantic processes involved in verbal semantic inferential tasks (reproduced from Calzavarini 2017)

In philosophical semantics, inferential tasks have been assumed to have a privileged connection with quasi-linguistic conceptual information that bears no relationship to the perceptual and especially visual features of their referents (Marconi 1997). It is clear that, if we endorse the propositional view of concepts, the cognitive processes underlying human inferential competence turn out not to rely on sensory, perceptual, or motor systems. Rather, inferential competence turns out to be completely language-driven, in the sense that it does not exploit information outside the language faculty. In accordance with this hypothesis, inferential tasks have been found to be selectively correlated with increased activation in language-related areas of the left hemisphere, such as the superior and middle temporal gyri (Marconi et al. 2013). However, surprisingly, in a previous study (Marconi et al. 2013), some typical visual areas were also engaged in purely inferential tasks, not involving visual perception and recognition of objects or pictures. This activation might reflect visual imagery/visual semantic processes triggered by the concrete and highly imageable sentences and words used in that study. Intuitively, imagery or simulative processes can be expected to play a role in inferential performances when concrete words are involved. For example, defining the word tiger by a visually loaded description like *The animal with black and yellow stripes*, or verifying a statement like *Bananas are yellow*, are tasks which seem to involve the production and on-line processing of mental images reproducing the way tigers or bananas look. This might in turn be associated with the activation of a portion of the same cortical areas that are critically involved in visual processing and visual mental imagery.

Researchers working within the Embodied or Simulation Framework have claimed that mental imagery is critical to semantic competence. Mental imagery is conceived as simulation, the partial re-enactment of perceptual, motor and introspective states acquired during experience with the world, body and mind (Barsalou 2008). According to such an approach, simulation is a necessary condition for the exercise of lexical semantic competence. Understanding a word is taken to involve a partial simulation of the sensorimotor states that would occur during an actual perceptual encounter with the referents of the word. Such simulation is executed by retrieving perceptual information stored in the modality-specific neural systems (e.g., visual system). According to some versions of the Simulation Framework (e.g., Barsalou 1999), simulation is supposed to be constitutive of semantic competence: to know the meaning of a word like *cat* is just to have the skill or ability to generate appropriate visual representations, and perceptual representation more generally, of cats in a given situation (see Kemmerer 2010). As restricted to visual modality, the Simulation Framework predicts that the visual cortex, particularly the visual association cortex in ventral temporal lobes (see, e.g., Martin 2007), stores conceptual knowledge related to the visual attributes of concrete objects. For instance, according to Simmons and Barsalou (2003), visual feature maps in the ventral temporal stream represent low-level visual properties of concrete objects that are routinely mobilized not only in visual recognition, but also in more general conceptual and linguistic processing.

It is clear that, if we endorse such a visually (and more generally perceptually) based theory of concepts, inferential performances heavily rely on the visual association cortex. However, an immediate objection is that many inferential tasks involve the processing of words that express abstract concepts, such as *democracy* or *hope*. Clearly, such words do not have a referent with a characteristic color, shape, or movement; their relationship with visual perception and visual imagery/simulation, if there is any, must be quite complex. At first glance, it is therefore hard to imagine how inferential semantic processing of such words (and sentences built on them) could be grounded in referential visual regions. More generally, the mere existence of abstract, lowly imageable words like *democracy* or *justice* appears to falsify strong versions of modality-specific theories. Nevertheless, according to many of its defenders, the Simulation Framework can account – at least in principle – for semantic processing of abstract linguistic stimuli. Several theoretical proposals have been articulated in the context of attempts to deal with abstract words within the Simulation Framework (see also Bolognesi and Steen 2018 for a recent debate on this issue). For instance, it has been argued that semantic processing of all types of words might involve the activation of concrete situated simulations, i.e., simulations of concrete contexts in which they have been used by the speaker. In order to understand the word *democracy*, the speaker has to implicitly recall, e.g., a concrete situation in which she went to vote, mentally simulating perceived objects such as the pencil she used to vote, the voting card, the ballot papers, and so on. Clearly, within this view, even inferential processing of words lacking visually characterizable referents would induce some kind of visual imagery, perhaps based on metaphoric processes or activation of episodic memory (Lakoff 1990; Prinz 2002).

In this chapter, I shall provide a critical review of the data concerning the alleged role of the visual association cortex during inferential semantic tasks with concrete and abstract linguistic stimuli. The main question I shall try to answer in this chapter is the following: Do inferential processing of concrete words and inferential processing of abstract words differ regarding the involvement of visual cortex? This question can be in turn divided into two parts: (1) Does inferential processing of concrete words involve the visual cortex? (2) Does inferential processing of abstract words involve the visual cortex?

Due to the amount of relevant data, the review cannot be exhaustive, but will be selective. Specifically, I will neither discuss in detail the neuroscience data relevant for the general contrast between concrete vs. abstract words/concepts, nor the theoretical interpretations of these findings (for a recent comprehensive review on this issues, see Borghi et al. 2017). Rather, in the first and in the second section of this chapter, I will focus on a number of neuroimaging and patient studies that have contrasted concrete vs. abstract words during inferential tasks.

Results of my review suggest that, on the one hand, the visual association cortex not only accompanies inferential processing of concrete words but is also an active factor of it. However, patient data do not conclusively support the idea that the visual association cortex is a critical, necessary component of inferential processing with concrete words. On the other hand, inferential processing of abstract words does not seem to involve the visual cortex. Such results are at odds with some particularly strong versions of the Simulation Framework, according to which visual imagery is critical also for abstract words and may have implications also for the inferential/referential distinction. They indicate that an important aspect of inferential processing does not involve visual activity, which speaks for the cognitive reality of the inferential/referential distinction in the human brain.

2. Evidence from neuroimaging studies

Several neuroimaging studies have contrasted concrete, highly imageable stimuli with abstract, lowly imageable stimuli during inferential verbal semantic tasks such as word-word matching (Bedny and Thompson-Schill 2006; Hoffman et al. 2015; Sabsevitz et al. 2005; Wise et al. 2000), semantic relatedness decision (Whatmough et al. 2004), sentence completion (Mestres-Missé *et al.*2009), and definition naming (Mellet et al. 1998). Results of these studies suggest that inferential performances with concrete words, as compared to inferential performances with abstract words, is correlated with selective activation of the visual association cortex in posterior ventral temporal lobe, particularly in the middle portions of fusiform gyrus, parahippocampus, and temporo-occipital junction (e.g., Bedny and Thompson-Schill 2006; Sabsevitz et al. 2005; Whatmough et al. 2004; Wise et al. 2000). Concreteness effects in these areas were clearly left-lateralized. For instance, in the inferential word-word matching task of Sabevitz et al. (2005), triads of concrete and abstract words were presented, and subjects were asked to select which word that was most similar in meaning to the probe word. Results show a strong effect of word concreteness in the left fusiform gyrus, the parahippocampal gyrus, and the anterior hippocampus (Figure 2). Bedny and Thompson-Shill (2006) performed a very similar inferential word-word matching task with concrete vs. abstract words belonging to two grammatical classes (nouns and verbs). Activity in the left fusiform gyrus (among other areas) was found to be correlated with the concreteness of verbs and nouns. These regions are known to be involved in high order visual processing (Kravitz et al. 2013 , and they have been independently associated with the production of visual images in neuroimaging (e.g., D'Esposito et al. 1997; see McNorgan 2012 for a meta-analysis) and traditional neuropsychological studies (see Bartolomeo 2002, 2008).

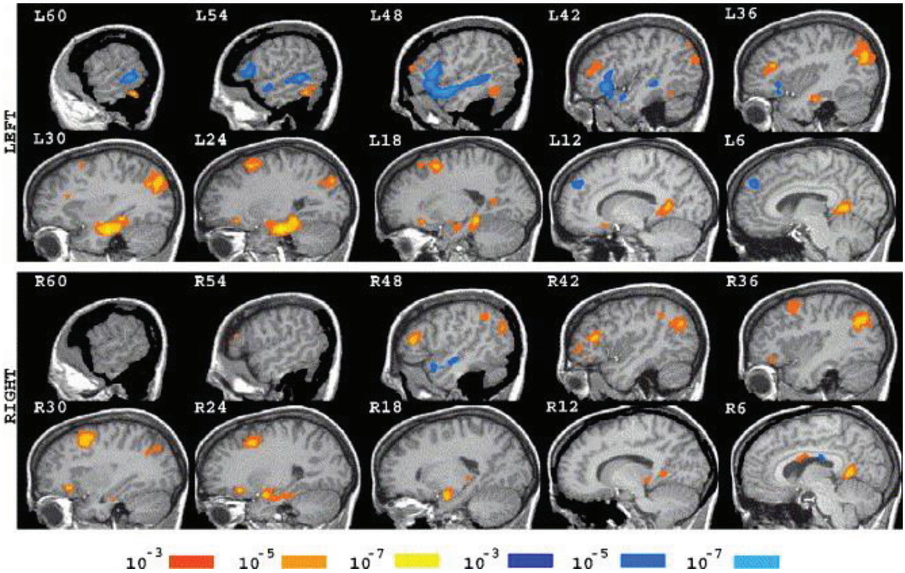

Figure 2. fMRI activation map for the highly imageable (red-orange-yellow) vs lowly imageable (blue-cyan) contrast in the study of Sabsevitz et al. (2005). A major focus of greater activation for concrete, highly imageable words was centered on the collateral sulcus in the ventral visual temporal cortex. This activation was mainly left-lateralized and spread towards the anteror-medial portions of the fusiform gyrus. For more details, see Sabsevitz et al. (2005) (reproduced from Sabsevitz et al. 2005)

These findings, which support the idea that the posterior portions of the left temporal lobe are critical for inferential processing with concrete words, also offer an alternative interpretation, namely that visual cortex activity reflects the explicit retrieval of visual imagery that accompanies inferential performance but is not necessary to it. However, it should be noted that in most of these studies subjects were not explicitly requested to generate visual imagery, suggesting that visual imagery is automatically triggered during linguistic performance. Moreover, results of most of the studies revealed a significant concreteness effect on standard behavioral measures, i.e., accuracy and reaction times, meaning that inferential performance was significantly better during the processing of concrete compared to that of abstract stimuli. Some of the reviewed studies report the typical concreteness effect during inferential tasks such as word-word matching (Hoffman et al. 2015; Wise et al. 2000), semantic relatedness judgments (Whatmough et al. 2004), or sentence completion (Mestres-Missé et al. 2009). For instance, in the word-word matching task of Hoffman and coll. (2015), concrete and abstract words were presented on a screen in a pyramid arrangement. Subjects were asked to perform a semantic judgement task on each triad. The results of this study revealed a significant difference in reaction times in semantic decisions, with significantly shorter reaction times for triplets of concrete words compared to the triplets of abstract words. These results provide further support for the hypothesis that visual imagery is not a mere side effect of inferential processing with highly imageable, concrete words, but an 'active' factor, the role of which is at least facilitating.

Indeed, it should be observed that in most of the visual studies presented above results were potentially confounded by the visual presentation of the stimuli (e.g., Sabsevitz et al. 2005). However, in at least two inferential studies linguistic stimuli were presented acoustically, rather than visually. In the Experiment 2 of Wise et al. (2000), subjects were acoustically presented with triplets of words and were asked to perform a semantic decision task on each triplet. The triplets of nouns were divided into triplets of concrete, highly imageable words (e.g., "Which is closer in meaning to *plank* – *timber* or *wood*?") and triplets of abstract, lowly imageable words (e.g., "Which is closer in meaning to *evidence* – *clue* or *fact*?"). The results revealed a positive correlation between activity in the visual cortex and imageability; activation was found in the left mid-fusiform gyrus, extending along the fusiform gyrus and back to the inferior temporal gyrus. In the naming to definition study performed by Mellet et al. (1998), subjects were asked to listen to 15 words and their respective definitions. In the first ("concrete") condition, both definitions and target words were highly imageable. In the second ("abstract") condition, the words were part of the usual vocabulary expressing abstract concepts. A strong concreteness effect was found in the inferior temporal and fusiform gyrus (among other areas), bilaterally, but mainly in the left hemisphere. Results of these studies suggest that the correlation between inferential performances with highly imageable, concrete words and vision-related regions in the ventral temporal lobe may not be artefactual.

On the other hand, as far introspection tells as, inferential processing with abstract, lowly imageable words (e.g., *hope*) does not seem to involve the generation of mental pictures. Consistently with this observation, neuroimaging studies comparing abstract and concrete materials during inferential tasks do not report selective activation of visual-related cortex during inferential processing with abstract words.[1] Inferential processing with abstract words can plausibly be expected to be associated with a more widespread cortical activation in the language network, particularly in the brain areas that have been found to be selectively dedicated to inferential semantic processing. This prediction was confirmed by

1. An extensive literature has been produced within the Simulation Framework. For reviews and critical discussions, see, e.g., Barsalou (1999); Binder and Desai (2011); Dove (2009); Gallese and Lakoff (2005); Kiefer and Pulvermüller (2012); Lambon Ralph (2014); Mahon (2015); Mahon and Caramazza (2008); Martin (2007); Meteyard, Cuadrado, Bahrami and Vigliocco (2012); Pulvermüller (2012).

studies in which word concreteness during inferential tasks is manipulated. These studies reported selective activation for abstract words in a left-lateralized network in frontotemporal areas comprising the left ventrolateral prefrontal cortex (VLPFC) (Hoffman et al. 2015) and the left middle and superior temporal gyri (Hoffman et al. 2015; Mellet et al. 1998; Wise et al. 2000). One or more of these areas have been consistently activated during inferential processing with abstract words or sentences (Marconi et al. 2013), and have been included in metanalyses of semantic processing (Binder et al. 2009). The strongly left-lateralized activation that has been observed for abstract, lowly imageable words is consistent with a series of patient data indicating a strong correlation between left hemisphere lesions and semantic impairments with abstract words (e.g., Goodglass et al. 1969; Katz and Goodglass 1990).

An initially plausible interpretation of the data is that activation in language and semantic areas during inferential processing involving abstract material reflects a quantitative, and not a qualitative, difference. According to this interpretation, even though inferential processing with both concrete and abstract words causes activation in language and semantic regions, inferential processing with abstract words causes a more intense and protracted activation. This in turn results in a greater value in BOLD response for abstract words. However, it should be noted that some inferential studies with concrete vs. abstract words have controlled for task difficulty by means of task manipulation (Sabsevitz et al. 2005) or statistical analysis (Wise et al. 2000). Interestingly, the results of these studies show that the left frontotemporal network associated with language processing is critical for abstract words even with general difficulty of the task is statistically controlled.

This clearly supports another interpretation of the neuroimaging data, according to which the observed pattern of activation might reflect the involvement of regions that are responsible only for inferential processing of abstract words irrespective of the degree of difficulty of the task. For the purposes of this chapter, however, the critical point is that inferential processing with abstract words does not seem to involve visual cortex activation. Granted, the contrast of concrete and abstract words only shows relative differences and therefore it is still possible that inferential processing with abstract words activates visual-related cortex though at a lower intensity than concrete words. This hypothesis cannot be ruled out based on the neuroimaging studies I have considered in this section, since results of the direct contrast between the abstract conditions and the "rest" or the non-semantic baseline have not been reported. However, the neuropsychological studies we will consider in the next section strongly suggest that the visual-related cortex has no special role in abstract inferential processing.

3. Evidence from patient studies

In the previous section, I have argued that some neuroimaging studies suggest that inferential processing with concrete words activates visual cortex in the left posterior temporal lobe, as opposed to abstract, lowly imageable words, and that such visual activation might reflect visual imagery/simulation processes that is critical for inferential processing with such words, as predicted by the Simulation Framework. From a circulatory point of view, the visual association areas that have been associated with word concreteness/imageability in inferential studies are located in the vascular territory of the left posterior cerebral artery (PCA). It is clear that further support for the hypothesis that the visual association cortex is critical for inferential competence would come from the observation that left PCA damaged patients tend to have corresponding impairments during inferential tasks with concrete words. Some support for this lesional correlation comes from a case-series study of Goldenberg and Artner (1991) investigating visual recognition and linguistic abilities in 55 patients, 19 with left PCA damage, 15 with right PCA damage, and 21 controls. Among the left PCA stroke patients, 10 had vascular damage involving the temporo-occipital branch of the PCA, resulting in extensive lesions to the posterior portions of the ventral temporal lobe, at the junction with the occipital lobe. Results of the study show that left PCA patients had severe impairments in an inferential sentence completion tasks in which they had to verify concrete, highly imageable sentences with reference to objects' shapes (e.g., *The hindlegs of a cat are longer than the forelegs/shorter than the forelegs*) or objects' colors (e.g., *Most squirrels are reddish-brown*), in the absence of more general language impairments or cognitive decline. Since the inferential impairment was associated with visual recognition deficits in picture naming tasks, the authors postulated a loss of visual knowledge in such patients, rather than an inability to recreate visual images from preserved knowledge of visual attributes.

Some more recent single patient studies seem to support the hypothesis that the posterior temporal cortex is critical for inferential competence with concrete linguistic stimuli. For instance, Manning (2000) reported the case of RG, who had a left vascular accident involving the fusiform gyrus and the inferotemporal cortex. This patient presented an association of optic aphasia, pure alexia, and imagery impairment for object form and color. Critically, RG showed significant impairment in inferential tasks with concrete, highly imageable words. In a naming to definition task, RG's performance was very poorly in retrieving concrete words (5/15), and his reaction times were abnormally long (range 10–60s). Similar cases are SRB and DM (Forde et al. 1997; Humphreys et al. 1997), who suffered from a vascular lesion in the left inferior medial region of the temporal lobe extending down to the occipital lobe. A first examination (Forde et al. 1997) reported SRB to have specific impairment in a definition naming task with visual, highly imageable definitions; he scored 39/76 (51%) compared to a mean of 65/76 (86%). In a second examination (Humphreys et al. 1997), both SRB and DM showed comparable inferential impairments with perceptual, highly imageable definitions: SRB scored 39 out of 76 (51%) and DM 32 out 76 (42%). These data seem to support the idea that, in human speakers, preservation of the brain regions associated with vision and word concreteness is necessary for inferential competence with concrete words.

However, it should be noted that, in the case of some of the above-mentioned patients with left posterior vascular lesions, inferential and more general language impairment with concrete words was evident only when the subjects were formally tested in experimental conditions. For instance, the patient of Manning (2000) had no evident language problem in spontaneous conversational exchanges, when no visual stimuli were involved. This might suggest that, at least in some cases, lexical inferential and general language impairment following damage to the left posterior ventral temporal cortex can be subtle rather than catastrophic, and can be limited to relatively complex verbal tasks (Binder and Desai 2011). More importantly, damage in posterior ventral temporal cortex of the left hemisphere is sometimes associated with fairly well preserved inferential performances with highly imageable words (see also Calzavarini 2017). For instance, HJA (Riddoch and Humphreys 1987) had bilateral infarcts of the inferior occipitotemporal gyri, involving the fusiform gyrus and the temporo-occipital junction, greater in the left hemisphere. Despite the lesions, HJA was perfectly able to provide verbal definitions of words referring to common objects or animals (e.g., *duck*), including details about their referents' visual properties. At least three other patients with posterior temporal lobe and/or occipital lesions were still perfectly able to verbally describe the visual properties of common objects and animals (Behrmann et al. 1994; Carlesimo et al. 1998; Fery and Morais 2003).

Contrary to the data I have discussed at the beginning of this section, these latter neuropsychological data clearly support the view that preservation of left posterior ventral temporal cortex is not strictly necessary for the exercise of lexical inferential competence with concrete, highly imageable words. Therefore, further research is necessary to disambiguate between these two hypotheses. The critical point here is that, in contradiction to strong versions of the Simulation Framework, there is no evidence that vascular damage in left visual association cortex is invariably associated with impaired inferential performances with abstract, lowly imageable words. In fact, lesions in the posterior portions of the ventral visual stream are generally associated with sparing of inferential performances in definition naming tasks with "abstract" definitions (Manning 2000), or with "functional-associative" definitions (Forde et al. 1997; Humphreys et al. 1997; Vandenbulcke, Peeters, Fannes, and Vandenberghe 2006). For instance, one of the patients I described, RG (Manning 2000), with fusiform and occipitotemporal lesions, had perfectly preserved performances in definition naming with abstract, lowly imageable definitions (15/15 correct, range 0–2s for each answer). Similarly, JA, with a focal lesion in the fusiform gyrus, had no problem in recovering words when definitions were based on functional-associative attributes (Vandenbulcke et al. 2006). These data strongly suggest that at least some aspects of inferential competence, i.e., inferential competence with abstract words, do not involve left posterior ventral temporal lobe activity.

As I have anticipated in the previous section, impairments with abstract, low imageable words are usually associated with lesions in a left-lateralized language network. Particularly, the left VLPFC has been suggested as critical for the semantic processing for abstract words (see Hoffman 2016; Shallice and Cooper 2013). This region is usually damaged in the syndrome called "semantic aphasia" (SA), which is associated with deregulated semantic cognition, or semantic control (Lambon Ralph 2014). Hoffman, Jefferies, and Lambon Ralph (2010) tested six SA patients, all of whom had left hemisphere damage that included the VLPFC, during an inferential word-word matching task with concrete and abstract word triads. The authors found poorer inferential semantic performances with abstract words in every case. Interestingly, SA patients had better performance when each inferential judgment was preceded by the presentation of a sentence placing the target word in a meaningful context. To explain these findings, the authors suggest that "the patients found it particularly difficult to make decisions about abstract words because, in the absence of context, these words activate a wide range of semantic information and the patients lacked the semantic control resources necessary to focus on the appropriate information" (Hoffman, Jefferies, and Lambon Ralph 2010: 329). In the same study, the authors also observed that rTMS applied to the left VLPFC in healthy subjects selectively affects inferential processing of abstract words but only when words were presented without contextual clue. This suggests a quantitative interpretation of the role of the VLPFC in inferential competence, according to which the greater involvement of this area is due to the inherently greater difficulty of inferential processing with abstract words, rather than a qualitative interpretation according to which the VLPFC underpins a general mechanism devoted to the semantic processing of abstract words/concepts (Shallice and Cooper 2015).

4. Conclusions

To summarize, results of my selective review strongly suggests that visual cortex activity not only systematically accompanies lexical semantic inferential processing of concrete, highly imageable words, but is also an active (facilitating) component of it. This is consistent with the Simulation Framework, according to which language understanding in general just consists in imagery/simulation processes that are sustained by dedicated areas in the brain (e.g., visual cortex). This view entails that also processing of "abstract" words ought to correlate with modality-specific activations, and specifically visual activations (e.g., Prinz 2002). Nevertheless, results of my review do not support this empirical prediction: inferential processing of abstract words does not seem to involve visual cortex. These results may have implications for the first general question raised in the editors' introduction to this volume (i.e., "On which dimension of meaning do abstract and concrete concepts differ?"). They show that the presence/absence of visual cortex activation is an important criterion to distinguish the processing of concrete words from the processing of abstract words in the human brain.

Results of my review may have also implications for the second general question raised in the introduction of the volume (i.e., "How does perceptual experience affect abstract concept processing and representations?"). They suggest, in fact, that visual experience is likely to have little impact on processing of words expressing abstract concepts.

Finally, results of my review may have implications also for the inferential/referential distinction. As I argued, lexical inferential competence is traditionally conceived as a purely verbal/propositional cognitive capacity, without any immediate connection with modality-specific and especially visual structures of the brain, as opposed to lexical referential competence. The involvement of visual-related cortex during inferential performances clearly undermines this assumption, and this in turn seems to weaken the cognitive reality of the inferential/referential distinction at the level of the human brain (see Calzavarini 2017). Nevertheless, results of my review clearly indicate that an important aspect of inferential processing, i.e., inferential processing of abstract words, does not involve visual activity, providing more support for the cognitive reality of the inferential/referential distinction in the human brain.

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CHAPTER 4

Are abstract concepts grounded in bodily mimesis?

Anna Jelec

In this chapter I address the role of mental simulations for processing and representing abstract concepts, suggesting that abstract concepts are grounded in mimetic schemas: dynamic, concrete and preverbal representations that have been observed in early childhood development. The analysis is based on recordings of gesture and speech of a congenitally blind child gathered over the course of three years. The child displayed an early preference for using mimetic strategies to explain abstract concepts but drifted toward more language-centered strategies as she grew older. Through behavioral data collected in a case-study, I provide empirical evidence to support the hypothesis that embodied mental simulation play a crucial role in abstract concepts' cognitive grounding.

Keywords: blindness, bodily mimesis, conceptual development, embodied simulations, gesture, mental simulations

1. Introduction

Theories of embodied cognition propose that thought and language are tightly related to perceptual and motor experience. In other words, what we think and say depends on what we do and feel. While it is relatively easy to draw a link between perception, action, and the emergence of concrete concepts, finding a way to tie abstract concepts and physical experiences has been more challenging.

Research demonstrates that a vast majority of abstract concepts is represented in concrete terms both in speech and gesture (e.g., Cienki and Müller 2008), and that abstract concepts are commonly described in terms related to sensorimotor experiences, e.g., through metaphorical speech and gesture. Despite the consensus that the emergence of meaning depends on the interactions with the world (for a review see, e.g., Borghi and Pecher 2011), there is little clarity as to how non-physical concepts could be grounded in physical experience. Perhaps we should

https://doi.org/10.1075/hcp.65.05jel

seek the origins of abstract conceptualization in the body itself. How is it possible for a child to learn not only the meaning of tangible words, such as *cake* and *ball*, but also to understand more complex notions, like *marriage* and *trouble*?

One option is that memory traces of entire situations can be stored and later retrieved to serve as representations of a specific idea or concept. The mental simulation hypothesis proposes that concepts are embodied simulations: internal enactments of their embodied content (Gallese and Sinigaglia 2011). Within this view, sensory and motor experience is considered a direct part of mental representation, and concepts are generally assumed to be learned in a particular context, which is helpful in their retrieval (Barsalou 2015). In other words, the brain can replay a situation or event as part of its effort to understand meaning. Many studies suggest that both language understanding and solving complex tasks require access to mental simulations. Listening to descriptions of objects, for example, activates those parts of the brain that are related to the objects' perceptual features. Similarly, understanding descriptions of physical actions causes activation of the brain's motor cortex. In a review of evidence for the embodied nature of abstract concepts, Pecher and Zeelenberg (2015) catalog studies showing that actions congruent with the emotional valence of a word can facilitate word retrieval, while incongruent actions have an inhibitory effect. Such studies further support the idea that the meanings of words are associated with congruent actions. These and similar findings have been taken to support the idea that concepts (represented by words) are grounded in simulations activated through the brain's perceptual, motor, and emotive systems (Barsalou et al. 2005). Through the investigation of external representations of conceptual processes, such as speech and movement, the studies described above provide indirect evidence for the mental simulation hypothesis.

Social experiences are likely also an important component of embodied simulations. The Words As social Tools (WAT) theory views simulations of abstract concepts as social in nature (Mazzuca and Borghi, this vol.). More recently, it has been proposed that aspects of mental simulation can be studied through gesture (Marghetis and Bergen 2014; Hostetter and Alibali 2008). Hostetter and Alibali argue, in fact, that gestures emerge from perceptual and motor simulations that underlie embodied language and mental imagery.

Gesture studies contributed to the understanding of the mental simulation mechanism, but the mechanism itself remains underexplored. How and when are mental simulations formed? Can mental simulations account for the formation of abstract concepts, and, if so, what kind of role is played by language? While it is demonstrably a step in the right direction, the mental simulation account of conceptualization would benefit from evidence that people form and use embodied simulations of abstract concepts. Ideally, we would need to see someone spontaneously engaging in mental simulation as a conceptual strategy.

In this chapter, I argue that abstract concepts are founded on mental simulations of embodied experience, and that this is made possible by a process called bodily mimesis (Donald 1991; Zlatev 2013). I discuss evidence in support of two hypotheses: the mental simulation hypothesis, which proposes that "using concepts is qualitatively similar (…) to experiencing the real-world scenarios they are built from" (Bergen and Feldman 2008: 318) and the mimetic schema hypothesis, stating that children's "first concepts (…) emerge as mimetic schemas: dynamic, concrete and preverbal representations, involving the body image, accessible to consciousness and pre-reflectively shared in a community" (Zlatev 2005: 334). Finally, I present the results of a longitudinal case study of DM, a congenitally blind girl observed between the ages of 7 and 10. DM was diagnosed at birth with congenital bilateral optic nerve hypoplasia, a condition that affects the development of both optic nerves making the patient fully blind from birth. I provide examples of the explanatory strategies DM employed to discuss abstract concepts, such as *love*, *crisis* or *success*, as well as examine the developmental changes that occurred in these strategies. Throughout the discussion, I highlight the relevance of DM's spontaneous linguistic and gestural performance both for the mimetic schema hypothesis and mental simulation hypothesis.

2. How do concepts get their meaning?

Experiences leave traces in memory. Theories of grounded cognition propose that concepts are founded on these memory traces. Much of the research conducted over the past 15 years operates on the assumption that concepts are sensorimotor patterns that reflect experience. At the same time, neurological evidence shows that there are differences in the way we process abstract and concrete concepts. If concepts acquire meaning through relevant experience, how is it possible to understand concepts that are loosely connected to physical experience, such as *love* or *crisis*? Abstract concepts are "neither purely physical nor spatially constrained" (Barsalou and Wiemer-Hastings 2005). How do concepts get their meaning? Researchers have proposed several solutions to this problem.[1]

1. Although I make the assumption that the way in which we initially learn a concept affects how we understand it, this section discusses evidence for various aspects of grounding in experience and does not make any claims regarding concept usage or form.

2.1 Are abstract concepts amodal?

Traditionally, concepts have been seen as amodal symbols (cf. Pylyshyn 2007). The symbolic approach proposed that the meaning of a concept consists of the links between abstract symbols. However, symbols are meaningless if they are only defined in terms of other symbols (Harnad 1990).

One advantage of amodal symbolic representation over the embodied account is that it does not require separate mechanisms for abstract and concrete concepts. Both ends of the concreteness spectrum could be represented by similarly abstract symbols. Embodied accounts, on the other hand, need to ground the meaning of abstract concepts.

Today, there is a widespread consensus that knowledge is both embodied and situated, acquired through bodily interaction with the world in a specific setting (Barsalou et al. 2005; but see Bolognesi and Steen 2018 for a recent debate on this issue). Embodied theories share the core assumption that the representation and processing of semantic information recruit the same neural systems that are engaged during perception and action (Vigliocco et al. 2014a) and that mental access to concepts involves the activation of internal encodings of perceptual, motor, and affective experiences. These activations are called mental simulations (Zwaan 2016), multimodal simulations (Barsalou et al. 2005) or sensorimotor simulations (Pecher and Zeelenberg 2015). Their origins, nature and role in grounding abstract concepts are the focus of the first part of this chapter.

2.2 Mental simulations: Meaning construction inside and outside the body

Simulating actions can help us create mental representations. A mental simulation involves the same neural states that were associated with performing or witnessing a particular action but does not require any action to be taking place. During a simulation, motor and premotor areas of the brain are activated to reflect the simulated action or event (Hostetter and Alibali 2008). So what happens if we ask someone to explain how to peel a banana and there is no fruit in their vicinity? While engaging in simulation does not require action, simulations are not always strictly internal. In fact, an explanation of banana-peeling will likely involve some gesture: another way to recruit the body for creating meaning.

Meaning can be constructed inside and outside of the body (Marghetis and Bergen 2014). Inside, embodied simulations use brain areas specialized for perception or action to generate dynamic mental representations. Outside, the body is recruited to create meaning through gestures that represent objects, actions, and ideas (Cienki and Müller 2008). Researchers have long used spontaneous gesture co-occurring with speech as a source of information on conceptual structure and the relation between gesture and conceptual structure has been the subject of intensive inquiry.

One possibility is that gesture is an intermediate step between experience and language, grounding language in action through abstraction of experience (Calbris 2003). Some view gesture and speech as manifestations of the same conceptual process. Spontaneous co-speech gesture and language share some brain infrastructure: the functional network related to Broca's area (Marstaller and Burianová 2015). However, some aspects of gesture production remain separate from language. Studies involving split-brain patients demonstrate that while language production is usually lateralized in the left hemisphere, gesture production is associated with processes in both hemispheres (Lausberg et al. 2007). Such findings suggest that, while gesture and language are closely related, they involve separate channels.

The Gesture as Situated Action framework (Hostetter and Alibali 2008) proposes that gesture is an explicit expression of mental simulation arising when speakers engage in simulation during meaning-making. If embodiment is both internal (mental simulation) and external (gesture) with "bidirectional causal influences between gesture and simulation" (Marghetis and Bergen 2014), then an analysis of the mental correlates of abstract concepts would do well to take into account their gestural representations. Finding aspects of mental simulations in behavior would support the mental simulation hypothesis. However, when it comes to multimodal communication, gesture is hardly the only variable that needs to be taken into account.

A vast majority of abstract concepts is represented through concrete terms both in speech and gesture (Cienki and Müller 2008). This is consistent with the conceptual metaphor theory, which proposes that the meaning of abstract concepts is grounded in concrete experience (Lakoff 2012). Gestures became a source of evidence for conceptual mappings between concrete and abstract domains. They are "visible actions" (Kendon 2004) that express abstract concepts in concrete terms because there is no other way to translate them into the movement of the hands, arms and body. There is no doubt that gestures contribute to the expression of meaning, and little doubt that they are involved in meaning creation. However, certain aspects of simulations appear to be difficult to translate into movement. Perception, emotion and contextual data are prominent elements of the mental simulation hypothesis. If the neural correlates of experience are activated to access meaning, we should be able to observe all types of sensory, motor and affective information. Perhaps multimodal simulations have not been observed outside of the body not because they do not exist, but because their use is a developmental stepping-stone, phased out as communication becomes increasingly language-dependent.

2.2.1 *Concepts and language*

The role of language in concept acquisition has been viewed as qualitatively different from the role of sensorimotor and affective data (Paivio 2007). Researchers generally assume that concrete concepts rely on experiential data while abstract concepts are linguistically coded. A meta-analysis of brain imaging studies on the neural correlates of abstract and concrete concepts showed that different concept types typically activate different brain areas. Processing abstract concepts tends to involve activity in language-related areas. Hence, researchers believe that the verbal system is more involved in processing abstract concepts. Evidence from computational cognitive science suggests that some aspects of meaning representation can be learnt solely from the statistical distribution of words across texts (Schutze 1992). Therefore, it is theoretically possible for some concepts to be grounded in language rather than experience.

Because in this model meaning is determined by proximity to other words in a multidimensional vector space, such approaches are better suited for disambiguation rather than representation of meaning. Computational studies yielded insight into the nature of conceptual structure and the differences between abstract and concrete concepts. Reaction-time studies usually show that concrete concepts are understood more easily and quickly (e.g., Roxbury et al. 2014) and that it is more difficult to provide relevant context for abstract words (cf. Context Availability Hypothesis Schwanenflugel and Schoben 1983). These findings should be viewed in light of the fact that abstract words can be found in texts on a large range of subjects, while the occurrence of concrete words is more constrained. The strength of connection between abstract words and their context is also weaker than for concrete words (Hoffman et al. 2013). Although such studies show that abstract and concrete concepts may be processed differently, others point out that such differences may be an artifact of study design. For instance, abstract sentences can be understood as readily as concrete sentences if presented in an appropriate context (Zwaan 2016).

2.2.2 *Concepts and sensory perception*

The relation between conceptual structure and sensory perception is complex. Understanding concepts requires the activation of context-dependent sensory information, such as vision, hearing, touch and smell. People asked a question about the sensory properties of an object, e.g., "Are apples red?" are quicker to respond if the previous question required them to access the same type of sensory information than if they have to tune into a different sensory modality (van Dantzig et al. 2008). Presumably, answering two consecutive questions involving separate senses is difficult because we engage in mental simulation to access the sensory properties of objects; e.g., to decide whether apples are red we must first simulate the experience of observing an apple. There is a cost to switching between modalities in mental simulations. This modality switching cost is also observed if the first stimulus is sensory (burst of light or sound) rather than linguistic (Pecher and Zeelenberg 2015).

The involvement of the sensory cortex in processing abstract words is relatively less well explored, although studies show that abstract concept understanding involves some sensorimotor cues (Moseley and Pulvermüller 2014; Pulvermüller et al. 2012). In general, it is assumed that mental access to concepts involves the activation of internal encodings of modality-specific experiences. Hence, it is feasible to assume that abstract concepts are associated with experiential information that was relevant at the time of concept acquisition. These experiences are not limited to what we perceive, but also include information about movement and emotion.

2.2.3 *Concepts and action*

Together with perception, action is the most commonly investigated source of experiential data. Mental simulations are also called sensorimotor simulations for a good reason. Understanding verbal descriptions of actions appears to rely on internal motor simulations; studies show that the brain's systems for action and accessing language meaning are interdependent. Transcranial magnetic stimulation (TMS) indicates that motor areas play an active role in word processing. When researchers applied TMS to brain areas responsible for hand movement, participants were slower to respond to words related to hands (in comparison to, e.g., leg-related words) (Pulvermüller et al. 2005). Behavioral studies show a similar effect: if we ask people to move their hands and read sentences describing actions they can judge their relevance better when the movement direction is consistent with the action in the sentence (Glenberg and Kaschak 2002). Similarly, Casasanto and Lozano (2007) observed a relation between manual motor actions (moving a marble) and processing the meanings of abstract words (metaphorical expressions based on spatial words). If the movements were congruent with the direction of the metaphor (e.g., upward movement accompanying the expression "my grades are getting better") the fluency of the speaker increased. Such studies demonstrate that motor data is involved in abstract concept comprehension.

2.2.4 *Concepts and emotion*

The emotional valence of a concept is the degree to which a concept generates positive or negative emotions. It is associated with certain actions: people are likely to approach good things and avoid bad experiences. Studies show that people react more quickly if the action they are asked to do is congruent with the valence of the stimulus. Chen and Bargh (1999) demonstrated that people understand words with positive meanings more quickly if they are asked to perform a positive movement such as pulling a lever (bringing it closer to themselves), rather than a negative movement, such as pushing the lever away. The reverse is also true, as negative words are understood more quickly if participants are asked to perform movements away from themselves. Other studies (Vigliocco et al. 2014a) demonstrated that emotional information is crucial for learning and representation.

Concepts are frequently studied in relation to the words they denote. From this standpoint, it is easy to believe that meaning has a significant emotional aspect as connections between language and emotions are broadly documented. Glenberg et al. (2005) proposed that just like understanding action relies on a mental simulation of that action, understanding emotion relies on mental simulations of emotional states. The strong version of this claim is that language about any given emotion is easier to process if the state of the body corresponds to the emotion in question. Recent behavioral work suggests that abstract concepts rely on affective information to a greater extent than concrete concepts. Vigliocco and colleagues showed that abstract words are judged as more emotionally charged and intense than concrete words. They argued that while "concrete concepts are grounded in our sensory-motor experience, affective experience is crucial in the grounding of abstract concepts" (Vigliocco et al. 2014b).

2.3 Experiential evidence for mental simulations

Grounded cognition attempts to solve the symbol grounding problem by proposing that mental representations (concepts) share processing mechanisms with systems for perception and action, and that those mental representations are simulations of embodied experience. As we have seen, there is plenty of evidence to suggest that understanding concrete concepts relies on embodied simulations.

At the same time, the mental simulation account of conceptualization has been subject to criticism. Studies consistently show a link between concepts and experience in adults, but the origins of this connection are still debated. While embodied accounts of concrete concepts are seldom contested, there is still uncertainty regarding which of the existing theories is the most suitable account of abstract conceptualization. Research showing that perception and action facilitate or hinder certain cognitive tasks does not constitute direct evidence for the existence of mental simulation, but rather provides the most felicitous explanation for the observed data.

3. Are abstract concepts grounded in bodily mimesis?

Concepts are multimodal, likely to be learned as embodied simulations, constructed on the basis of perception, action, language and emotion. For the purpose of this chapter, we assume that embodied simulations ground, although not necessarily constitute, linguistic meaning. The mental simulation hypothesis can easily account for learning concrete or highly imageable concepts. Abstract concepts, on the other hand, are not likely to be associated with a simple set of sensorimotor experiences. In this section, we investigate how mental simulations for abstract concepts could be formed.

3.1 Situated cognition – concepts in context

What kind of experiential data could be used to form a mental simulation of an abstract concept? To answer this question, we need to remember that concepts are seldom learned in a vacuum. New words and ideas are encountered against a social and environmental background. Concepts are not only embodied and grounded – they are also situated in context (cf. Barsalou 2015). Therefore, in the situated cognition paradigm even abstract concepts are associated with rich sets of experiential data. Indeed, a series of studies demonstrated that participants provided with relevant context were able to process abstract words in a lexical decision task just as rapidly as concrete words (Schwanenflugel and Shoben 1983; Wattenmaker and Shoben 1987). With these findings in mind, Barsalou and Wiemer-Hastings (2005) demonstrated that people associate situational properties with both concrete and abstract concepts. Interestingly, while concrete concepts tend to be associated with physical entities and actions, abstract concepts are more likely to be viewed as part of the social dimension of experience. Social experience forms the basis for the intersubjective aspect of conceptualization, as communication relies on sharing concepts through externalization and conventionalization (cf. Schmid's Entrenchment & Conventionalization Model, Schmid 2015). This intersubjectivity is at the forefront of the mimetic schema hypothesis, which proposes that concepts emerge as pre-linguistic mimetic schemas (Zlatev 2014) driven by imitation of behavior–as we will develop now.

3.2 Bodily mimesis, mimetic schemas and concepts

Broadly speaking, bodily mimesis is the use of the body for representational means. The *bodily mimesis hypothesis* states that the ability to intentionally manipulate the body has improved the human capacity for imitation, empathy and communication. In line with situated and grounded cognition, the bodily mimesis hypothesis sees our ability to understand concepts as grounded in experience, which includes perception, action, emotion, and social interaction. Imitation not only grounds concepts in experience but also makes conceptual referents available to others. After all, understanding the world through physical experience is just one aspect of conceptualization. Being able to share that understanding and negotiate meaning with others is equally important for the formation of mental representations. Even before they can speak, children mimic their caretakers' actions to signify what they want. By grounding representation in the world through imitation, mimesis paves the way for the evolution of language (Donald 1991). Zlatev (2013) proposes that the child's early concepts are formed on the basis of the so-called mimetic schemas and learned in a social context.

Mimetic schemas constitute body-based, pre-linguistic, consciously accessible representations that serve as the child's first concepts (Zlatev 2005). They ground but do not constitute linguistic meaning (Zlatev 2007: 327). They can be observed in children's early communicative attempts, for example, schemas available for KICK and KISS (Zlatev 2014). Although they are not linguistic, mimetic schemas are experiential and emotionally charged. For example, the KICK and KISS schemas are each other's opposites in terms of affective valence.

The bodily mimesis hypothesis is not only consistent with the dearth of available empirical data but also compatible with grounded and situated cognition. As an account of the emergence of gesture, it is also consistent with the Gestures as Simulated Action (GSA) framework (Hostetter and Alibali 2008), which proposes that gestures emerge from embodied mental simulations underlying both conceptualization and language.

3.3 Mimesis vs. mental simulation

The use of the body for representational means has been identified as one plausible link between action and mental representation. Piaget (1962) proposed that mental representations emerge from imitation. Zlatev goes one step further to suggest that all concepts emerge as mimetic schemas (Zlatev 2014). In this view, concepts are grounded through mimetic actions through the selective re-enaction of relevant linguistic, sensory, and affective situational experience. The mental simulation hypothesis proposes that "mental access to concepts involves the activation of internal encodings of perceptual, motor, and affective (…) experiences" (Bergen 2015: 142). In other words, the mental simulation hypothesis is remarkably similar to the mimetic schema hypothesis. In fact, Zlatev proposes that mental simulations are instances of "internalised or covert mimesis" (Zlatev 2014) and that the major difference between the two is that simulations are unconscious (Gallese and Lakoff 2005) while mimetic behavior is deliberate. It is clear that the notions of mimetic schema and embodied simulation are compatible as accounts of abstract conceptualization in that both assume meaning is grounded in interactions with the (physical and social) environment. Both simulations (Hostetter and Alibali 2008;) and mimetic schemas (Zlatev 2014; Cienki 2015) have been analyzed at the level of gesture. Mimetic grounding emphasize that learning concepts never occurs in social vacuum. Consequently, efforts have been made to expand the simulation view to include a social dimension (e.g., Barsalou 2015).

3.4 Finding mimesis

Mimesis is "the ability to produce conscious, self-initiated, representational acts that are intentional but not linguistic" (Donald 1991: 168) which manifests in pantomime, imitation, gesturing, shared attention, ritualized behaviors, and many games. So far the notion of mimesis has been applied to children's early gesture (Zlatev 2014). In the context of the mental simulation hypothesis, however, mimetic behavior should not be limited to gesture. If the ability to engage in mimesis (as well as recognize mimetic behavior) supports concept learning, then it would be feasible to assume that mimesis is possible in more than one modality.

Motor behavior is considered mimetic if it fulfills certain conditions: cross-modality, volition, representation, and communicative function. *Cross-modality* means that there is a mapping between proprioception and some other modality, for example when a child moves her hand to her mouth in a scooping motion to mean EAT. *Volition* is taken to mean that the analyzed motion is under conscious control. To satisfy the *representation* condition, the body part and its motion need to be differentiated from and correspond to some action or event. That means a gesture performed from a first-person perspective, e.g., the scooping motion associated with eating with a spoon, is mimetic because it both corresponds to the action of eating and stands for the concept EAT. A similar gesture performed from a third person perspective would not be mimetic because it does not correspond to the action but the observation of the action. Finally, the behavior has a *communicative function* when the subject intends the act to communicate a concept. For instance, by producing the motion for eating, the child communicates the concept EAT, much like they would if they used the word for *eating*. Instances of motor mimesis have been described in studies of children's early gestures (Zlatev 2014). Zlatev showed that mimetic gestures present in early infancy were later gradually replaced by language.

If these criteria are applied to multimodal data, then communication can be considered mimetic if the conditions above are fulfilled in verbal and non-verbal layers of behavior. The first condition is satisfied if there is a mapping between perception and another modality, e.g., the child who saw a barking dog and associated the sound with the concept DOG, later imitates a barking sound "woof woof" to mean DOG. Volition is taken to mean that the behavior in question is under conscious control, that is the sound or speech stream is produced deliberately. To satisfy the representation condition, the sound or speech stream need to be differentiated from and correspond to some action or event. For a sound or speech stream to be mimetic, the verbal behavior cannot describe the event from a third-person perspective but rather needs to be produced from a first-person perspective and stand for a concept, action or event. Finally, the behavior has a communicative function when the subject intends the act to communicate a concept. Ideally, multimodal mimetic behavior would involve the recreation of experience through a variety of sensory modalities and refer to specific situations, confirming the assumption that representations are rich sensorimotor simulations of experiences acquired in a specific context.

A preliminary analysis of verbal mimesis has already been attempted in the context of explanatory strategies used in blindness (Jelec and Jaworska 2014). Here, insights from the previous study are discussed in a longitudinal perspective, which demonstrates that instances of mimesis are also gradually replaced with strategies based on language.

4. Method

As part of a larger research project we have recorded interviews with 12 blind and 7 seeing children to analyze their speech and gesture (Jelec 2014; Jelec and Jaworska 2014). The performance of DM, a girl with congenital bilateral optic nerve hypoplasia, displayed remarkable features in that she explained concepts by providing detailed, multimodal re-enactments of entire situations. To investigate this further, the participant was asked to participate in a slightly amended version of the same study in 2016, when an additional hour of data was recorded.

We used audio recordings of Polish words for abstract and concrete concepts (21 abstract and 21 concrete words) pre-tested for understandability, frequency and tangibility in the course of a previous study (Jelec and Jaworska 2011). A computer program was developed by the author in Psyscript, a programming environment developed for psycholinguistic research (Bates and D'Oliveiro 2003). The software was designed so that it interacted with the participant as if the computer was a person asking (pre-recorded) questions. Both times, the participant was asked to explain 11 concrete and 11 abstract concepts randomly chosen from the list. The analysis in this article focuses on the responses to abstract concepts.

The first series of interviews employed a free speech and gesture elicitation paradigm with two conditions: monologue (where the participant was prompted only with the name of the concept) and dialogue (where the computer asked additional questions). There were no differences in gesture rates between the two conditions (Jelec 2014), therefore the second interview conducted three years later consisted only of the monologue condition. In both cases, the participant was told that the aim of the study was to teach the computer the meaning of concepts by explaining them verbally and in gesture. The sets of concepts used in both interviews were the same, although presented in a different order. One concept ("władza" POWER) used in the 2013 list was excluded from the 2016 list because the participant was unable to describe it in her first interview.

The reasons behind using a computer interaction paradigm rather than more standard researcher-directed interviews are discussed in detail in Jelec (2014). Opting to use a computer instead of a human interviewer had the additional benefit of improved control over the experimental procedure, which ultimately made it possible to replicate the experimental conditions more than two years after the original study.

The experiment took place in a classroom of the child's boarding school. Imagine walking into that classroom and seeing a seven-year-old schoolgirl dutifully explaining ideas to a laptop computer on the desk in front of her. At the moment, the girl (DM) talks about *life*. As she begins, her voice lowers. Speaking in a voice deeper than her usual pitch, she says: "Soon our lovely boy will be born. Yes, my love, you will give birth to a boy." Then, she pitches a high shriek, imitating the cry of a newborn baby. Finally, in a tone reminiscent of the self-assured voice of her mother, the girl concludes: "I will call him Kubuś (the name of her baby brother). He was born, and he will live peacefully when he is an adult." The performance is a re-enactment, a play-by-play of a situation that the participant associated with the abstract concept she was asked to explain. The explanation is rich in sensorimotor detail, with different voices, vocalizations and gestures used to situate the concept within a specific context. In short, it is a mental simulation outside of the mind.

5. Analysis

Across the two experiments, approx. 9 hours of video data had been gathered, transcribed and annotated for the presence of gesture by two annotators, with 30% of the data coded twice and problematic cases resolved immediately through discussion. Data analyzed in this chapter consists of two interviews of the same participant, one conducted in 2013 (when the participant was 7 years old) and lasting approx. 25 minutes, and another conducted in 2016 (when she was 10 years old) and lasting approx. 28 minutes. Both sets of videos were transcribed and divided into chunks, where each chunk corresponds to one explanation of an abstract concept. Each description was transcribed and annotated in ELAN (Brugman and Russel 2004) with speech, vocalizations and gestures marked on separate tiers.

5.1 Gestures

In his analysis of mimetic gesture of normally developing children, Zlatev classified gestures as belonging to one of the three categories: deictic, iconic, and emblematic (Zlatev 2014). This distinction was applied to the current data; from the three categories, only iconic gestures were found in the performance of the participant. This is likely because deictic gestures (pointing) depend on visually based perception of space, while emblematic gestures are conventionalized and thus likely to be acquired visually.

A gesture was considered iconic if it had a clearly marked beginning and end, occurred in a communicative context, and the movements of the body, or parts of it, resembled actions, objects, or events (Zlatev 2014). Iconic gestures were classified according to viewpoint: being performed from a first-person perspective (character viewpoint or CVP) or third person perspective (observer viewpoint OVP). Only CVP gestures are considered mimetic according to Donald's (1991) criteria.

5.2 Mimetic behavior

Behavior was considered mimetic or indicative of the involvement of mental simulation if movements of the hands and body, vocalizations, or speech were used consciously to stand for, or explain a concept. Speech transcripts were analyzed to see whether each explanation fulfilled the criteria listed in the previous sections: cross-modality, volition, representation, and communicative function.

6. Results

At the age of 7, the participant's explanations relied heavily on affective and embodied experience (Jelec and Jaworska 2014; Jelec 2014). Three years later, she still produced some iconic gestures, but none of her explanations satisfied all four criteria for bodily mimesis. Let us refer to those two stages of development as DM(7) and DM(10). Table 1 and 2 sum up how the descriptions of abstract concepts have been classified, and whether they can be considered mimetic.

Table 1. Classification of descriptions as mimetic based on Donald's (1991) features; participant age: 7

Abstract concept	Cross-modality	Volition	Representation	Communicative	Mimetic
LIFE	yes	yes	yes	yes	yes
LOVE	yes	yes	yes	yes	yes
KNOWLEDGE	yes	yes	yes	yes	yes
IDEA	no	yes	yes	yes	no
BEAUTY	no	yes	yes	yes	no
WEIGHT	yes	yes	no	yes	yes
TROUBLE	yes	yes	yes	yes	yes
CAREER	yes	yes	yes	yes	yes
POVERTY	yes	yes	yes	yes	yes
STRESS	yes	yes	yes	yes	yes
SUCCESS	yes	yes	no	yes	no

Table 2. Classification of descriptions as mimetic based on Donald's (1991) features; participant age: 10

Abstract concept	Cross-modality	Volition	Representation	Communicative	Mimetic
LIFE	no	yes	no	yes	no
LOVE	no	yes	no	yes	no
KNOWLEDGE	yes	yes	no	yes	no
IDEA	no	yes	no	yes	no
BEAUTY	no	yes	no	yes	no
WEIGHT	no	yes	no	yes	no
TROUBLE	no	yes	no	yes	no
CAREER	yes	yes	no	yes	no
POVERTY	no	yes	no	yes	no
STRESS	yes	yes	no	yes	no
SUCCESS	yes	yes	no	yes	no

6.1 To mime or not to mime: Explanations of abstract concepts

6.1.1 *Cross-modality*

Cross-modality was taken to mean that there is a mapping between the sense used to perceive the event (proprioception, hearing etc.) and some other modality (movement, speech). An explanation fulfilled the cross-modality condition if the participant recreated experiential (perceptual, motor, affective) data through her body or (verbal, motor, affective) behavior. For instance, DM(7), asked to explain POVERTY, said:

(1) I am very sorry about your toy [pretend-crying]. I cannot find it anywhere, and I've searched in the school. I am very sorry about your best Mickey Mouse. We will look for the CD, and you will stop being so poor.

This utterance is an example of cross-modality because the affect (sadness) is reproduced as mimetic sadness in the form of a vocalization. On the other hand, a description was not considered cross-modal if the experiential data was merely described instead of re-enacted. DM(7), asked to explain BEAUTY to the computer exclaimed

(2) Do you see how beautiful my blouse is? Now, look at the sleeve of my blouse, for instance.

This description is not cross-modal because there is no mapping between the experiential data (presumably, sight) and the means used to explain it. The participant asks the computer to appreciate the blouse but does not explicitly offer her own experience to explain the concept.

As DM develops, there are fewer instances of cross-modality in the explanations. DM(10) explains POVERTY as follows:

(3) My parents … or maybe not. Perhaps not my parents because my parents are rich. But let's say for instance that the parents of some other girl are poor then, how to say it, they simply have no money for anything. And then simply I would never say that my parents are poor because, how to say it, because always my parents can afford everything. But now, how to say it, actually I will have a touch-screen phone then I will write to my friend Ania an SMS about, an SMS with the question why Ania sang that she was poor if she is not. How do I know she isn't? Because she told me.

Here we can see that the associations she makes are linguistic, for instance using antonyms (poor – rich) to relate the concept to her own experience. Similarly, DM(10) explains BEAUTY:

(4) Oh well, beauty is important to me. I would very much like to wear make-up, dye my hair. Although I have been dyeing my hair for two years during summer vacation, and for three years I've been wearing make-up during the summer. It is a lot of fun.

As this fragment shows, once again DM(10) relates the concept to her own experience through linguistic rather than situated means. She employs words related to physical beauty (the Polish word *uroda* tends to be used for physical beauty) – make-up and hair dye. As can be seen from the appendix, the descriptions of DM(10) also tend to be longer and more linguistically elaborate than DM(7)'s.

6.1.2 *Representation*

To satisfy the representation condition, an explanation had to correspond to some action or event but be differentiated from it. The application of this criterion to whole utterances, rather than particular words was complex. Explanations were considered representative when they corresponded to an action or event but re-enacted rather than described it. Scenes re-enacted from the character viewpoint were considered representative, while scenes described from the point of view of an observer were not. This also means that a scene could contain mimetic gestures (CVP gestures corresponding to action) but not be considered overall representative. See DM(7)'s description of TROUBLE:

(5) It was Mother's Day and I did not sing at all. *You are the only one not to sing but sway. If you don't start singing immediately you will not perform*. I had trouble.

The text in italics is produced in a different tone of voice, clearly meant to stand for being scolded by a teacher. This description is considered representative because the re-enactment of an event from CVP is used to stand for the concept of trouble. The presented scene situates the abstract concept for the listener.

Compare DM(7)'s description of SUCCESS:

(6) That means, for example, yyy someone says *I am shy and don't want to sing*, but they sing after all [vocalizes: lalalala].

Although DM uses the word "I" to introduce the protagonist of the situation, she does not re-enact any particular scene. Her voice does not change, and the situation is described from OVP. Later on, descriptions become entirely non-representative as DM(10) no longer re-enacts situations to represent concepts. Rather, she describes scenes from OVP. See her explanation for SUCCESS:

(7) Mr Andrzej, my music teacher, played different intervals, that is distances between sounds [taps on table as if playing the piano] and I had to say what kind of interval it was. He played chords [mimics playing the piano with both hands] and I had to recognize what kind of chord that was: major [taps fingers on table] or minor [taps fingers on table].

This utterance contains CVP iconic gestures (playing the piano), but the movements illustrate particular elements of the story (chords, intervals), rather than stand for the concept of SUCCESS as a whole. The scene is described from OVP. Hence, this description is not considered representative. While 9 out of 11 explanations of

DM(7) were representative from the point of view of bodily mimesis, none of the explanations produced by DM(10) could be classified as such.

6.1.3 *Volition*

Volition is taken to mean that the behavior is under conscious control and produced deliberately, as opposed to, for example, unvoluntary vocalizations of surprise. All explanations of DM(7) and DM(10) were assumed to be deliberate as the participant promptly and accurately responded to cues from the computer.

6.1.4 *Communicative function*

All behaviors had been classified as communicative because both DM(7) and DM(10) displayed clear communicative intent. That is, all the answers that they provided were pragmatically relevant to the questions.

Interestingly, in the data set recorded when DM was seven years old, the participant makes multiple attempts to establish an intersubjective frame of reference by carefully tailoring her explanations to what she perceives as the embodied experience of the computer.

6.2 Intersubjectivity

Intersubjectivity, or the ability to refer in a way that is understood by others, is one advantage of the hypothesis that meaning is grounded in bodily mimesis. If mental simulations are founded on mimetic behavior, then references are immediately available both inside the mind, as mental simulations of the imitated situated concept, and outside of the mind as externalized simulations. To answer the question how abstract concepts are formed, we need to take into account that grounding has an intersubjective component. Throughout her performance as a seven-year-old, DM(7) made multiple attempts to establish a shared platform of reference with a computer. Explaining WEIGHT:

(8) If you have *games inside you they can be heavy*. For example, like a double bass. Or if you have some music in you where they play the double bass. The lady told me you are not very smart but double basses are very heavy.

Here, in an effort to relate to an interlocutor whose experience she assumes to be different from her own, DM(7) comes up with an experience that she believes would be relatable for a computer: music and games installed in the machine. Similarly, when asked to explain TROUBLE, she offers:

(9) If your keyboard broke or if you don't yyy don't want to be switched on because you are broken then you are going to have trouble.

Earlier, the child brought up a story in which not wanting to sing had negative consequences for her. DM(7) knows that computers are rarely asked to sing, but she also realizes they have certain functions. To make the explanation intersubjective, DM(7) substitutes singing with "being switched on". Realizing that the anatomy of a computer is different from that of a human but likely subject to similar constraints, she suggests that a computer may experience a keyboard malfunction as a type of TROUBLE. In a similar vein, the idea of BEAUTY is explained as follows:

(10) If you didn't talk in the voice of an old grandpa, but for example like my computer, my teacher, then you would sound beautiful.

In an effort to explain BEAUTY to a machine DM(7) cannot rely on appearances. After all, humans and computers seem to have vastly different beauty standards. However, the computer program speaks in recordings of a male voice, which she can compare to other familiar voices and offer her judgment of what she assumes is shared experience: that the soft, feminine voice of her teacher is more beautiful than the low masculine voice of the computer program.

Finally, POVERTY is explained by referring to the computer's awareness of the existence of other computers:

(11) Imagine that you are a toy like my two toy computers. That means you aren't real. And imagine your batteries ran out. And then you could be poor.

All of the above examples demonstrate clear attempts to establish an intersubjective frame of reference with someone whose embodied experience DM(7) assumes to be different from her own. The computer interacts with her in a male voice, so she refers to voice quality as a means to explain beauty. Computers do not have bodies like people, but she knows that they store data, so this becomes a way to explain WEIGHT. Computers do not attend classes, but they are expected to do certain things. Therefore, TROUBLE is a situation where the computer breaks down and refuses to perform. Perhaps the most interesting assumption is that the computer experience is not only embodied, but also social. DM(7) refers to the existence of other computers that are not "real" because they are toys. It is not that toy computers are not real in any objective human sense. They are not real only from the perspective of an actual working computer. In other words, DM(7) proposes that toy computers and real computers are different variants of the computer species, and believes that her computer interlocutor shares this assumption. Attempts to establish intersubjectivity were not found in the later interview, possibly because DM(10) was more familiar with computers.

7. Discussion

In the age of big data, what insight can be gained from a detailed description of a singular phenomenon? The analysis above is based on a longitudinal case study. Naturally, it could be said that the performance of one disabled child cannot serve as evidence for anything more than the creativity of the young participant. After all, the study that originally sparked interest in external mental simulations included more than 20 participants (Jelec 2014) and while simulation behavior was noted in other students (Jelec and Jaworska 2014) only DM reliably exhibited the behavior that could suggest mental simulations used outside of the mind.

Historically, case-studies such as that of Phineas Gage, the man whose personality changes after a traumatic brain injury sparked scientific interest in the role of the frontal lobe (Damasio 1994), had paved the way towards resolving many mysteries of the human mind (for a discussion see, e.g., Siggelkow 2007). Strategies identified in DM's performance may or may not be generalizable to a broader population. However, their existence demonstrates that in the search for the evidence for mental simulations researchers are not necessarily constrained to studies of the mind. On the contrary, simulations could be a phenomenon observed both inside the mind (e.g., through reaction time studies) and outside it (through gesture analysis).

The results of this study support the hypothesis that gesture is a type of simulated action (Hostetter and Alibali 2008). At the same time, they expand the boundaries of what can be considered external embodiment. It is clear that motor action is not the only modality that permits simulation. As DM put herself in the shoes of various speakers, conjuring situations relevant for each concept, she reproduced linguistic data by repeating others' sentences verbatim, launched simulations of perceptual representations (e.g., by vocalizing the screams of a newborn or the sound of a closing car trunk); recreated the affect of a given experience (e.g., fake-crying to demonstrate sadness), and used motor representations by performing mimetic gestures (e.g., pretending to play the piano). It is perhaps unsurprising that DM was able to use mental simulations for concrete concepts successfully. After all, concrete concepts are expected to have straightforward associations to sets of experiential data.

This study focuses on her explanations of abstract concepts, which also took the form of simulations. Clearly, for DM external mental simulations represented a coherent cognitive strategy. What is more, this behavior could not have resulted from observation, as DM was born entirely blind.

8. Conclusions

This study investigates a unique phenomenon – the explicit use of embodied simulations as abstract concept representation strategies by a congenitally blind child, and their subsequent disappearance in the course of the child's development. I have shown that multimodal re-enactments of entire situations can be considered a type of mental representation strategy, as they are found in the behavior of a child who could not have learned to do so through observation. Importantly, the behavioral data discussed in this chapter demonstrates that abstract concepts can be grounded in embodied simulations, and that this information can then be retrieved for communication purposes.

This study supports the view that embodiment can operate outside of the body. The relationship between mental simulations and motor behavior has already been discussed by Hostetter and Alibali (2008), who argued that gestures emerge from perceptual and motor simulations that underlie embodied language and mental imagery. In this way, gesture became an important avenue for the study of mental representation. Yet, embodied simulations consist of multiple types of experiential data, including representations of motor, sensory, emotive and social experience.

Beyond gesture studies, the complex and multimodal nature of embodied simulation as a representation strategy has so far been studied primarily through psychological and linguistic empirical methods, such as the lexical decision task. While the results of these studies yield substantial support to the mental simulation hypothesis, the analysis of spontaneous communicative behavior can directly demonstrate that mental simulations are not merely available as a conceptualization strategy, but actively used for conceptualization and communication. This study contributes to the understanding of abstract concepts by showcasing examples of behavior where a child consistently chooses to rely on embodied simulations as a conceptualization strategy, in that she performs rich, modality-specific re-enactments in order to explain a series of abstract concepts. The behavior highlights the complex nature of representation that goes beyond sensorimotor data and into the domain of emotion and social behavior (e.g., the child pretend-crying to demonstrate the affective valence of POVERTY).

I also argue that the representation structure necessary to produce these re-enactments is likely to be established through bodily mimesis (Donald 1991). This allows the child to understand the world through imitation and subsequently share her experiences with others. The observed data are consistent with the mimetic schema hypothesis, which proposes that concepts are grounded in experience through mimetic behavior (Zlatev 2007, 2014).

One advantage of this view is that mimesis not only grounds representation in experience, but also makes it intersubjective and immediately available for sharing. As we have seen in DM(7)'s performance, entire situations stored in memory and associated with a given abstract concept can be used to achieve a goal in a communicative setting. Furthermore, such simulations can be creatively applied in a hypothetical scenario to make mental representations available for sharing even with an interlocutor whose experiences are radically different from the speaker's. Both representation and communication are grounded in the capacity for mimetic behavior.

This volume tries to answer four important questions regarding the nature of abstract concepts, among which is the issue of perceptual experience and its role in abstract concept processing and representation that has been tackled in this chapter. I have argued that multimodal simulations are not merely a theoretical construct, but rather cognitive strategies observable in spontaneous behavior. If gestures reflect the motor layer of embodied experience, it is plausible that all perceptual layers are available for re-enactment. And, indeed, the many of the analyzed behaviors can be traced back to sensory, affective and social experience. Although adults may choose not to explicitly perform multimodal mental simulations, the relevant data remains available for conceptual tasks such as property listing or motor behavior, such as co-speech gesture. Conceptualization strategies observed in adults might be different from those employed by children. Perhaps this is why spontaneous multimodal simulations have so far not been reported in neurotypical adults.

It needs to be noted, however, that the observations have been made in a very specific population. Further research on the topic should be extended to include other atypical populations and participants at various stages of development, including children. Many such efforts are already under way, including a series of studies on semantic representations in the blind (cf. Lenci et al. 2013). Studying atypically developing populations is a complex endeavor, not only because of ethical concerns but also due to significant interpersonal variation in the subjects' performance. This is especially important when multimodal analysis is used to study conceptual structure of congenitally blind persons, as their motor behavior may differ from their seeing peers. Nevertheless, such studies can be sources of valuable insight regarding spontaneous communicative behavior in the absence of a visual model.

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CHAPTER 5

Is the acoustic modality relevant for abstract concepts?

A study with the Extrinsic Simon task

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An emerging class of theories of knowledge assumes that the representation and processing of concepts is achieved by reactivating multiple aspects of experience. Abstract concepts such as *freedom* and *justice* constitute a challenge for these theories because they have no clearly identifiable referent that we can experience. The Words As social Tools theory (WAT) posits that while both concrete and abstract concepts activate sensorimotor networks, the linguistic network is activated more by abstract than by concrete concepts given that the mode of acquisition of abstract concepts relies more on language. In this chapter we extend this argument and report results from an experiment with the Extrinsic Simon task suggesting that when we process abstract words we re-enact the experience of their acquisition and/or explain to ourselves their meaning.

Keywords: abstract concepts, Extrinsic Simon task, Words As social Tools (WAT) theory

1. Introduction

Why are concrete words (e.g., *table*) faster and easier to learn, recall, comprehend, read and process in lexical decision and word naming tasks than abstract words (e.g., *freedom*)? Traditional theories ascribe this concreteness advantage to the existence of a dual coding system of semantic memory (Dual Coding Theory, DCT: Paivio 1971, 1986, 2007). That is, semantic memory is conceived as consisting of two representational codes: the verbal and the imaginal (or imagistic) codes. While the verbal code involving associated linguistic representations is assumed to be available during processing of both concrete and abstract concepts, the imaginal

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code involving images of objects would only be available during processing of concrete concepts, given the richness of perceptual information that characterizes them. The availability of a dual system of representation for concrete words would thus explain their advantage over abstract words.

The explanation of concreteness effects in terms of disposable systems of representation has been questioned by a different proposal emphasizing the availability of information from prior knowledge. According to the Contextual Availability Theory (CAT: Bransford and McCarrell 1974; Kieras 1978; Schwanenflugel 1991; Schwanenflugel, Harnishfeger, and Stowe 1988; Schwanenflugel and Shoben 1983), concreteness effects can be best explained assuming differential availability of context for abstract and concrete verbal materials. Thus, people are facilitated in determining the appropriate linguistic information and world knowledge for concrete words because these words are strongly linked to a narrow range of more complete representations in memory. By contrast, people experience greater difficulties in determining the adequate contextual information for abstract words because abstract materials are weakly linked to a much wider range of less detailed representations in memory.

More recently, a promising perspective on abstract concepts known as Multiple Representation theories proposes multiple formats of representation for concrete and abstract concepts (for a review see Borghi et al. 2017; Borghi et al. 2018; Bolognesi and Steen 2018). Within this stream, a number of proposals have been advanced, starting from the idea that not only concrete concepts but also abstract ones are grounded in perception and action systems, though other factors also play a major role in characterizing them (for a review see Borghi et al. 2017). Multiple Representation theories mostly focus on emotional (e.g., Kousta et al. 2011; Moffat et al. 2015; Newcombe et al. 2012; Siakaluk et al. 2014; Vigliocco et al. 2014), linguistic (e.g., Barsalou et al. 2008; Dove 2009, 2011, 2014; Recchia and Jones 2012), and linguistic and social experience (e.g., Borghi and Binkofski 2014; Borghi and Cimatti 2009; see also Prinz 2002, 2012; Farias et al. 2013 for different yet related views). Importantly, these theories take into account the most innovative aspects of distributional accounts (Landauer and Dumais 1997; Lund and Burgess 1996), according to which meaning is given by distributional patterns of co-occurring words. As a matter of fact, Multiple Representation theories bridge distributional account that model semantic representations based on simple word co-occurrences, with embodied and grounded accounts of cognition, according to which semantic representations encompass information derived from experience (Andrews et al. 2014; Barsalou 2008; Glenberg and Gallese 2012; Pulvermüller and Fadiga 2010).

A recent proposal adopting this grounded approach, known as the Words As social Tools (WAT) theory (Borghi 2013; Borghi and Binkofski 2014; Borghi and Cimatti 2009), proposes that concrete and abstract words differ because of their different contexts of acquisition. Thus, concrete words would be mainly acquired through sensorimotor experience of the world, whereas abstract words would be mainly acquired through linguistic and social experience. To illustrate, a table can be seen, touched, we can eat upon it, we can even smell its wood's scent or hear the noise it makes when we move it. In contrast, abstract words such as *freedom* have no clearly identifiable referents that we can perceive through our senses. That is, we cannot see or smell freedom except figuratively speaking. Moreover, unlike concrete words, which have a physical, perceivable referent, abstract words are related to a wide range of situations and domains. For example, the content of *freedom* relates to a bird being let out of a cage as well as to a man being let out of the usual rules or patterns of his life, and to the liberty of speech, the ease of movement and performance, etc.

Although abstract words lack physical objects as referents, WAT argues that they (i.e., their processing) nevertheless involve sensorimotor brain networks given their broadly-focused and complex contents, which mostly evoke events and situations anchored to everyday experiences. Yet abstract words also and especially involve linguistic areas, i.e., areas related to auditory processing, language production and phonology as well as social areas. That is, given the higher heterogeneity of abstract words, we become aware of the inadequacies of the underlying concepts through metacognition, and we feel bounded to rely more on the competences and the help of others in order to grasp their rich meaning (see Borghi et al. 2017). Specifically, the WAT theory assumes that, since the physical environment is less efficient as a scaffold to support the acquisition of abstract concepts, language itself would play an important scaffolding role for these concepts. The more various and heterogeneous the experiences evoked by abstract concepts, the more crucial language would be to keep them together like a sort of glue (see also Chapter 2).

It is worth noting that although the emphasis on language is in common with distributional theories of meaning (e.g., Landauer and Dumais 1997; Lund and Burgess 1996), the WAT proposal does not consider language activation as simply given by associations between words. Instead, it assumes that a simulation of pronouncing the word (and, possibly, a simulation of the explanation of its meaning) occurs, involving the oral motor system (see also Topolinski and Strack 2009) as well as auditory resources. That is, a re-enactment of configurations of neurons previously established during our interaction with the word would take place on subsequent uses of that word.

In this chapter we focus on whether in order to access the meaning of a word we actually re-enact previous acquisition experiences of that word. In addressing this question, we will first present previous findings in line with the WAT theory, and then turn to illustrate and discuss recent empirical investigations of specific WAT predictions.

1.1 Previous findings in line with the WAT theory

Evidence in favor of the WAT theory comes from psycholinguistics studies (e.g., Wauters et al. 2003) showing that the mode of acquisition of words (MoA), i.e., the way people acquire the meaning of a word, either perceptually, linguistically or both, is a valid measure of the type of information a concept consists of. Wauters et al. (2003: Experiment 1) asked 26 students to rate MoA for 566 words selected from reading texts in elementary schools on a 5-point rating scale where 1 indicated word meaning acquisition through purely perceptual information and 5 indicated word acquisition through linguistic information only. They found that MoA of words occurring in Grades 1 and 2 reading texts was rated low on the scale, whereas MoA of words occurring in Grade 4 to 6 reading texts was rated high on the scale. Higher MoA ratings in the higher grades were also observed with a different sample of participants (i.e., educational professionals, see Experiment 2). Furthermore, a sudden increase in the number of linguistically acquired words has been observed after Grade 5 in both experiments.

Given that linguistic information is necessary to acquire the meaning of at least some concrete and imageable words (e.g., *balsa wood*; *comrade*), Wauters et al. (2003: Experiment 2) also investigated whether MoA can be differentiated from concreteness (CNC) and imageability (IMG). Concreteness and imageability ratings for 283 words (half of those used in Experiment 1) were made on a 7-point scale with 1 indicating low concreteness or low imageability, and 7 indicating high concreteness or high imageability. Although results showed that words with a high concreteness rating or a high imageability rating tend to have low MoA ratings and that words with low imageability and low concreteness (i.e., more abstract words) tend to have high MoA ratings, judgments of words in terms of the MoA were different from judgments of words in terms of concreteness and imageability. Specifically, MoA did show an increase between grades, whereas concreteness and imageability did not. Thus, MoA and concreteness (and imageability) are not the same type of measure.

Finally, using data from two other studies (Van Loon–Vervoorn 1985; Krom 1990), Wauters and colleagues compared MoA ratings with the age of acquisition (AoA) ratings for 444 of their words. Neither MoA predicted AoA nor AoA predicted MoA completely. All of these results show that MoA is a variable capable of representing the experiential and linguistic components of meaning and confirm that while some words are actually acquired through sensorimotor experience, others are mainly acquired through linguistic inputs. Similar results have been demonstrated by a number of other psycholinguistics studies (e.g., Della Rosa et al. 2010; Wauters et al. 2008).

Further support in favor of WAT comes from fMRI research. Sakreida, et al. (2013) demonstrated that besides activating the core sensorimotor areas, abstract concepts engaged part of the language processing system. Specifically, reading multi-word expressions containing either a concrete noun/verb or an abstract noun/verb (e.g., *caress a dog/an idea, think of a dog/an idea*) led to the activation of the left lateral (precentral gyrus) and medial (supplementary motor area) premotor cortex regardless of the type of the noun-verb combination. However, at the same time, considerable differences in neural activation (other than the motor activation) were observed as a function of the concreteness or abstractness of the noun-verb combination. That is, concrete noun-verb combinations (e.g., *caress a dog*) elicited activation of the fronto-parietal network, which is a network involved in object perception and manipulation (see Binkofski et al. 1999; Buccino et al. 2001), whereas abstract noun-verb combinations (e.g., *think of an idea*) evoked a remarkable activation in the left anterior middle temporal gyrus, an area known to underlie lexical and phonological processing (see Price 2010).

Converging evidence has been provided by meta-analyses (Binder et al. 2009; Wang et al. 2010) consistently reporting strong activation of the left inferior frontal areas, i.e., left inferior frontal gyrus (LIFG) (Broca area, BA 44/45), left middle temporal gyrus (LMTG), and superior temporal gyrus (LSTG) – areas typically associated with phonological processes, lexical retrieval, and verbal short-term memory – during processing of abstract concepts. Importantly, it has been shown that the LIFG is involved in subvocalizations (Fiebach et al. 2007), and in phonological processing during working memory tasks (Fiebach and Federici 2004). Furthermore, lexical decision has been shown to be less accurate with LIFG TMS stimulations (Papagno et al. 2009). Moreover, it has been found that lesions to left IFG produce deficits in phonological and syntactic processes (Bookheimer 2002). This multi-faceted body of evidence is fully in line with the WAT assumption that different types of linguistic information (i.e., semantic, phonological, orthographic, and syntactic) comprise abstract concepts representation.

Moreover, the left middle temporal gyrus (lMTG) activation has often been linked to text comprehension (Ferstl et al. 2008), access to word meaning (Acheson and Hagoort 2013) and comprehension of ironic messages (Bosco et al. 2017). More specifically, the finding of different activations of the left middle temporal gyrus (MTG) during processing of abstract and concrete words has been linked to the use of different retrieval strategies (Noppeney and Price 2004), which is consistent with the WAT hypothesis that abstract and concrete words are acquired according to different modalities, the abstract words relying more on linguistic information.

Interestingly, many studies also reveal that the concreteness effect decreases with age (for a short review on concreteness effects in aging, see Borghi and Setti 2017). In one study in which the concreteness effect is unaffected by age (Roxbury et al. 2015), LIFG is relevant to abstract words more in older than in younger adults, likely because of the activation of compensatory strategies.

1.2 Empirical investigations of WAT predictions

Since, according to WAT, the contexts of acquisition vary for concrete and abstract concepts, a straightforward prediction is that abstract concepts activate the mouth-related motor system more because of their link with language, whereas concrete concepts activate the hand-related motor system more given their link with manipulative actions. Evidence supporting this prediction has been gathered by behavioral (Borghi et al. 2011; Borghi and Zarcone 2016; Ghio et al. 2013; Grade et al. 2016; Granito et al. 2015) as well as neuropsychological and fMRI research (Dreyer et al. 2015; Fiebach et al. 2007; Lieberman 2009; Moseley et al. 2011; Papagno et al. 2009; Petrides 1994; for a review see Binder et al. 2009; Wang et al. 2010).

A further prediction ensuing from WAT is that, due to their link with language, abstract concepts should activate the auditory modality more than the visual one. That is, since auditory processing and phonological information are assumed to underlie the acquisition and representation of abstract concepts, this should result in a tighter connection between abstract concepts and the auditory modality. To illustrate, in order to access the meaning of abstract words people might internally reproduce their sounds, re-enact their modality of acquisition and/or explain to themselves their meaning.

In this chapter, we address the question of whether the activation of linguistically conveyed information (i.e., that concerning abstract words) also triggers the re-enactment of an acoustic experience – for example, the experience of being taught the name of the concept and of being explained its meaning. Previous research (e.g., Hoffman et al. 2015) investigated differential activations during semantic judgments for concrete and abstract words. Hoffman et al. (2015) showed that although the Anterior Temporal Lobe (ATL) was clearly involved in processing both types of words, there was a graded specialization in its function. To illustrate, within the left ATL, abstract words (e.g., *alternative*) activated more strongly the Superior Temporal Gyrus (STG), which is a dorsolateral temporal area associated with acoustic experience, while concrete words (e.g., *asparagus*) preferentially activated the fusiform and parahippocampal gyri, which are ventromedial temporal areas associated with visual experience (see also Binney et al. 2012). Importantly, Hoffman et al. demonstrated that this graded specialization, which had been previously observed by studies manipulating the perceptual modality of the input stimulus (picture vs. word, see Visser et al. 2012), can also be observed when the type of words (i.e., concrete vs. abstract), each with its own relevant type of conceptual information (i.e., sensorimotor vs. linguistic), is being manipulated.

Building on the neuroimaging finding that auditory-verbal experience is involved in abstract conceptual knowledge, we assessed to what extent the acoustic modality is relevant for abstract concepts by means of implicit measures. An implicit measure has been defined as "a measurement outcome that reflects a certain attitude or cognition in an automatic manner" (De Houwer 2006: 14). Being implicit in this sense thus refers to the fact that in the current study, three coexisting and interdependent conditions occurred: (a) participants were unaware of what the measurement outcome could reflect (see Brunel et al. 2004); (b) participants did not have conscious access to the behavior being measured (see Asendorpf et al. 2002); (c) participants had no control over the measurement outcome (see Fazio and Olson 2003). With implicit measures, participants are not required to perform a self-assessment. Rather, the measurement concerns another behavior (in our case, discriminating the ink color of words), which reflects the automatic processing of a certain stimulus (in our case, the processing of abstract and concrete words). Thus, participants are unaware of the aim of the study (i.e., what the task measures) since they are unable to discern the test stimuli from the priming or training stimuli. The most interesting aspect of implicit measures is that they provide an insight into the effects of automatic processing (for a discussion on implicit measures see De Houwer 2006). That is, using implicit measures allows studying mechanisms such as that of simulation, which are considered to be quintessentially automatic (Barsalou 1999, 2016).

2. The experiment: Overview

We conducted an experiment with the Extrinsic Simon task (De Houwer 2003). Through such a task, responses became extrinsically associated with visual and auditory content through short-term associations created on the basis of task instructions. Our aim was to test whether discriminating the color of abstract words (e.g., *culture*) is faster when the correct response is the response that is also assigned to words with an auditory content (e.g., *echoing*). Words were presented on the screen. Participants discriminated the ink color (i.e., green/blue) of abstract and concrete words (e.g., *culture*, *horse*) by pressing one of two buttons previously associated to the hearing and visual field through a training. Throughout the training, all participants were instructed to press the visual key (e.g., P) for words with a visual content (e.g., bright) and the auditory key (e.g., Q) for words with an auditory content (e.g., *echoing*) such that responses became extrinsically associated with the visual and the auditory dimensions. We predicted to find a better performance when participants had to choose the extrinsically auditory response in response to abstract words (e.g., *culture*).

3. Method

3.1 Materials

Five concrete and five abstract nouns were selected from the pool generated by Della Rosa et al. (2010). Five vision-related and five hearing-related adjectives were taken from the norming study by Lynott and Connell (2009). Vision-related adjectives were mainly perceived through the sense of sight, whereas hearing-related adjectives were mainly perceived through the sense of hearing (see the Appendix for the full set of materials).

3.2 Participants

Sixty students from the University of Bologna took part in the experiment in exchange for course credits or voluntarily.

3.3 Procedure

Participants were to classify adjectives and nouns by pressing the visual key (i.e., key P) or the auditory key (i.e., key Q) of an Italian QWERTY keyboard depending on the meaning of the adjective (visual/auditory) or the color (green/blue) of the presented noun. The instructions informed participants about what key to press in response to which type of stimulus. Participants were told that white adjectives (i.e., training trials) had to be discriminated on the basis of their meaning. Half of the participants were instructed to press the visual key (P) for white words with a visual content (e.g., *bright*), and to press the auditory key (Q) for white words with an auditory content (e.g., *echoing*). The other half of the participants was assigned to the reverse mapping, that is, to press the visual key (Q) for white words with a visual content and the auditory key (P) for white words with an auditory content.

With colored nouns, however, participants were instructed to press the visual or auditory key on the basis of the color of the word. Half of them were instructed to press the visual key in response to words in a bluish color and the auditory key in response to words in a greenish color. The other half of the participants was assigned to the reverse color-response assignments.

There were 4 conditions to this Experiment: Auditory-Abstract (AA) in which participants were required to press the auditory button for colored nouns with an abstract content; Auditory-Concrete (AC) in which participants were required to press the auditory button for colored nouns with a concrete content; Visual-Abstract (VA), in which participants were required to press the visual button for colored nouns with an abstract content; and Visual-Concrete (VC), in which participants were required to press the visual button for colored nouns with a concrete content.

In all training and test blocks, stimuli were presented in a random order with the restriction that the same word could not be presented on two or more consecutive trials and that the required response could not be the same on four or more consecutive trials.

4. Results

Only the results of the test trials on which nouns were presented were analyzed. Of primary interest was whether the Auditory-Abstract condition demonstrated a significant facilitation compared to the other three conditions (Auditory-Concrete, Visual-Abstract, and Visual-Concrete). To this end, a priori contrasts were conducted on both RTs and percentages of errors (see Lebois et al. 2015 for a similar approach). All erroneous trials (2.85%) were removed before the analysis of RTs. As for RTs, Helmert contrasts showed that decision latencies in the Auditory-Abstract (AA) condition were significantly faster than decision latencies in the other three conditions, F (1, 59) = 4.258, MS_e = 14700.08, p = .043, η_p^2 = .067. No other contrast turned out to be significant, F_s < .960, p_s > .3. As for error rates, Helmert contrasts did not reveal any significant difference between conditions. As Figure 1 illustrates, the results of the RTs analysis supported our prediction.

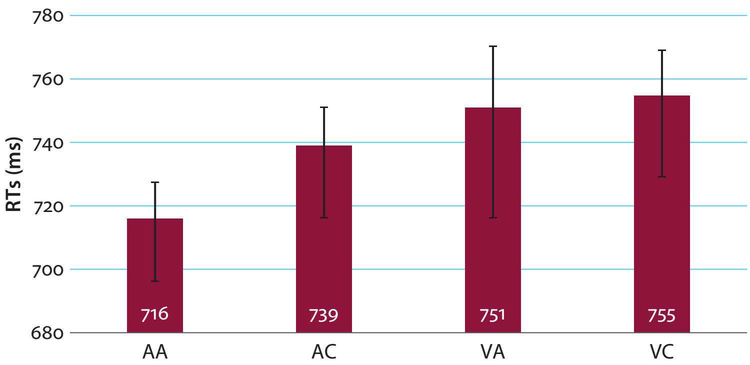

Figure 1. Mean response times (in milliseconds) as a function of condition (AA, AC, VA, VC). Bars are Mean Standard Errors corrected for within-participant designs (Loftus & Masson, 1994).

5. General discussion and conclusions

The empirical investigation reported in this chapter was aimed at testing the relation of auditory-verbal experience and abstract conceptual knowledge. In line with WAT predictions (Borghi and Binkofski 2014), and with previous fMRI findings (Hoffman et al. 2015), our results demonstrated that the auditory modality is relevant for abstract words processing. We found that discriminating the color of abstract words was faster when the correct response was the response that was also assigned to auditory words.

More generally, our finding is in line with Multiple Representation theories of concepts, which suggest that different components of abstract word meaning (i.e., linguistic, social, and emotional) are relevant to better capture how people represent and process abstract concepts. In line with these views, and especially with the WAT theory, the results reported here suggest that during abstract words processing a simulation of pronouncing and listening to the words occurs. That is, a re-enactment of patterns of neurons previously activated during the acquisition of the corresponding words takes place (see Scerrati et al. 2015; Scerrati et al. 2017 for further investigations of the mechanisms of simulation).

The introduction of implicit measures (i.e., the Extrinsic Simon task) further suggests that our results indicate the occurring of a simulation process. Implicit measures are indeed more suitable to study automatic mechanisms such as that of simulation (Barsalou 1999, 2016) since they reflect cognitions in people who are unaware of the behavior being measured, let alone the fact that people have relatively little control over the measurement outcome. Therefore, the present finding supports the WAT suggestion that when we process abstract words we tend to simulate the experience of listening to them. This might occur because, due to their complexity, we might need to re-explain to ourselves their meaning through inner speech (see Borghi and Zarcone 2016 for discussion). More plausibly, the relevance of the acoustic modality for abstract concepts might depend on the re-enactment of the experience of their linguistic and social acquisition.

In keeping with theories of reuse (e.g., Anderson 2010, 2016; Gallese 2008), our results suggest that the simulation occurring when processing abstract words might exploit structures and mechanisms characteristic of previously emerging systems, such as the oral motor system and the acoustic system (Topolinski and Strack 2009). It is widely known that evolution recycles existing mechanisms to perform new functions (Gould 1991). The grounded framework assumes that the reuse of neural circuits for different cognitive purposes is a central organizational principle that contributes to explain the functional structure of the brain. Specifically, grounded theories argue that neural circuits developed for one purpose (e.g., audition) are exapted or recycled during evolution or normal development, and are made available for new uses (e.g., representation of abstract concepts) without losing their initial roles (see Barsalou 2016; for a discussion see Scerrati 2017).

As sketched in the Introduction, the WAT proposal is a thoroughly embodied theory of language, which can handle the problem of the meaning of abstract words. Since abstract words such as *culture* have no perceivable referent that individuals can experience, their grounding must be social rather than individual. The WAT proposal considers words as linguistic social tools. More specifically, concrete words are more individually grounded linguistic tools, whereas abstract words are more socially grounded linguistic tools. In both cases, the meaning of the words is grounded in the sensorimotor system, however, their grounding differs depending on the available context of acquisition (Borghi and Cimatti 2009). In particular, abstract words involve sensorimotor brain networks since their contents relate to a wide range of situations grounded in concrete experiences. However, their context of acquisition is mainly linguistic and social since we mostly avail ourselves of others' linguistically conveyed expertise in order to grasp their meaning.

In sum, a promising line of research on abstract concepts is the one referred to as the Multiple Representation theories (and several theories adhering to it: for a review see Borghi et al. 2017; Borghi, et al. 2018), suggesting that linguistic, social and emotional formats of representation play a major role in characterizing abstract concepts. Further research is, however, needed to investigate in more detail the role these multiple formats play in shaping abstract words meaning.

Overall, we are confident that this Chapter contributes to the ongoing debate on the representation and processing of abstract concepts by providing evidence suggesting that the context of acquisition of words is relevant for their subsequent processing. If the acquisition of abstract words is mainly linguistic, it is likely that their subsequent processing requires the re-enactment of the linguistic information underlying their acquisition, just like the processing of concrete words requires the re-enactment of the sensorimotor information underlying concrete words acquisition. We have shown that a perceptual experience involving the auditory modality facilitates performance on a subsequent color discrimination task on colored words when these are abstract words. We argue that such facilitation is due to people pre-activating a relevant modality (i.e., auditory) for the processing of abstract words. More generally, we maintain that the role of language in shaping the content of abstract concepts is primarily a scaffolding role. What the physical environment does not provide to support the acquisition of abstract concepts, language does provide.

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Appendix

	Italian noun	English translation
Abstract		
	critica	criticism
	cultura	culture
	enigma	enigma
	infinito	infinity
	morale	moral
Concrete		
	cavallo	horse
	poltrona	armchair
	quercia	oak
	stivale	boot
	zucca	pumpkin

	Italian adjective	English translation
Auditory		
	altisonante	sonorous
	assordante	deafening
	echeggiante	echoing
	rumoroso	noisy
	stridente	squealing
Visual		
	abbagliante	dazzling
	colorato	colorful
	luminoso	bright
	raggiante	glowing
	splendente	gleaming

PART II

Abstract concepts in language

Insights from psycholinguistics and lexical semantics

CHAPTER 6

Determinants of abstractness and concreteness and their persuasive effects

Lettica Hustinx and Wilbert Spooren

The writing guideline to avoid abstractness and to use concrete language instead has a long and well-deserved reputation. Nevertheless, it is not clear what constitutes concrete language. In this chapter we report two studies. The first investigates the determinants of concreteness and abstractness using a rating task. The results show that for all word classes sensory perceptibility is an important component and that the determinants specificity and drawability/filmability vary with word class. In the second study, we used the insights from study 1 to manipulate a text from the National Budgeting Institute (Nibud) that addresses adolescents from different educational levels. The results only show effects of educational level on comprehension and persuasive power; no effects of concreteness were found. The studies raise issues about the validity of the writing guideline to be concrete.

Keywords: abstractness, comprehension, concreteness, determinants, persuasion

1. Introduction

Abstract language has a bad press in writing guides, educational environments, and journalism. Many writing guidelines recommend the use of concrete language. A classic example is the quote from Gowers' *Plain words*: "The reason for preferring the concrete to the abstract is clear. Many concrete words have a penumbra of uncertainty round them, and an incomparably larger one surrounds all abstract words. If you are using an abstract word when you might use a concrete one you are handicapping yourself in your task, difficult enough in any case, of making yourself understood" (Gowers 1986: 78). Orwell famously advocated the use of concrete language in his essay 'Politics and the use of the English language': "As soon as certain topics are raised, the concrete melts into the abstract and no one seems able to think of turns of speech that are not hackneyed: prose consists less and

https://doi.org/10.1075/hcp.65.07hus

less of *words* chosen for the sake of their meaning, and more and more of *phrases* tacked together like the sections of a prefabricated henhouse" (Orwell 1961: 339).

An interesting issue is *why* concrete language is thought to have such an advantage. The quotes suggest that concrete language is more easily comprehensible than abstract language, and consequently less viable to abuse for manipulation. There is substantial empirical evidence to back up such claims: in his overview of research findings Sadoski (1999: 28) concludes that "the concreteness of the language used [in the texts] is a powerful predictor of comprehension and memory for common forms of informational text […]. Most of these studies also show that concrete language tends to be more interesting and affectively engaging to readers". Also, in text production tasks concreteness was found to be important. In a task where students had to produce word definitions, participants were faster, produced more words and the quality of the results was better when they had to define concrete words compared to abstract words. It is for such reasons that Graesser, McNamara and Kulikowich (2011) put word concreteness in the top 5 of important text comprehension predictors.

Although we have an intuitive grasp of what words are concrete and what words are abstract, it seems very difficult to put the finger on the exact nature of concreteness and abstractness. Most language users will recognize words like *castle*, *to cycle* and *warm* as more concrete than words like *risk, to reason* and *moral*. We will also agree that there are gradations of concreteness: a relatively concrete word like *warm* seems less concrete than *castle*. But why would that be the case? And why would a word like *to reason* be less concrete than *to cycle* or *to calculate*?

A possible explanation is offered by the Dual Coding Theory (Paivio 1971, 1986), which postulates that language users make different representations of the information they encounter: a propositional or verbal representation and a mental imagery representation. Abstract information will only be represented in the propositional format, whereas concrete information will be represented in the mental imagery format as well. This explains why concrete information is more easily retrievable from memory. DCT puts imageability as the core explanation for concreteness effects, focusing on the visual sense. In a similar vein Van Loon-Vervoorn (1985: 1) characterizes concreteness as "imageable:[1] the ease with which a word evokes a visual representation" (translation from the original by the authors). Many studies, acknowledge the relevance of imageability or have added additional characteristics to concreteness. Spreen and Schulz (1966: 459) state that "any word that refers to objects, materials or persons" is concrete. Douma (1994: 25–27) refers to sensory perceptibility and also specificity, where specificity

1. The literature uses both the terms "imageable" and "imaginable". Throughout the chapter, we use the first term.

is described as giving examples and detail (p. 28). Connell and Lynott (2012: 453) also stress the importance of sensory perceptibility, and even claim that effects of concreteness disappear once the effects of sensory perceptibility have been controlled for. Pettus and Diener (1977) used the addition of details in the form of personal and demographic information about a few representative characters in the text (versus abstract statistical data about the town in which the story is set) as a characteristic of concrete information. In sum, there is no unequivocal understanding of the determinants of concreteness, let alone of those of abstractness. One of the goals of the present study is to shed light on the intricate nature of these notions (Study 1).

A second goal is to understand the effects of concreteness. Sadoski's (1999) claims about its effect on comprehensibility may also extend to persuasion. The results of several experimental studies on the persuasiveness of vividness, use of evidentials and of anecdotal evidence may well be explained in terms of concreteness: a vivid, anecdotal or concrete style was found to be more persuasive than its non-vivid, statistical or abstract counterpart (Gibson and Zillmann 1994; Hustinx and De Wit 2012; Shedler and Manis 1986; Smith and Shaffer 2000; Spooren et al. 2000). Hansen and Wänke demonstrated that statements containing concrete verbs are considered "as more probably true" (Hansen and Wänke 2010: 1576) than their abstract equivalents, irrespective of the actual truth of the statements.

The persuasive effects of concrete information have often been explained using the Availability Heuristic (Tversky and Kahneman 1973). According to this hypothesis concrete information is more available and salient in memory, easier to recall, and therefore more readily available to use in judgment and decision tasks. Note that just like the Dual Coding Theory the Availability Heuristic assumes that information is stored in memory in two ways, one in the verbal memory and one in the imagery memory.

The afore-mentioned concreteness effects are not found across the board. Some studies only show a moderated effect (for example, only after a delay; Reyes et al. 1980), no effect of concrete material (Guadagno et al. 2011; Study 2) or even the opposite effect (Frey and Eagly 1993). This variation in effects may well be caused by the variation in the manipulation of the materials used in the experiments. Concreteness was in some studies manipulated by adding details to the information while keeping the factual content similar (Reyes et al. 1980: 4; Shedler and Manis 1986: 27). Others manipulate concreteness by comparing texts about concrete topics with different texts about other, abstract topics (Sadoski et al. 2000). A second goal of our study (Study 2) is to use a very strict manipulation of the materials and use that manipulation to investigate experimentally whether this strictness sheds light on the persuasive potential of concrete information.

2. Study 1: Determinants of concreteness and abstractness

Instead of using pre-existing definitions of concreteness to assess a word's concreteness, the present study used a data-driven strategy: participants were asked to assess a large number of words on a number of dimensions that could constitute the notion of abstract/concrete. These dimensions were assembled on the basis of a literature review.

There have been previous studies using such an operational approach. For example, in Coh-metrix, a collection of instruments to analyze the coherence of English texts automatically on the basis of more than 100 indices (cf. www.cohmetrix.com, accessed on July 10 2017), concreteness of a text is calculated using concreteness scores of 4293 individual words as found in the MRC Psycholinguistics Database (Coltheart 1981; McNamara et al. 2014: 75). For Dutch, Van Loon-Vervoorn (1985) collected imageability scores and 'age of acquisition' scores of 6,136 words. Although strictly speaking imageability is not the same as concreteness, work by Paivio, Yuille and Madigan (1968) suggests that the two are highly correlated (they report a correlation of 0.83; Paivio et al. 1968: 7). A recent example of an operational definition of concreteness is provided by the work of Brysbaert et al. (2014), who collected concreteness scores and 'age of acquisition' scores for 30,000 Dutch words.

What is lacking from these studies is that they do not discuss possible determinants of concreteness: dimensions like drawability, specificity, perceptibility. Also, we wanted to investigate the relationship between concrete/abstract language and comprehensibility. A final goal of the study was to collect responses from the participants in an unbiased way. This differs for example from Brysbaert et al. (2014), who gave very explicit instructions as to what participants should consider concrete and abstract, for instance: "Some words refer to things or action in reality. […] You can experience it through one of your senses (smell, taste, feel, hear, see) or by performing an action. […] by showing it […] In order to explain the word 'sweet', you can for example have someone taste sugar. To explain 'jump' you can jump up and down or show a video clip of someone jumping. To explain the word 'couch' you can show a couch or a drawing of a couch. An abstract word refers to something that you cannot experience directly. […] The easiest way to explain the word is by using other words. For example, there is no easy way to show the word "law", but you can explain the word by using other words"[2] (Brysbaert et al.

2. Original: "Sommige woorden verwijzen naar dingen of acties in de werkelijkheid. […] Je kunt het ervaren via een van je vijf zintuigen (ruiken, proeven, voelen, horen, zien) of door een actie uit te voeren. […] door het te tonen […] Om het woord "zoet" uit te leggen, kun je iemand bijvoorbeeld suiker laten proeven. Om "springen" uit te leggen, kun je op en neer springen of

2014: 83). The diversity of these illustrative examples is indicative of the complexity of identifying the determinants of concreteness and demonstrates the necessity to investigate what those determinants are. That is why we decided to set up a survey in which participants judge a large number of words on five dimensions (see below for details).

2.1 Method

2.1.1 *Word list*

A list of 2,011 Dutch words was assembled on the basis of the words used by Ernestus and Cutler (2015) (2,781 words). This particular list was chosen because it contains all kinds of processing information about the words, which could be interesting for future research. We only chose those words that also occurred in the list of Brysbaert et al. (2014) (30,000 words) and the SoNaR[3] corpus of newspaper texts (Oostdijk et al. 2008), so that we had concreteness data and frequency data as well. A visual inspection of the log frequencies of the words (based on the frequency data from the SoNaR corpus) showed a normal distribution, showing that the entire spectrum of word frequencies is represented in our word list.

Participants evaluated these words using an online questionnaire that was specifically created for this study.[4] Every word occurred five times in the list so that it could be rated on five dimensions: sensory perceptibility, comprehensibility, specificity, concreteness/abstractness, and drawability/filmability.[5] The words were randomly distributed over the list, so that a participant had to evaluate each word with respect to each concept independently. The program showed 10 words per webpage. The participants expressed their judgments using a slider running

een videoclip tonen van iemand die springt. Om de betekenis van "sofa" uit te leggen, kun je een sofa of een tekening van een sofa tonen. Een abstract woord verwijst naar iets wat je niet rechtstreeks kunt ervaren. […] De gemakkelijkste manier om het woord uit te leggen is door andere woorden te gebruiken. Zo is er geen eenvoudige manier om het woord "wet" te tonen, maar je kunt het woord uitleggen door andere woorden te gebruiken.

3. SoNaR stands for "STEVIN Nederlandstalig Referentiecorpus", i.e., "STEVIN Dutch Reference Corpus".

4. We thank Wessel Stoop for helping us in creating this questionnaire.

5. In a pilot study (n = 60) also the concept 'familiarity' was used, inspired by Sadoski (2001: 265). The results showed that this concept, which in itself is a prerequisite rather than a determinant of concreteness, explained a relatively large proportion of the variance. Therefore, we did not use it in the main study.

from 0 to 100.[6] The participants could make use of a check mark if they were not familiar with the word.

2.1.2 *Participants and procedure*

An email was sent to 36 students of Radboud University to participate, twelve of whom responded positively (six men, six women). Ten participants actually finished the task (five men, five women). The mean age was 20.9 years (ranging from 20 to 22). All respondents were native speakers of Dutch. They all signed a consent form designed by the faculty's Ethical Committee. They received a remuneration of € 100 for their participation.

The participants were instructed to rate each word on one of five scales, using a slider (see Figure 1). They were told that each word was accompanied by information about the word class (indicating whether it was a noun, verb, or adjective). They were asked to indicate for each word how specific, concrete, drawable, sensory-perceptible, or comprehensible that particular word was. In contrast to Brysbaert et al. (2014), who gave a very explicit description of the notion of concreteness, the participants did not receive any explanation about the nature of these concepts, in order to avoid biasing the responses.[7] Since the task was too

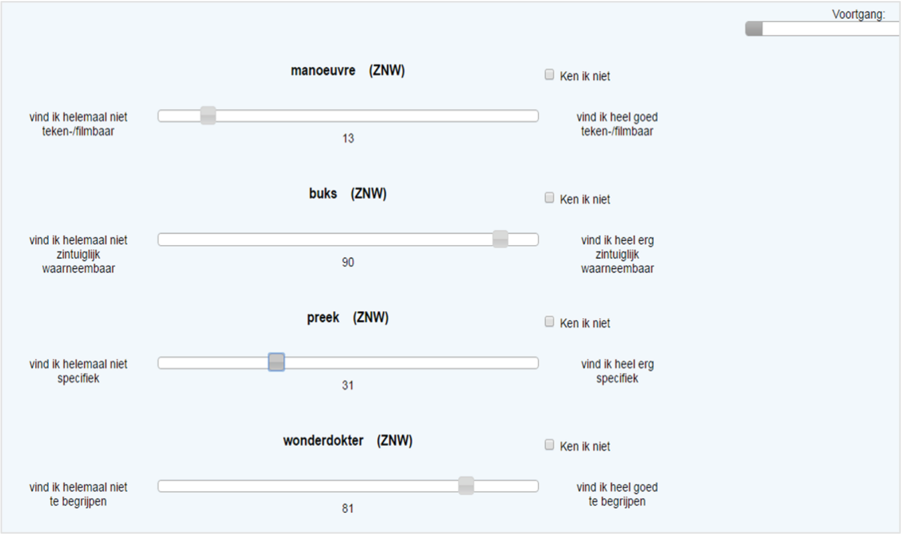

Figure 1. Presentation mode of the main experiment

6. This option was chosen as it was the favorite of several presentation formats in a pilot study (n = 20).

7. This instruction was chosen as a result of a pilot study (n = 20) that showed no differences between extensive and minimal explanation of the concepts.

long to finish in a single session, participants were told that they could interrupt the task at any given moment and resume the task later on. Information about the progress was visually present in the form of a progress bar. Participants were advised to work individually and to keep focused on the task for no longer than an hour. They were also asked to not think too long about their responses and to base them on their intuitions.

A screenshot of a web page from the questionnaire is presented in Figure 1.

2.1.3 *Results*

The scalar judgments of the respondents were transformed onto an interval scale of 0 to 100. Words that were flagged as not known were disregarded. For each word the mean score for each of the five concepts was calculated. A regression analysis was carried out with concreteness as the dependent variable and the other concepts as predictors. All variables were added at once into the analysis (method = Enter), because there were no clear theoretical expectations about the relative importance of the various predictors. To test the interaction with word class an additional one-way ANOVA was carried out on the concreteness scores with the various word classes (noun, verb, and adjective) as the independent variable.

The concreteness scores of the participants correlated highly with those in the Brysbaert et al. (2014) study ($r = .84$), which demonstrates that detailed and limited instruction of participants do not necessarily lead to different results.

The results of the regression analysis are summarized in Table 1.[8] The β-coefficients and their confidence interval are visually presented in Figure 2.[9] Figure 2 shows that sensory perceptibility is the main predictor of concreteness, followed by drawability/filmability and specificity. It is also clear that comprehensibility does not contribute to predicting concreteness. The amount of variance explained by the predictors is moderate: only sensory perceptibility has an effect that is described in the literature as small ($r^2 = .04$).

The concreteness scores differed significantly between word classes (F (2, 1997) = 174.63, $p < .001$, $\eta^2 = .15$; see Figure 3). For that reason, regression analyses were carried out for each word class separately.

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8. In order to investigate the multicollinearity of the model, the VIF and the tolerance were calculated. The mean VIF is 2.94; tolerance varies from 0.22 (specificity) to 0.45 (comprehensible). From this we conclude that the multicollinearity is within acceptable boundaries.

9. Created using the function "coefplot" in the R package "car". If the CI does not cross the vertical 0-axis, this means that the coefficient differs significantly from 0, i.e., that it contributes to the regression. The larger the distance between a coefficent and the 0-axis, the more important the contribution is.

Table 1. Summary of the regression analysis

Coefficient	R^2	B	se B	β	*p*	r^2
	0.23					
Intercept		24.50	2.74		<.001	
Perceptible		0.34	0.04	0.30	<.001	0.04
Draw/filmable		0.16	0.04	0.16	<.001	0.01
Specific		0.06	0.03	0.06	<.05	0.00
Comprehensible		0.02	0.04	0.01	0.78	0.00
LogFreq		−1.00	0.36	−0.06	<.01	0.00

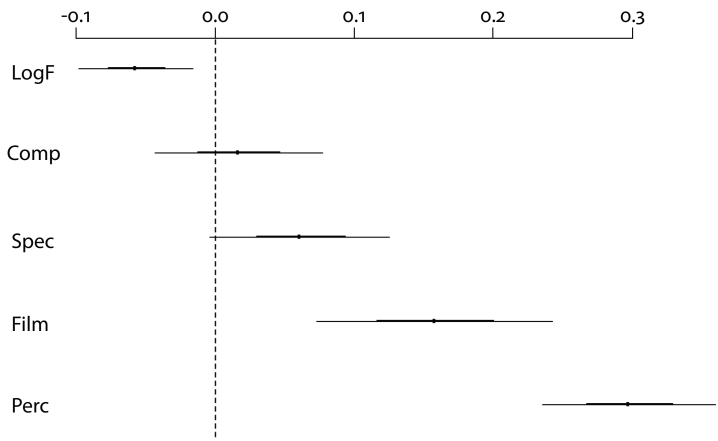


Figure 2. Visual representation of the β coefficients and their confidence intervals in the regression model.

The adjusted R^2 for the three analyses differed strongly: For nouns $R^2 = .25$, for verbs $R^2 = .18$, and for adjectives $R^2 = .10$. The *β*-coefficients (and their CI's) are visually presented in Figure 4.

The analysis shows that for different word classes concreteness to a degree is determined by different concepts. In all three classes, sensory perceptibility is the most important predictor. For adjectives, it is even the only significant predictor. For nouns, specificity also plays a role in determining the concreteness, and for verbs, besides sensory perceptibility, also drawability/filmability.

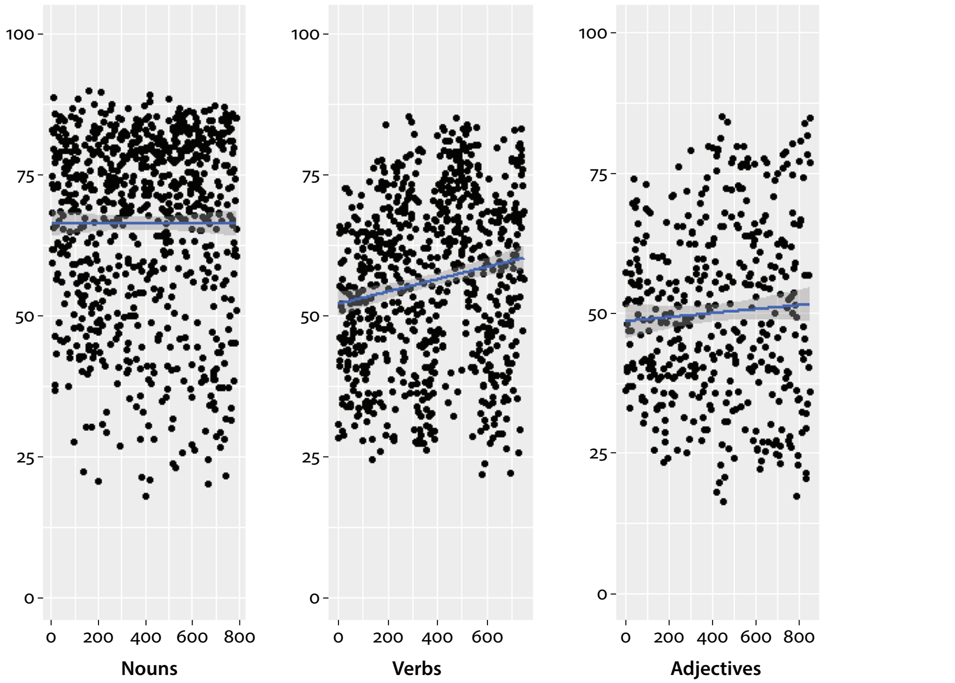


Figure 3. Concreteness scores as function of word class

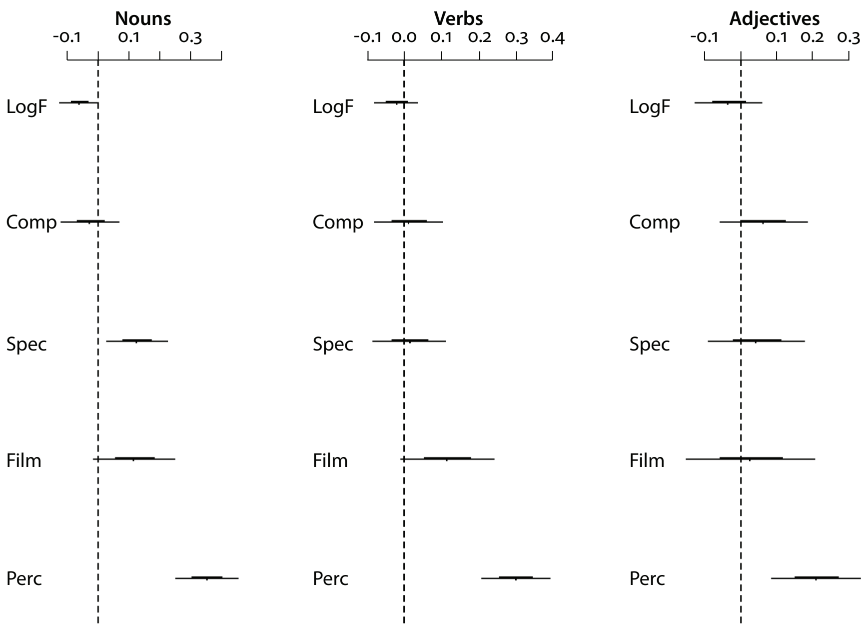


Figure 4. β coefficients for the regression analysis per word class

2.2 Conclusion and discussion

Our study aimed at getting a deeper insight into abstractness and concreteness, two notions that in the literature have been treated and measured in very different and not always converging ways. To that end, we asked participants to rate a large set of words from different word classes on several dimensions that have been suggested in the literature as determining the concreteness of a word. A first thing to note is that despite the fact that, unlike for example Brysbaert et al. (2014), we did not bias our participants by giving detailed instructions about the nature of the concepts, the correlation between this study's concreteness scores and those of Brysbaert et al. (2014) was high. The very fact that the different concepts make different contributions to the regression model indicates that participants have an intuitive grasp of systematic differences between the concepts under investigation. For instance, sensory perceptibility demonstrates a different pattern from a notion like drawability/filmability, even though from a distance one could consider these as related concepts, given that drawability/filmability can be seen as a subcategory of sensory perceptibility. An abstract and complex notion like specificity seems to have been understood in a similar way by the participants, even though we did not explain this notion in the instruction.

Overall, sensory perceptibility turned out to be most important to predict concreteness. This resembles Connell and Lynott's (2012) suggestion that concreteness is more than visual imageability. Another important finding, already suggested by Van Loon-Vervoort (1985), is the difference between word classes: apparently, the notion of concreteness for nouns correlates more strongly with specificity, whereas for verbs drawability/filmability seems important. Intuitively this makes sense, given that nouns typically depict objects with superordinates and subordinates, whereas verbs typically depict actions and processes.

A critical note is due on the small amount of variance captured by our regression model. Apparently other important factors are involved in accounting for the abstract-concrete dichotomy. This obviously is an area of future research. An interesting suggestion made by Connell and Lynott (2012) is to disentangle a concreteness scale from an abstractness scale, leaving the possibility that determinants of concreteness may differ qualitatively from those of abstractness. We can imagine for example that a concept like arousal is important for the concreteness of words, whereas the ease with which it is possible to describe the meaning of a word may be more important for abstract terms.

An important practical implication is that the availability of concreteness scores and their determinants for different words classes allows us to manipulate experimental materials in a more detailed and systematic way. This potential was used in Study 2.

3. Study 2: Effects of concreteness

3.1 Introduction

An experiment was set up in which the materials were manipulated according to the operational results of Study 1. To that effect, a page of the internet site of Nibud (a public service for budgeting), which explains to young people the need for insurance arrangements, was manipulated. The Nibud website is popular among both parents and adolescents as a source of information on budgeting. Its information can be characterized as both instructional and persuasive. On the one hand it gives factual information on procedures and regulations, on the other it urges readers to find ways to keep within budget, by formulating 'money tips' and providing tools to calculate the amount of pocket money or alimony to be paid. As it targets both higher and lower socioeconomic status (SES) groups and education groups of all ages, it is an ideal domain for measuring both comprehension and persuasion.

There is reason to believe that there is an important correlation between educational level and comprehension of expository texts (cf. McMaster et al. 2012; Sanders et al. 2007; van Silfhout et al. 2014). For example, McMaster et al. (2012) showed that comprehension interventions had different effects for readers differing in reading proficiency. There is also a demonstrable link between comprehension and persuasion, even though this link has not been studied often. For instance, Scharrer et al. (2014) demonstrated that readers were less persuaded by a text that they found difficult to comprehend. The goal of the current experiment is to tackle the issue of the effectiveness of concrete information: if materials are manipulated meticulously in accordance with the dimensions constituting concreteness and abstractness, do they differ in comprehension, interestingness and persuasive power, and do educational levels display different result patterns?

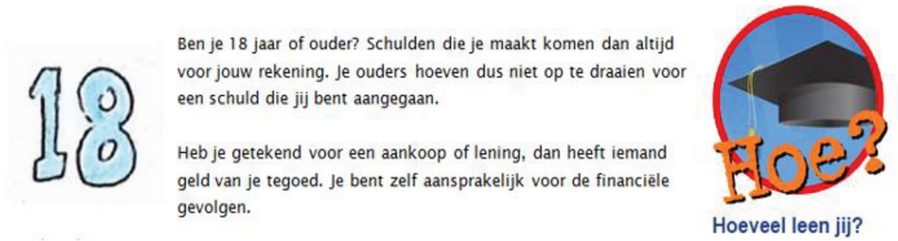
3.2 Method

3.2.1 *Materials*

The webpage chosen for the experiment had as a topic "financial responsibility", and talked about liability, independence and legal changes after reaching the age of 18 (at which age one is of legal age in the Netherlands). The topic of the webpage is not very popular and relatively complex, because the text also discusses consequences of not being insured. That makes it suitable for testing the profit to be gained from optimizing the text using concrete words, because it can become more attractive and comprehensible, which is one of the reasons why Nibud recommended the use of the page for this study.

The webpage is a relatively frequently visited page, but less frequently so than others. The webpage chosen had 37,000 page views in 2014 (or 2.90% of all the Nibud web page views). This is much less than the most popular page "Income, jobs, how does it pay?", with 266,000 views in 2014 (approximately 20%). It aims at readers around the age of 18. It was considered useful for our study because it contains both persuasive and instructive elements, and the formulation is varied in that it contains both abstract, concrete and detailed information.

An example fragment of the original webpage is presented in Figure 5.



[Translation of body text: "Are you 18 years or older? In that case, debts that you will make will always be at your expense. That means that your parents need not pick up the check for the debt that you have made. In case you signed for a purchase or a loan, you owe someone money. You yourself are responsible for the financial consequences"].

Figure 5. Example fragment from the original webpage used for the experiment

We constructed four versions of the internet page by systematically manipulating words differing in concreteness scores. We made use of the list provided by Brysbaert et al. (2014).[10] We made sure that each version fitted on a single page.

Original version. The original version contained abstract words as well as concrete words and concrete words with detailed examples. There are only a few detailed examples in the original text. The original version contained 335 words. The concreteness score of each content word in the original version was looked up in the list of Brysbaert et al. (2014), and a mean concreteness score was calculated (total mean concreteness score: m = 2.43 on a scale of 1 = abstract to 5 = concrete). An example of an abstract formulation is: "until you have reached the age of majority you can only make expenditures that are fitting for your age" (mean concreteness score: 2.43).[11] A concrete sentence in the original version is for instance: "until

10. We used the 30,000 words from the Brysbaert et al. (2014) study, rather than our list described in study 1, because in the latter we only had concreteness scores for 2,000 words.

11. The concreteness scores that we report are based on the Dutch version of the text.

you are 14 years old your parents will have to pay this debt" (mean score: 2.83). An example of a detail is "You can vote, learn to drive, ask for a health care allowance" (mean score: 3.82).

Abstract version. The concrete words in the original version were replaced by abstract equivalents (synonyms or hyponyms). All detailed examples were removed. All abstract words in the original version were maintained. Concrete words were replaced by a more abstract formulation when possible.[12] For example, the original concrete sentence "This is used to pay for example the general physician and medication." (Mean score: 3.82) was made more abstract by changing it into "From this the necessary care is reimbursed" (mean score: 2.04). In total, the abstract version contained 311 words (mean concreteness score: 2.18).

Concrete version. All abstract formulations in the original version were replaced by concrete words as far as possible, and all concrete words were maintained. Again, all detailed examples were removed. An example of a concrete sentence is "Until you are 18 years old, you can only buy and order things that fit boys and girls under 18." (Mean concreteness score: 3.07). The concrete version contained 393 words (mean concreteness score: 2.49).

Concrete version with detailed examples. In this version, examples were added to the sentences of the concrete version. In total, there were 22 additions to 26 sentences. All details were thematic elaborations of the sentence that they elaborated upon (cf. Smith and Shaffer 2000; Guadagno et al. 2011). Following a suggestion by Van Silfhout et al. (2014), the additional information targeted the presumed interests of 18-year-olds. For example, the details concerned scooters, renting a room, mobile phones and the like. An example of a concrete sentence with an example is "Until you are 18 years old, you can only buy and order things that fit boys and girls under 18. So, you cannot rent a room or buy a car yet" (mean score of the additional detail: 3.35). The concrete version with detailed examples contained 657 words (mean concreteness score: 2.79).

An analysis of variance showed that the four versions differed in concreteness (F (3, 800) = 17.07, $p < .01$, $\eta^2 = .06$). LSD comparisons showed that the abstract version ($M = 2.18$) was less concrete than the concrete version ($M = 2.49$), which in turn was less concrete than the concrete with detailed example versions ($M = 2.79$) (all of these differences: $p \leq .01$). The original version ($M = 2.43$) did not differ significantly from the concrete version but did differ significantly from the other two.

12. It proved impossible to replace words like "can", "may", and "are" by more concrete alternatives. Consequently, the concreteness score of even the concrete version is relatively low.

3.2.2 *Participants and design*

The four versions were presented in a between-subjects design to 252 pupils, 145 from intermediate vocational training programs (IVT) and 107 from general higher secondary education (GHSE) (ages ranging from 17 to 23 for IVT and from 16 to 19 from GHSE). Of these 252 participants, only 18 reported that Dutch was not a language used at home. Given that all participants take part in a Dutch-language education program at the secondary level, we assumed that they all understand Dutch sufficiently for present purposes.

3.2.3 *Instruments*

The questionnaire comprised 15 items. The first seven items were 5-point Likert scales, measuring perceived comprehensibility (one item: 'I could understand this text very well'); text appreciation (three items: 'I liked reading this text'; 'I was bored while reading this text' (reverse coded); 'I would read this text voluntarily if I were to visit this site'); persuasion (one item: 'This text makes me think about my money and insurances'); persuasion of others (one item; 'This text will probably make people of my age think about their money and insurances'); imageability (one item: 'I could imagine some things from the text').

One item differed for the two educational groups. GSHE students answered a question about the degree of concreteness of the text, on a 5-point semantic opposition ranging from 'abstract' to 'concrete'. IVT students answered a question about the amount of text they had read, on a 5-point scale ranging from 'nothing' to 'everything'.

Item 9 measured initial attitude toward the topic of the text (one item: 'How often do you normally think about managing money and insurances?' (Five options ranging from 'never' to 'often'). The next four items measured observed comprehension using four multiple choice items. For each of these items, participants also had to indicate the degree of certainty of their answer ('certain', 'not certain'). Finally, there were demographic questions about gender, age, first language at home and class level.

3.2.4 *Procedure*

The participants were recruited on primary vocational schools (IVT) by their teachers. Most of the participants from general higher secondary education (GHSE) were also recruited by their teachers. Twenty participants were recruited during exam preparation days by one of the research assistants. Following a recommendation from a teacher, the experiment was conducted during a regular class hour. In the experiment, six classes from IVT took part and five classes from GHSE. The twenty remaining participants took part individually. All participants signed a consent form in which they were informed that they participated voluntarily. They explicitly gave permission to make use of the data for research. In case of minors, the participants were given an email address together with their participant number that their legal responsible could use if they refused consent. Nobody made use of that possibility.

Each teacher read out an instruction containing global information about the background of the experiment and the procedure. The participants received a booklet containing the experimental text, a questionnaire and the consent form. They were instructed to read the text on the first page at their own pace; then they should turn the page and answer the short questionnaire on the back page, without looking back in the text and without consulting their fellow participants. Finally, they were asked to sign the consent form. The pupils were also told that all information would be treated confidentially. After the teacher had read out the instruction, he or she handed out the booklets. After the pupils had finished, the booklets were collected and the teacher made sure that the consent forms had been signed. In the IVT classes occasionally an additional explanation was necessary to explain the scales used in the questionnaire.

3.2.5 *Statistical analysis*

The observed comprehension scores were computed as follows. Items answered correctly received a score 4 if the student was certain and 3 if the student was uncertain. Items answered incorrectly received a score 1 if the student was certain and 2 if the student was uncertain. Incomplete responses were coded as 1 (incorrect, certain). Subsequently an average score over the four comprehension items was calculated.

The results were analyzed using a multivariate analysis of variance, with perceived and observed comprehensibility, the three text appreciation items, the two persuasion items, imageability, and initial attitude as dependent variables, and school type and text version as independent variables.

3.3 Results

3.3.1 *Text appreciation*

The results for text appreciation are summarized in Table 2.

As to 'like to read', there were no differences between the versions between educational level, nor was there an interaction between the two (all *F*'s < 1). The same holds for 'bored' (educational level: F (1, 241) = 1.05, $p = .31$, $\eta^2 = .004$; for version and version*educational level: $F < 1$). As to 'read voluntarily' there is a difference between educational levels (F (1, 243) = 4.18, $p = .04$, $\eta^2 = .02$): the higher educational students are more inclined to read the text voluntarily than intermediate level students (high: 2.60 (1.03); intermediate: 2.30 (1.18)). This

Table 2. Judgments about 'like to read', 'bored' (reverse-coded), 'read voluntarily' as a function of text version (Original, Concrete, Concrete-Details, Abstract) and educational level (Intermediate, High) (sd between brackets)*

	Like to read	**Bored (rev.-coded)**	**Read voluntarily**
Original			
Intermediate	2.82 (0.87)	3.06 (0.83)	2.21 (1.23)
High	2.78 (0.93)	3.33 (1.11)	3.00 (1.00)
Concrete			
Intermediate	3.00 (1.24)	2.97 (1.32)	2.47 (1.28)
High	2.69 (0.93)	3.07 (1.00)	2.38 (0.94)
Concrete-Details			
Intermediate	2.77 (1.17)	3.03 (1.20)	2.46 (1.12)
High	2.96 (0.88)	3.32 (0.95)	2.45 (0.86)
Abstract			
Intermediate	2.68 (1.10)	3.18 (1.25)	2.10 (1.10)
High	2.54 (0.84)	3.11 (1.03)	2.57 (1.20)

* Scales from 1 (minimum) to 5 (maximum).

difference is moderated by a marginally significant interaction between text version and educational level (F (3, 243) = 2.11, $p = .09$, $\eta^2 = .03$). Inspection of the means shows that in the original and abstract version there is a difference between higher and intermediate educational level that is absent in the concrete and the concrete-details version. It seems as if the intermediate level students are discouraged to read the text voluntarily if it contains abstract information.

3.3.2 *Persuasive impact*

As to the question whether the text makes the reader think about money and insurances, there was no effect of text version (F (3, 244) = 1.88, $p = .13$, $\eta^2 = .02$). There was an effect of educational level (F (1, 244) = 27.36, $p < .001$, $\eta^2 = .10$): high level students indicated more often that the text made them think about money and insurances ($M = 3.01$, $sd = .86$) than intermediate level students ($M = 2.30$, $sd = 1.18$) (see. Table 3). The interaction was not significant ($F < 1$).

As to the question whether the text makes their peers think about money and insurances, there were no differences between the groups (text version, interaction text version*educational level: $F < 1$; educational level: F (1, 244) = 1.32, $p = .25$, $\eta^2 = .005$).

As to the question how often the reader normally thinks about money and insurances, there was no difference between text versions ($F < 1$). Educational levels

Table 3. Judgments about 'makes me think about money'; 'makers others of my age think about money', and 'normally think about money' as a function of text version (Original, Concrete, Concrete-Details, Abstract) and educational level (Intermediate, High) (sd between brackets)*

	Text makes me think about money	Text makes others think about money	How often do I normally think about money
Original			
Intermediate	2.21 (1.23)	2.44 (1.05)	3.24 (1.32)
High	2.85 (0.91)	2.89 (0.97)	3.22 (1.12)
Concrete			
Intermediate	2.47 (1.28)	2.58 (1.27)	3.63 (0.94)
High	3.14 (0.69)	2.62 (1.01)	3.31 (0.71)
Concrete-Details			
Intermediate	2.46 (1.12)	2.77 (1.33)	3.61 (1.00)
High	3.22 (0.80)	2.87 (1.01)	2.78 (1.00)
Abstract			
Intermediate	2.10 (1.10)	2.53 (1.18)	3.25 (1.03)
High	2.86 (1.01)	2.61 (1.07)	3.32 (0.82)

* Scales from 1 (minimum) to 5 (maximum).

did differ (F (1, 240) = 4.37, $p < .05$, $\eta^2 = .02$): intermediate level students thought more about money and insurances ($M = 3.43$, $sd = 1.08$) than high level students ($M = 3.18$, $sd = .93$). The interaction between text version and educational level was marginally significant (F (3, 240) = 2.28, $p = .08$, $\eta^2 = .03$). Inspection of the means suggests that the difference between educational levels emerges specifically after having read the two concrete versions.

In order to interpret the persuasive impact of the text, difference scores were calculated for the variables 'text makes me/others thinks about money' and 'how often do I normally think about money'. These difference scores were subsequently analyzed with text version and educational level as independent variables. The results showed an effect of educational level for both 'text makes me think about money' (high: −0.17 (1.16); intermediate: −1.14 (1.36); F (1, 240) = 37.17, $p < .001$, $\eta^2 = .13$) and 'text makes others think about money' (high: −0.44 (1.25); intermediate: −0.87 (1.47); F (1, 240) = 6.90, $p < .01$, $\eta^2 = .03$). Apparently, intermediate students are less triggered to think about money and about insurances by the experimental text than they usually do, compared to high level students. The same pattern holds for their estimates of the effect of the text on others. There is no effect of version (text makes me think: F (3, 240) = 1.48, $p = .22$, $\eta^2 = .02$; text makes others think: F (3, 240) = 1.48, p = .22, η^2 = .02). There was also no interaction between version and educational level version (text makes me think: F (3, 240) = 1.44, p = .23, η^2 = .02; text makes others think: F (3, 240) = 1.09, p = .36, η^2 = .01).

3.3.3 *Comprehensibility*

The results for text comprehensibility are summarized in Table 4. As to perceived comprehension, there were no effects of text version (F < 1), of educational level (F (1, 244) = 2.20, p = .14, η^2 = .009) nor was there an interaction between the two (F < 1). As to observed comprehension, there was no effect of text version, nor was there an interaction between text version and educational level (both F's < 1). There was, however, a strong effect of educational level (F (1, 244) = 23.35, p < .001, η^2 = .09): high level students answered more questions correctly (3.43, *sd* = .67) than intermediate level students (2.82, *sd* = 1.14), even though the two groups were equally optimistic about their perceived comprehension (high: 4.45, *sd* = .66; intermediate: 4.31, *sd* = .76).

Table 4. Judgments about 'I could understand' and 'observed comprehension' as a function of text version (Original, Concrete, Concrete-Details, Abstract) and educational level (Intermediate, High) (sd between brackets)*

	Could understand*	**Observed comprehension****
Original		
Intermediate	4.44 (0.79)	2.94 (1.15)
High	4.52 (0.75)	3.35 (0.69
Concrete		
Intermediate	4.25 (0.65)	2.81 (1.16)
High	4.48 (0.63)	3.50 (0.77)
Concrete-Details		
Intermediate	4.29 (0.83)	2.76 (1.19)
High	4.48 (0.73	3.50 (0.50)
Abstract		
Intermediate	4.28 (0.79)	2.81 (1.10)
High	4.32 (0.55)	3.38 (0.69)

* Scale from 1 (minimum) to 5 (maximum)

** Scale from 1 (minimum) to 4 (maximum).

3.3.4 *Other measures*

The two groups differed substantially in their responses to the imageability question (high: 3.18, *sd* = 1.04; intermediate: 2.74, *sd* = 1.19; F (1, 243) = 8.45, p < .01,

$\eta^2 = .03$), although the versions did not differ in degree of imageability ($F < 1$); the interaction between text version and educational level was not significant (F (3, 243) = 1.46, $p = .23$, $\eta^2 = .02$). Apparently, the concrete versions were not considered more imageable than the abstract version.

The high-level students also answered the question how concrete they considered the text to be. Contrary to expectation, there were no differences between text versions (F (3, 106) = 1.23, $p = .30$, $\eta^2 = .03$). Overall, the text versions were considered relatively concrete (grand mean: 3.42, *sd* = .96, on a scale from 1 to 5). This lack of difference in imageability and the overall concreteness of the text versions casts doubts on the success of the concreteness manipulation of such abstract concepts like insurances.

The intermediate level students answered the question how much of the text they had read, in order to make sure that the responses are based on actually having read the entire text. This seems to have been the case: the overall mean on a 5-point scale was 4.39 (*sd* = 1.06). The four versions did not differ in this respect ($F < 1$).[13]

3.4 Conclusion and discussion

The experiment demonstrated differences in the comprehension and the persuasive effect of a text between school levels, but no differences between text versions. That is, the experimental results do not support the assumption that intermediate-level students benefit more from concrete reading materials.

Another finding is that all participants were less inclined to think about money and insurances, compared to what they normally do, after reading the text. This suggests that it will be very difficult to reach adolescents with these types of texts.

High-level students have a better comprehension of the text, found it more imageable and are more persuaded by the text. A possible explanation is that the text topic suited the high-level students better than the intermediate-level students. An interesting suggestion for following research is whether this finding generalizes to other topics from other domains.

As to the difference in effect of concrete and abstract words on the processing of the text, the study shows a complex picture. We feel that this is one of the first studies that has manipulated concreteness scrupulously: firstly, by using the concreteness scores from Brysbaert et al. (2014), secondly, by using the determinants identified in Study 1, and thirdly, by distinguishing between concrete information

13. This may be an artefact of the experimental situation: all participants of the intermediate level filled in the questionnaire supervised by their teachers, forcing them more or less to read the entire text.

and detailed information, and using only relevant details, as described in the literature (cf. Guadagno et al. 2011). In some sense the manipulation has proven successful: the four versions differed significantly with respect to the concreteness scores obtained by Brysbaert et al. (2014), although overall these scores were not that high (ranging from 2.18 for the abstract version to 2.79 for the concrete version with details). On the other hand, high-level participants rated the concreteness of the entire text relatively high (3.42). An additional issue is that the topic (money and insurances) in itself is relatively abstract, whereas the kind of information in the text is procedural (explaining what to do in a particular situation). The latter has the effect that the question asked in the questionnaire to check the manipulation can be interpreted otherwise: the statement "I found this text abstract/concrete" can be interpreted as "the text doesn't tell me/tells me what to do in a concrete way". Future research should disentangle these different interpretations. Future research should also take the abstractness of the text topic into account, preferably by varying text topics systematically as a factor in an experimental design.

4. General discussion

The basis for this study was the writing guideline to "be concrete". Informed by the literature on concreteness, we have investigated which determinants contribute to the perception of abstractness and concreteness. It was found that across the board sensory perceptibility acts as such; additionally, for nouns specificity makes a significant contribution, whereas for verbs drawability/filmability does. For adjectives no additional components were found to be effective. These results echo the suggestions of Douma (1994) and the empirical findings of Van Loon-Vervoorn (1985) and Connell and Lynott (2012). The dimensions that we found to be important in study 1 were also used by Brysbaert et al. (2014) in the instructions for their participants; moreover, the concreteness scores obtained in our study correlated highly with those from Brysbaert et al. (2014). This is remarkable, since we did not give any explicit instruction to our participants.

Using the concreteness scores, we have manipulated our materials in study 2 very carefully, in contrast to many studies that have either not manipulated their materials systematically (while keeping the content similar, e.g., Shedler and Manis 1986) or used altogether different materials (with completely different contents, e.g., Sadoski et al. 2000). In contradistinction to other studies (e.g., Reyes, Thompson and Bower 1980; Shedler and Manis 1986; Smith and Shaffer 2000), our data did not show any effects of concreteness (either with or without details) on comprehension and persuasion. It is difficult, at this stage of research, to explain the absence of an effect. We are reminded of the following quote from Connell and Lynott (2012: 453) "… concreteness effects do not always reliably emerge in semantic processing. Null effects are rarely publishable and tend to languish in experimenters' file drawers […]".

The success of experiments reported in the literature can be explained in part by the use of within-designs, in which participants read both concrete and abstract materials. Shedler and Manis (1986: 33) propagate the use of such within-designs, as it generates contrast effects (allowing the reader to compare abstract and concrete information). To this we might add the advantage of ecological validity: in real life abstract and concrete materials tend to co-occur. Even though our experimental text had an abstract flavor because of its topic, ours was a between-subjects design.

Another explanation might be the lack of attractiveness of the text for this particular audience: text appreciation scores were low. It may well be that the combination of money and insurance does not appeal to adolescents. In fact, the difference scores between the variables 'text makes me/others thinks about money' and 'how often do I normally think about money' suggest that the text is counterproductive, especially for the intermediate-level students. A suggestion for future research is to focus on high-attraction topics for this audience.

Data that support the advantage of concreteness often come from studies in which the researcher could manipulate their materials freely and creatively, by adding colorful details, choosing another topic and so on. However, when the researcher's hands are tied by a strict and systematic manipulation of their materials, the backing for the writing guideline 'be concrete' is not as strong as often suggested.

A final important issue is the exact relationship between abstractness and concreteness. Interestingly, many authors suggest that abstractness is the negative counterpart of concreteness (cf. Douma 1994; Brysbaert et al. 2014). In our experimental studies we also have operationalized abstractness as non-concreteness. However, that may well be a simplification. For example, Connell and Lynott (2012) find that perceptual experience of abstract words is not the inverse of the perceptual experience of concrete words. From this they conclude that abstractness and concreteness may be two different concepts and do not form a semantic opposition. Our suggestion for follow-up research is to replicate our first study in order to investigate the determinants of abstractness, rather than concreteness.

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CHAPTER 7

Acceptability properties of abstract senses in copredication

Elliot Murphy

This chapter explores the acceptability properties of copredication and how they can inform debates about the representation of abstract concepts. Across a series of acceptability judgment experiments, it was tested whether copredication in *book*-, *lunch*- and *city*-type nominals is difficult across-the-board or depends on adjective ordering in sentences like "John said that the folded and educational newspaper was on the shelf". The results revealed no acceptability difference between copredication and non-copredication, however there was a strong preference for concrete adjectives to be placed before abstract ones. It is suggested for the first time that the parser is sensitive to semantic complexity, and that it is more optimal to access abstract concepts after associated concrete concepts than the reverse.

Keywords: copredication, lexical frequency, sense order, simplicity first

1. Introduction

Copredication is standardly defined as "a grammatical construction in which two predicates jointly apply to the same argument" (Asher 2011: 11, see Cruse 2000, Gotham 2015; Murphy 2014, 2016, 2017a, 2017b). The nominal within the noun phrase takes multiple semantically unrelated predicates. Theories of copredication often discuss this phenomenon in purely ontological terms, speculating about the structure of *book*, *video* and *person* in complete abstraction from any actual grammatical organization (e.g., Arapinis 2013). Philosophers typically argue that *concrete* entities exist contingently, whereas *abstract* entities exist necessarily (Moltmann 2013), without acknowledging that both things can exist side by side: Companies can be *demolished* but also *criticized*, cities can be *sunny*, *upland* and *liberal*, bills can be *paid* and *folded*, and newspapers can be *read*, *held*, *sued*, *located outside the city* and *unable to offer John a job.* Mixing an abstraction with the

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concrete is simply part of the productive nature of lexical semantics, and it is exhibited most clearly in certain cases of polysemy (see Cruse 2004 for an argument that different senses are contextually-triggered "facets"; an idea closely related to underspecification accounts in psycholinguistics). Relatedly, most experimental work into polysemy has focused on the processing costs of individual senses, but an account is also needed of how multiple senses relate to each other (the original goal in Pustejovsky 1995, the first modern work to identify the problem). In brief, the phenomenon of copredication presents something of a challenge for models of abstract concepts given how readily they can be combined with seemingly incompatible senses.

This chapter will report two acceptability judgment experiments and two norming studies examining a range of copredications. These experiments will be used to gain insight into the potential parsing procedures and principles governing the interpretation of copredicated structures. Theories of copredication typically invoke type-shifting operations to generate complex polysemies (Pustejovsky 1995; Asher 2011; Gotham 2015), operations that have elsewhere been argued to bear processing costs (Traxler et al. 2005). It was therefore predicted that copredicated structures may be less acceptable than non-copredicated structures, using acceptability as an indirect gauge of processing cost. It will ultimately be suggested that certain contemporary type-theoretic debates concerning copredication can be reduced to parsing problems, not semantic ones. For instance, instead of invoking a host of unique types to account for acceptability distinctions in copredication (as in Asher 2011), a general *Simplicity First* parsing principle will be suggested to account for the most distinguishing acceptability patterns.

2. Experiment 1: Foundations of copredication

Since the judgments of individual researchers do not rise to the levels of quantitative standards seen in the rest of the cognitive sciences (as Gibson and Fedorenko 2010 argue), a series of online acceptability judgment experiments was performed. An online acceptability judgment experiment into the basic acceptability features of copredication was carried out using Qualtrics and sourcing participants from Prolific Academic. The range of stimuli was as broad as the experimental questions: Three copredicated nominal types were investigated for their acceptability properties relative to the same nominals in non-copredicated environments. The experiment was designed to explore the acceptability properties of copredicated structures relative to non-copredicated structures, with the latter departing as minimally as possible from the syntactic and semantic content of the former.

2.1 Materials and methods

2.1.1 *Participants*

Data from 48 participants was analyzed (mean age = 34; range = 18–54; 24 male). Participants were paid £6 per hour, with the average finishing time being 16 minutes. Participants were filtered from Prolific Academic based on their age (above 18), native language (English), and their rate of approval from previous experiments (at least 90%). They provided informed consent and were asked to write three sentences describing a recent activity they had participated in to ensure that they were proficient English speakers. A standard Likert scale (1–7; ranging from very unacceptable to very acceptable) was used for participants to judge acceptability.

2.1.2 *Materials*

36 experimental sets of four sentences (= 144 items; 12 *book*-type, 12 *city*-type, 12 *lunch*-type; namely, nominals hosting information-physical senses, institution-location-physical senses, or event-physical senses) were constructed, along with a series of ungrammatical (= 72 items, e.g.,'Sam say that those videos are going to be watched next week', *verb number agreement*; 'The red house were going to be put on sale that day', *verb tense agreement*) and grammatical (= 32 items, a mix of constructions, e.g.,'Russia and China are on John's long list of vacation resorts') filler sentences. An example of the experimental stimuli can be found below:

(1) a. John said that the *flat* and *folded* **newspaper** was on the shelf.
b. John said that the *educational* and *folded* **newspaper** was on the shelf.
c. John said that the *flat* **document** and *folded* **newspaper** were on the shelf.
d. John said that the *educational* **document** and *folded* **newspaper** were on the shelf.

(2) a. Mel read that the *respected* and *acclaimed* **school** was praised by her best friend.
b. Mel read that the *huge* and *acclaimed* **school** was praised by her best friend.
c. Mel read that the *respected* **teacher** and *acclaimed* **school** were praised by her best friend.
d. Mel read that the *huge* **teacher** and *acclaimed* **school** were praised by her best friend.

(3) a. Laura said that the *sweet* and *tasteful* **breakfast** was worth the effort.
b. Laura said that the *brief* and *tasteful* **breakfast** was worth the effort.
c. Laura said that the *sweet* **snack** and *tasteful* **breakfast** were worth the effort.
d. Laura said that the *brief* **snack** and *tasteful* **breakfast** were worth the effort.

The experimental items were categorized by the conditions *one nominal* vs. *two nominals* (1a and 1b vs. 1c and 1d) and *same sense* vs. *different sense* (1a and 1c vs. 1b and 1d). Two adjectives were coordinated and attributed either to a single nominal (1a and 1b) or distinct nominals (1c and 1d). The adjectives were either of the same semantic type (*flat* and *folded*) or of distinct types (*educational* and *folded*). Adjectives were selected to be as minimally ambiguous as possible between distinct senses (e.g., *brief* cannot select for the physical object sense of *breakfast*), and in the context of an experimental environment it was assumed that these readings would be clear. Ungrammatical fillers were characterized by a variety of illicit featural and lexical properties (e.g., verb number agreement, prepositional phrase agreement, superfluous conjunctions). All stimuli predicates and nominals were selected for their SUBTLEX-UK Zipf frequency (2–5; moderately frequent to very frequent), and all predicates and nominals had between 4–11 characters.

2.1.3 *Procedure*

Each participant saw one of four lists of 80 sentences (36 experimental, 27 fillers, 17 comprehension questions). The comprehension questions were randomly placed amongst the experimental and filler items. For instance, after making an acceptability judgment on the sentence "Pablo thought that the wholesome pudding and evening feast were the best part of the weekend", participants were asked: "Did Pablo think highly of the feast?", being required to answer "Yes" or "No" before proceeding. The participants were asked to rate sentences based on how natural they sounded, with ratings being placed on a Likert scale (1–7). Four practice judgments were presented before the experiment began.

2.2 Results

2.2.1 *Comprehension question analysis*

All participants scored above 80% on the comprehension questions, with no difference in accuracy across conditions.

2.2.2 *Acceptability judgment data*

All participants performed well on the fillers (above 80% accuracy), with their average scores falling below 4 on 90% of ungrammatical fillers and above 5 on 85% of grammatical fillers. Repeated measures ANOVAs (Field 2013) were carried out using IBM SPSS Statistics 21 ($\alpha = .05$), accompanied by Greenhouse-Geisser corrections (Greenhouse and Geisser 1959) to avoid Type I errors resulting from violating the assumption of sphericity. A 2 x 2 by-subjects ANOVA (Nominal Number x Sense Type) revealed a significant effect of sense type ($F\,(1, 47) = 32.410$, $p = .001$, $\eta_p^{\,2} = .408$) but no effect of nominal number ($F\,(1, 47) = 2.547$, $p = .117$,

$\eta_p^2 = .051$) and no interactions. A 2 x 2 by-items ANOVA (Nominal Number x Sense Type) also found a significant effect of sense type ($F(1, 35) = 9.794$, $p = .004$, $\eta_p^2 = .219$) but no effect of nominal number ($F(1, 35) = 1.615$, $p = .212$, $\eta_p^2 = .044$) and no interactions.

2.3 Discussion

The experimental results indicate that sentences containing different senses attributed to either one or two nominals are significantly less acceptable than sentences containing semantically related senses. This acceptability difference was not additionally modulated by the number of nominals in the construction. The results indicate that sentences that coordinate different senses, whether attributed to one or two nominals, are significantly less acceptable than those coordinating semantically related senses. Importantly, copredicated nominals were not singled out by this general effect, providing evidence that the proposed type-shifting operations involved in generating copredications (e.g., Pustejovsky 1995, Asher 2015) do not lead to acceptability impairments. One of the possible reasons for these results may be that while acceptability scores do not significantly differ between copredication and non-copredicated minimal pairs, the online processing of these structures may reveal a particular time course exhibiting significant processing differences.

Contrasts revealed that the difference between type-shifting and non-type-shifting conditions were indeed slight: (1-same – 1-diff) > (2-same – 2-diff) = (5.36–4.91) > (5.42 – 5.08) = .45 > .34. Further, as Sprouse (2011) discovered, online acceptability tests yield almost indistinguishable results from laboratory settings, and so these conclusions can be drawn with a serious degree of confidence. Finally, it may be that offline acceptability judgments do not differ significantly between copredication and non-copredication, but more specific forms of online processing may expose certain differences, for instance with reading times or event-related potential responses implicated in semantic reanalysis and prediction. Future work will address these questions.

3. Experiment 2: Sense order effects

A second acceptability experiment was also carried out, slightly modifying the conditions in the first. The reason why Experiment 1 did not find significantly differing levels of acceptability between copredication and non-copredication may have been because type-shifting is only difficult for *X to Y* adjective shifting, and not *Y to X* (e.g., PHYSICAL OBJECT (X) to INFORMATION (Y)), with the experimental stimuli only including one form of shifting. Moreover, the results of

Experiment 1 may have been a consequence of sense ordering effects more than a consequence of sense relatedness, and so the adjectives in Experiment 2 were of different semantic types across-the-board.

3.1 Materials and methods

3.1.1 *Participants*

168 participants were recruited (age range 18–59; 92 female). Participants were paid £6 per hour, with the average finishing time being 20 minutes. The filtering conditions for participants were identical to Experiment 1.

3.1.2 *Materials*

36 experimental sets of four sentences (= 144 items) were constructed manipulating the order of senses. As in condition 2 in Experiment 1, each of the two conditions included semantically unrelated senses. Each experimental set had identical sense ordering. In addition, counterbalancing was introduced to determine which predicates were associated with the nominals, such that four additional sentences were added to each experimental set, through which the nominals themselves switched places. For instance, the phrase "large pamphlet and heavy book" was counterbalanced with "large book and heavy pamphlet". This doubled the size of the experimental stimuli, creating the following conditions: Sense Order (1 or 2; Concrete First or Concrete Last), Nominal Number (1 or 2) and Nominal Order (1 or 2).

3.1.3 *Procedure*

The experimental procedure was identical to Experiment 1.

3.2 Results

3.2.1 *Comprehension question analysis*

All participants scored above 80% on the comprehension questions, with no difference in accuracy across conditions.

3.2.2 *Acceptability judgment data*

All participants performed well on the fillers (above 80%), with their average scores falling below 3 on over 95% of ungrammatical fillers and above 5 on over 90% of grammatical fillers. In particular, the new sets of ungrammatical and grammatical fillers averaged, respectively, below 3 and above 5.

Repeated measures ANOVAs were carried out using SPSS Statistics 21 ($\alpha = .05$), accompanied by Greenhouse-Geisser corrections. A 3 x 2 by-subjects

ANOVA (Nominal Number x Sense Order x Nominal Order) revealed a significant effect of Sense Order (F (1, 167) = 15.968, $p < .001$, $\eta_p^2 = .087$) and also Nominal Number (F (1, 167) = 70.871, $p < .001$, $\eta_p^2 = .298$). No effect of Nominal Order was found (F (1, 167) = .769, $p = .382$, $\eta_p^2 = .005$). There was found to be no interaction effect between Nominal Number and Sense Order, although this approached significance (F (1, 167) = 3.224, $p = .074$, $\eta_p^2 = .019$). No other interaction effects either reached or approximated significance.

A 3 x 2 by-items ANOVA (Nominal Number x Sense Order x Nominal Order) found no effect of Sense Order (F (1, 167) = 3.546, $p < .068$, $\eta_p^2 = .086$) or Nominal number (F (1, 167) = 3.309, $p = .077$, $\eta_p^2 = .092$), although these approached significance. No effect of Nominal Order was found (F (1, 167) = .396, $p = .553$, $\eta_p^2 = .011$). No interaction effects either reached or approximated significance.

Book-type items scored higher than both the *city*-type and *lunch*-type nominals (which averaged at approximately similar levels), and *book*-type items most clearly exhibit the effects of sense order manipulation.

3.3 Discussion

This experiment revealed that for the by-subjects analysis, sense order and also nominal number had a significant effect on acceptability. This effect was not entirely reliable, however, since it was not observed across all items. Comparing Concrete Last conditions across nominal number reveals that this type of sense integration on a single nominal is costlier with respect to acceptability scores than sense dispersal over multiple nominals. This may suggest that the acceptability costs associated with retrieving a distinct nominal, integrating it into the discourse and modifying it via an intersective adjective, are greater than the costs associated with merely attributing an additional sense to a single nominal. In addition, acceptability was moderated by predicate order, such that Concrete First items were significantly more acceptable than Concrete Last items. As with Experiment 1, this sense order effect was not exclusive to copredication. Type-shifting itself may not be costly, then, but the costs may rather lie with discourse (sense order) effects. Sense order sensitivity may be general to the parser, but simply become clearer in copredication.

The results of the by-subjects analysis were not repeated for the by-items analysis, and the results suggest that the *book*-type items were the major cause of this. One might be tempted to conclude that since the informational sense of *book* is known to be dominant, sense frequency might play a major role in sense order acceptability. We will return to this possibility below.

While previous work from Frisson (2015) detected an effect of polysemous sense order on single nominals, it was unclear whether this effect obtains only on single nouns; due to inadequate controls in Frisson's (2015) study it was not clear whether the effect is specific to copredication. The present study therefore sheds light on this question. Moreover, Frisson's (2015) target words in the eye-tracking study reported there were, crucially, different adjectives. Comparing two distinct words engenders its own problems, since the effects found may be due to any number of lexical/semantic factors. The present study, in contrast, approaches a more optimal minimal pair which sets the scene for follow-up eye-tracking studies in which the target word would be the same nominal across all conditions, eliminating the risks found in Frisson's study.

The general documented trend was that Concrete First items were deemed more acceptable than Concrete Last items. But not all items were judged this way. For the *lunch*- and *city*-type sentences, this may have been because the frequency of each sense may be approximately symmetric, whereas *book*-type nominals might display a far greater variation in frequency (with the information sense overwhelmingly being the dominant one). Only one of the *book*-type items deviated from the trend ("Sam claimed that the small and funny letter was in the post"). With *lunch*- and *city*-type nominals, nearly half the items deviated from the general trend (5 in both groups had greater Concrete Last scores, and 7 had greater Concrete First scores). Nevertheless, this suggests a preference for Concrete First copredications.

Before proceeding, I will distinguish between what I will call *frequency-based* accounts and *complexity-based* accounts of copredication acceptability. In order to derive the former, consider the seminal work of Rayner and Duffy (1986). These authors investigated whether lexical complexity increased the processing time of words using eye-tracking. They discovered that it was not lexical complexity, but rather lexical frequency that resulted in systematically longer reading times, such that low-frequency yields a longer reading time. Moreover, Duffy et al. (1988) found that placing a low-frequency word early in a sentence resulted in longer reading times for the remainder of the sentence compared to when a high-frequency word was placed early in the sentence, concluding from this that sense dedication was stronger in the latter case due to the high frequency of the item.

From this, we can construct the hypothesis that lexical frequency modulates copredication acceptability and processing effort. A particular implementation of this hypothesis would generate the prediction, tested below, that placing the most frequent polysemous sense first should result in lower acceptability ratings relative to the reverse order, since the participant is dedicated to a more frequent (and more easily accessible) sense before being forced to re-assess the nominal construction when the subordinate sense is presented (that is, the processing issues would arise at the second predicate). This follows early models of exhaustive access that propose that dominant meanings are generally available earlier than subordinate meanings (Simpson and Burgess 1985). This implies that placing the dominant sense first will result in a situation in which the subordinate sense is harder to access due to sense dedication being stronger after processing the frequent sense.

In contrast, it is possible that semantic category or complexity modulates sense order acceptability, such that the more concrete or abstract sense being placed first might influence acceptability. For instance, the abstract institution sense of *city* appears to be more semantically complex than the basic, geographical location sense or the physical sense associated with its built structures, since one can draw on the conceptual frame associated with an institution and it is also more closely associated with a network of other senses, whereas the physical or location senses cannot be decomposed further and have less complex semantic connections. The next section will test these ideas through a series of norming studies.

For now, the finding that Concrete First orderings were preferable to Concrete Last orderings leads me to propose the following principle.

> ***Simplicity First****: Seek to process linguistic representations in incremental stages of semantic complexity.*

Among other things, this may explain the contrast in (4), with the process sense in (4a) preceding the physical sense:

(4) a. #The translation that was difficult lies on the table.
    b. The translation that lies on the table was difficult.

Similarly, when the institution sense follows the other senses of *newspaper*, the results are much improved:

(5) a. #John sued the newspaper that he had spilled coffee on.
    b. John spilled coffee on the newspaper that he had sued.

One might be tempted to relate *Simplicity First* to Behaghel's Second Law ("That which is less important (or already known to the listener) is placed before that which is important"), but the notion of *importance* plays no role here; rather, the unvarying notion of semantic complexity is invoked.

If this effect of sense order is indeed a general one, not specific to *book*-, *lunch*- and *city*-type nominals, then theories of copredication might in fact be discussing processing effects, and not semantic structure and conceptual constraints. Related observations apply to the psycholinguistic literature. For instance, complement coercion might not be a complex operation (due to the apparent ease of type-shifting documented in the present experiments), and the processing effects documented in the coercion literature may therefore be due to some other effect (contrary to claims made in Traxler et al. 2005).

Simplicity First may be a general principle given that a number of other, unrelated constructions seem to exhibit parsing preferences such that delaying the more complex object leads to acceptable results, whereas placing the more complex object first results in degraded results. Manipulating Number is a case in point; (6b) is acceptable in a very particular context, but seems somewhat more difficult to parse than (6a), which does not need any contextual assistance:

(6) a. I saw a picture of us.
b. ?We saw a picture of me.

Verbal coercions also seem to exhibit a preference for increasing scales of semantic complexity. Consider (7), in which the physical sense of *glass* either precedes or follows the more complex metaphorical reading of *expectations*, yielding a clear zeugma in (7b):

(7) a. John raised his glass and his expectations.
b. ?John raised his expectations and his glass.

The results of Experiments 1 and 2 are also compatible with some pragmatic accounts; for instance, Relevance Theory predicts a cost of sense switching since the parser commits to the first, most cognitively relevant sense (see Frisson 2015). The next section will address a number of issues already raised through conducting a series of norming studies.

4. Norming studies

4.1 Study 1: Sense frequency and adjective coordination

The acceptability results of Experiment 2 could be due to factors ranging considerably far beyond the interpretation of the individual copredications, such as the acceptability of the adjectives, the co-occurrence of adjective pairs, and the frequency of the different nominal senses. As a result, a series of norming studies were carried out to focus on all these factors, again using Qualtrics.

A potential diagnostic for sense dominance arises with *former* modification. A *former school* is most easily interpreted as being a former institution, indicating that the institution sense of *school* is likely the dominant one (and not, say, the process sense, as in "School starts at 9am"). But what about *former newspaper*? This could be a burned physical copy, a poem comprised of old newspaper clippings, and an organization whose members changed their company into a law firm. Nevertheless, none of these readings seem more prominent than the other (at least according to intuition, although this issue has not been subject to experimental verification), and indeed it is questionable whether any are completely acceptable. Perhaps *newspaper* is composed of senses of such complexity that the number of potential options that *former* could modify cannot be easily computed and compared. In order to approach the matter of prominence and frequency empirically, the following study was carried out.

4.1.1 *Methods and materials*

The study was composed of two parts. The first part was a fill-in-the-blank task attempting to gauge the frequency of polysemous senses. After completing this, an acceptability judgment task was presented. The following stimuli were used: All 72 coordinated adjectives taken from Experiment 2, and 66 fill-in-the-blank determiner phrases using the nominals from the same experiment. Presenting these stimuli sets to the same participant group would permit legitimate comparisons between the results of both sets. Two lists were designed such that each participant saw one order from each coordinated adjective pair (e.g., Subject 1 saw "wealthy and multistory" and Subject 2 saw "multistory and wealthy"). Half the stimuli in each list (36) were Concrete First, half Concrete Last.

Likewise, the fill-in-the-blank determiner phrases (e.g., "The book was [blank]") were equally divided between the two lists. 22 nominals from the three main lexical categories (*book*-type, *city*-type, *lunch*/*construction*-type) were used, totaling 66 (where *construction*-type is also a case of conjoining an event with a physical object, as with *lunch*, such that a construction can be *large* and *time-consuming*). All of the primary and secondary nominals from Experiment 2 were used (i.e., both *movie* and *letter* from "short movie and funny letter" in Conditions 3 and 4), in addition to a number of similar nominals. Each participant saw 11 nominals from each category, totaling 33.

Together with the adjectival phrases, each participant was exposed to 69 sentences. The experiment was composed of 33 fill-in-the-blank stimuli followed by 36 adjective pairs.

The experiment was conducted in two parts, with the fill-in-the-blank stimuli being presented first, since this avoided the risk that participants would simply be primed to insert certain adjectives based on what they would have recently encountered through the coordinated adjectives. The results of this norming study will permit a more thorough and controlled interpretation of Experiment 2, along with future acceptability experiments using these nominals and adjectives.

Sixty-two participants were recruited for the experiment (29 male) and were paid £6 per hour, with the average finishing time being 17 minutes.

4.1.2 *Results and discussion: Sense frequency*

Of all the *book*-type nominals, only *atlas*, *brochure* and *dictionary* were physical-dominant (Figure 1). Interestingly, sense frequency does not seem to modulate sense order acceptability, since both *dictionary* and *book* (along with other *book*-type nominals) followed the same acceptability pattern in Experiment 2 despite their different frequency profiles: For the Concrete First condition, *dictionary* and *book* respectively scored 6.23 and 6.53, while for the Concrete Last condition they scored 5.92 and 5.76.

In addition, if the argument coming from the Duffy et al. (1988) school of thought is that frequency effects sense order, this cannot account for why the food sense was strongly dominant for all *lunch*-type when the results of Experiment 2 clearly indicate fairly symmetrical levels of acceptability when sense order is modulated. A possible explanation is simply that during copredication licensing the parser is sensitive to sense complexity, not frequency; a clear example of *Simplicity First* being applied.

For *city* and *town*, the results indicate that these nominals are physical-dominant. There were no institution-related responses from participants, although the POPULACE sense was cited fairly often. In Experiment 2, the Concrete Last condition for *city* scored 4.53, while the Concrete First condition scored 5.15. This again suggests that frequency-based accounts are not as empirically adequate as the present complexity-based hypothesis regarding *Simplicity First*, since placing the most frequent sense first leads to improved acceptability. Further, the adjectival phrases used for *city* – 'reactionary and polluted' and 'polluted and reactionary' – were rated 3.61 and 3.65, respectively, indicating that these particular co-occurrences cannot be invoked to explain the acceptability differences in the Experiment 2 data.

For *construction*, event was the dominant sense, and of the process and state sub-events, state was dominant. Of all the nominals, this was the one that grants the greatest support to frequency-based accounts, since for Concrete First in Experiment 2 it scored 3.92, and for Concrete Last it scored 5.07. This suggests that, in this case, placing the more dominant sense first results in greater acceptability. As the results of the second part of the norming study suggest (below), the phrases 'tall and difficult' and 'difficult and tall' were rated approximately the same (4.58 and 4.66, respectively), and so the acceptability difference must reside in the copredication.

School was found to be institution-dominant, but only moderately. The physical sense was also very frequent, with the event sense being dramatically subordinate. 43.5% of responses were institution, 38.7% were physical, leaving 17.8% for event. Again, this provides further evidence in favor of the complexity-based account proposed here and against any frequency-based models, since in Experiment 2 the physical-institution order was rated 5.84, while the institution-physical order was rated 4.92.

For *bank*, there were only two recorded institution responses, with the physical sense being overwhelmingly dominant. Factoring in the results from

NOMINAL	DOMIN.	SUBORD.	% DOM.	NOMINAL	DOMIN.	SUBORD.	%DOM.	NOMINAL	DOMIN.	SUBORD.	%DOM.
Translation	INFO		100	***Publication***	INFO	PHYS	75.8	***Feast***	FOOD	EVENT	91.9
Exam	INFO		100	*Building*	PHYS		100	***Breakfast***	FOOD	EVENT	87
Novel	INFO	PHYS	98.5	*Library*	PHYS		100	***Dinner***	FOOD	EVENT	87
Commentary	INFO	PHYS	98.5	*Village*	PHYS		100	***Meal***	FOOD	EVENT	85.4
Adaptation	INFO	PHYS	96.9	*Farm*	PHYS	INST	98.4	***Brunch***	FOOD	EVENT	83.8
Bill	INFO	PHYS	93.6	*Bank*	PHYS	INST	96.8	***Supper***	FOOD	EVENT	83.8
Video	INFO	PHYS	92.0	*Shop*	PHYS	INST	96.8	***Barbeque***	FOOD	EVENT	80.6
Message	INFO	PHYS	87.1	*Factory*	PHYS	INST	89.9	***Banquet***	FOOD	EVENT	77.4
Advert	INFO	PHYS	85.5	*Borough*	PHYS	INST	85.8	***Construction***	EVENT	PHYS	63
Dissertation	INFO	PHYS	77.8	*Workshop*	PHYS	INST	84.2	***Picnic***	FOOD	EVENT	55.5
Pamphlet	INFO	PHYS	77.5	*Company*	INST	PHYS	84.1	*Appointment*	EVENT		100
Newspaper	INFO	PHYS, INST	71.0	*Province*	PHYS	INST	73.1	*Gym*	PHYS	INST	93.6
Letter	INFO	PHYS	70.9	*Hotel*	PHYS	INST	71.4	*Church*	PHYS	INST	85.7
Magazine	INFO	PHYS, INST	68.3	*Settlement*	PHYS	INST	68.3	*Nursery*	PHYS	INST	85.7
Essay	INFO	PHYS	66.6	*Restaurant*	PHYS	INST	59.7	*Renovation*	EVENT	PHYS	63.5
Newsletter	INFO	PHYS	66.6	*College*	PHYS	INST	58.8	***Entrance***	PHYS		100
Book	INFO	PHYS	64.6	*University*	INST	PHYS	57.1	***Door***	PHYS		100
Journal	INFO	PHYS	63.5	*Arthouse*	PHY5	INST	56.5	***Archway***	PHYS	APERTURE	98.4
Atlas	PHVS	INFO	61.9	*School*	INST	PHVS, EVENT	43.5	***Passageway***	PHYS	APERTURE	77.7
Brochure	PHYS	INFO	58.7	***Dessert***	FOOD	EVENT	98.3	*Council*	INST	POP	79.3
Dictionary	PHYS	INFO	58.0	***Lunch***	FOOD	EVENT	98.3	*City*	PHYS	POP, LOC	67.7
Printout	INFO	PHYS	52.4	***Appetiser***	FOOD	EVENT	95.1	*Town*	PHYS	POP, LOC	62.9

Figure 1. Average scores for the fill-in-the-blank norming study. 'Domin.' denotes the dominant sense, 'Subord.' denotes the subordinate sense, '% Dom.' denotes the percentage of dominance exhibited by the dominant sense. The nominal types were grouped in the following way: PHYSICAL-INFORMATION, PHYSICAL-INSTITUTION, FOOD(PHYSICAL)-EVENT, EVENT-PHYSICAL-INSTITUTION, PHYSICAL-APERTURE, INSTITUTION-POPULATION-LOCATION

Experiment 2, this adds further support to the present complexity-based account: physical-institution was rated 5.84, institution-physical was rated 4.84.

Of the three main nominal types explored, *book*-type INFO-PHYS nominals are overwhelmingly PHYS-dominant, *shop*-type PHYS-INST nominals are overwhelmingly PHYS-dominant, *lunch*-type PHYS(FOOD)-EVENT nominals are overwhelmingly PHYS-dominant (where food is naturally a sub-type of phys). More generally, the most dominant sense across all nominals was PHYS, which not only dominated but was also a highly frequent subordinate sense.

A binomial logistic regression was performed to ascertain the effects of nominal and nominal type on the likelihood that the dominant sense would be either abstract or concrete. In order to conduct this analysis, it was necessary to collapse certain of the senses in Figure 1 into a single, coherent category; for instance, the location and physical senses of *city* were collapsed into a single concrete sense, while the populace sense was left as the sole abstract sense. The logistic regression model was statistically significant, χ^2 (65) = 2308.347, $p < .001$. The model explained 57.8% (Nagelkerke R^2) of the variance in sense dominance and correctly classified 80.8% of cases. For instance, the nominal *message* was 10.3 times more likely to have its abstract sense selected than its concrete sense.

At this point, it is useful to discuss the above proposed frequency-based and complexity-based accounts. As mentioned, the former account was inspired by Rayner and Duffy (1986) and Duffy et al. (1988), who found an effect of lexical frequency on word reading times. In the present experiment, all adjectives were already controlled for general lexical frequency and so this allowed a more direct investigation into the frequency of the polysemous senses which the distinct adjectives represented. The results crucially pave the way for an alternative account; namely, a complexity-based one, since this appears to be the core factor influencing sense order acceptability (and not sense frequency).

4.1.3 *Results and discussion: Adjective coordination*

The results of the phrase acceptability study, testing the predicate co-occurrences used in the above experiments, are as follows: On average, the Concrete First order scored 4.189, while the Concrete Last order scored 4.088. The Concrete Last ordering was found not to be significantly less acceptable, according to a repeated measures ANOVA (F (1, 35) = 2.820, $p = .102$, Cohen's $d = 1.33$). These results suggest that the acceptability results from Experiment 1 and 2 are not due to the co-occurrence of the adjectives, and likely reside instead with the copredications involved. This is due to the fact that isolating adjective coordinations does not yield similar results, and since only the adjectives and nominal constitute any given copredication in the above experiments, we can infer that the act of copredication is responsible for the results. This allows a more controlled, robust interpretation of the data, and suggests that copredication indeed involves significant differences in acceptability as a function of predicate order, following *Simplicity First*.

By-items and by-subjects ANOVAs (3 x 2; Nominal Type x Sense Order) were also performed over the three distinct nominal categories that the adjective pairs were used for in Experiment 2 (*book*-type, *lunch*-type, *city*-type). The by-items analysis revealed no significant effects of Sense Order (F (1, 11) = 2.031, p = .182, η_p^2 = .156) or Nominal Type (F (2, 10) = 2.685, p = .117, η_p^2 = .349). The by-subjects analysis revealed no significant effect of Sense Order (F (1, 61) = .845, p = .362, η_p^2 = .014), however there was found to be a significant effect of Nominal Type (F (2, 60) = 55.981, p < .001, η_p^2 = .651). The fact that there was found to be no significant effect of Sense Order for either the by-items or the by-subjects ANOVAs indicates that the effects of Sense Order found in Experiment 2 resulted from the adjective-noun combinations involved in the copredications. These results are distinct from those of Experiment 2, since Experiment 2 revealed a significant effect of sense order in the by-subjects analysis. This indicates that the effects in Experiment 2 were likely a result of the copredications involved and cannot be attributed to the pairings of adjectives.

The average difference between the adjective pairs was 0.28. Out of the 36 pairs tested, the scores of 14 pairs differed by a margin greater than 0.28. These were 'tasty and delayed' (.88), 'multistory and wealthy' (.67), 'sunny and organized' (.30), 'folded and educational' (.73), 'slim and insightful' (.38), 'huge and respected' (.65), 'hillside and rich' (.75), 'flavorful and prompt' (.34), 'delectable and stalled' (.50), 'short and funny' (.45), 'spicy and yearly' (.57), 'salty and rushed' (.47), 'lengthy and organic' (.33), and 'scrunched and famous' (.46).

Can these substantial differences in acceptability explain the results in Experiment 2? Certain results speak to the hypothesis that the acceptability properties of Experiment 2 (E2) can be derived purely from the adjective co-occurrences. 'Tasty and delayed' was found to be more acceptable than 'delayed and tasty', and this indeed maps onto the E2 scores for the full sentences they were used in, which were, respectively, 6.00 and 5.15. 'Multistory and wealthy' was found to be more acceptable than the reverse. Again, this matches onto the E2 scores, which were respectively 5.84 and 4.84. 'Sunny and organized' was more acceptable than 'organized and sunny', which matches onto the E2 scores of 6.15 and 5.07. 'Huge and respected' was more acceptable than the reverse, and this mapped onto the E2 scores of 5.84 and 4.92. 'Salty and rushed' was more acceptable than the reverse, with the E2 results exhibiting the same pattern with 6.46 and 5.84. Finally, 'lengthy and organic' was more acceptable than the reverse, and this was also the case in E2 since the scores were 5.38 and 3.84.

From this, we can conclude that the results of only 6 pairs matched the results from E2. Yet even though the general pattern was adhered to in these stimuli, the acceptability differences were nevertheless greater in the E2 results than in the present norming study, suggesting that the adjective pairs are not wholly responsible for the acceptability differences.

Nevertheless, there is also evidence against the hypothesis that the acceptability properties of E2 can be derived from the adjective co-occurrences. 'Folded and educational' was more acceptable than the reverse, however in E2 both sentences these phrases were contained in were scored 5.07. 'Slim and insightful' was more acceptable than the reverse, however the differences between the E2 scores was only 0.08. 'Hillside and rich' was more acceptable than the reverse, yet the opposite pattern was found in the E2 results, with both sentences the phrases were contained in scoring 4.30 and 5.15. 'Flavorful and prompt' scored higher than the reverse, yet the opposite pattern obtained in the E2 results, which were 4.84 and 5.07. 'Stalled and delectable' scored higher than the reverse, yet the opposite was found to be the case in E2, with the scores being 5.00 and 5.69. 'Short and funny' was more acceptable than the reverse, but the opposite was found to be the case in E2, with the scores being 5.15 and 6.30. 'Yearly and spicy' was more acceptable than the reverse, yet this was not the case for the E2 results, with the scores being 4.76 and 5.38. Finally, 'famous and scrunched' was more acceptable than the reverse, but the opposite was found to be the case for the E2 results, with the scores being 4.84 and 5.30.

It is also worth noting that the general mechanism proposed in this chapter of complexity ordering impacting parsing may also be at work when participants processed even the three-word phrases in the present norming study. That is to say, even if it was the case that the E2 results could be derived purely from the adjective co-occurrences, it may also be the case that both sets of results can in turn be derived from the general *Simplicity First* parsing principle, since as mentioned the Concrete First order for the adjective co-occurrences scored higher than the reverse. In addition, even if the pattern of co-occurrence acceptability scores matches onto the E2 scores, this does not rule out the possibility that the copredication the adjective pairs were inserted into was itself deemed unacceptable for additional reasons to do with the type mismatch derived from the copredication.

Crucially, none of the adjective pairs used could be considered conventionalized binomials of the *bread and butter* variety, and so the acceptability scores were not biased by any source of familiarity. These findings allow us to sidestep a potential criticism of the core experimental findings regarding predicate ordering. One might object, invoking Horn's principle, that an unconventional expression typically implies an unconventional meaning, such that *butter and bread* is thought to potentially license a meaning other than that implied by *bread and butter*. If the adjective orderings in the present norming study were found to be of significantly different levels of acceptability, one might argue that any interpretation generated by the copredications they are involved in would simply be a result of the unconventionality of the predicate orderings. Given the results reported here, however, it seems that this possibility can be ruled out, since no such differences were found.

4.2 Study 2: Adjective co-occurrence and sense relatedness

As reported above, the by-subjects ANOVA for the adjective coordination study found a significant effect of Nominal Type, a result that obtained for Experiment 2. Consequently, it may be that the participants were executing 'silent' copredications when processing the coordinated adjectives, with 'tasty and delayed' being interpreted as meaning 'tasty and delayed *x*, such that *x* fulfills the requirements of exhibiting both senses'. In order to address this issue, it was necessary to carry out a revised version of the previous acceptability norming study.

4.2.1 *Methods and materials*

The goal of the present study was to determine the *relatedness* of the adjectives used in the copredication stimuli, since if certain of them were deemed wholly unrelated then this might go some way to explain the results in the main experiments reported above, such that the need to invoke, for instance, costly type-shifting operations would be greatly lessened. The adjectives were presented to subjects without any coordination and with a space between them (e.g., 'heavy___amusing'; underscore not present during experiment), with two lists being created such that each participant only saw one order (Abstract-Concrete, Concrete-Abstract) per item. In addition, a list of 36 unrelated (e.g., 'plane___undermine') and 36 related (e.g., 'horse___cat') fillers were used.

The task for participants was to answer the question "How related are these words?" for each pair, again using the familiar Likert scale. A practice round was provided, with participants being informed that 'computer___microchip' was a related pair and 'book___olympic' was an unrelated pair. Throughout the experiment, the same adjectives were used as in the previous norming study.

Comparing both the present and the above studies (e.g., comparing 'heavy and amusing' with 'heavy___amusing') will reveal whether participants were likely performing silent copredications in the first norming study or whether the acceptability scores were simply a result of assessing the relatedness of the adjectives.

4.2.2 *Results and discussion*

A by-subjects ANOVA (3 × 2; Nominal Type × Sense Order) was performed over the three distinct nominal categories (book-type, lunch-type, city-type) used to categorise the adjective pairs (e.g. 'heavy amusing' was categorised as book-type). This revealed no significant effect of Sense Order ($F(1,61) = 1.118$, $p = .294$) and no effect of Nominal Type (F(2,60) = 1.758, p = .181), nor an interaction effect (p = .511). The by-items analysis also revealed no effects.

The results revealed no significant difference between the Abstract-Concrete and the Concrete-Abstract configurations concerning sense relatedness for the present stimuli set. As such, the participants' choice of sense relatedness was not impacted by the relative position of the adjectives. This may seem tautologous, but it leads to the suggestion that the sense order effects documented in Experiment 2 were not due to differences in sense relatedness across the nominal types. In the first norming study, for the adjectival phrases the task explicitly had participants focus on the acceptability of the phrases as linguistic units (i.e. how natural the phrase sounds in English), whereas the present experiment tasked participants with focusing on the more conceptual level of semantic relatedness. Since the results of the two norming studies were similar and there was found to be no difference between adjective orderings, the results of the first norming study likely resulted from the co-occurrence of the adjectives and their concomitant acceptability. This in turn allows us to conclude that the results of the main experiments were likely due to the noun-adjective associations involved in the stimuli (i.e. the effect of associating two adjectives with either one or two nominals) and were not the result of any particular feature of the adjectives.

5. Conclusion

The present series of experiments has provided strong evidence that adjective order plays a substantial role in the licensing of all copredication types investigated, and, furthermore, that this licensing incurs acceptability costs based on the semantic category and complexity of the adjectives. The results are in keeping with the predictions of the complexity-based *Simplicity First* account, with every condition pair in E2 adhering to the principle. The effects of *Simplicity First* were most pronounced in *book*-type nominals, then *city*-type nominals, and then finally *lunch*-type nominals, which showed only marginal effects (for reasons to be explored in future work). *Simplicity First* may also be implemented via a priming effect, such that simple senses prime complex senses to a greater extent than the reverse.

Given the results from the norming studies, these findings cannot be accounted for by invoking sense frequency, since all three nominal types exhibited particular sense dominance on the order of at least 70–80% for most of their nominals. Indeed, if anything, *lunch*-type nominals showed greater sense dominance than *book*-type and *city*-type nominals, reaching at least 85% for most; precisely the opposite state of affairs predicted under frequency-based accounts (see also Murphy 2017a, which provides evidence against any *acquisition*-based hypotheses, since the age at which polysemous senses are acquired varies considerably with respect to sense order acceptability).

In brief, while the language system may encode abstract and concrete representations in identical ways, the performance/parsing mechanisms which operate over these representations appear to obey a general stepwise principle when constructing composite (and typically nominal) representations such that it is preferable to access monadic senses (that is, non-decomposable senses like physical object) before more complex ones (like institution, which provides a frame hosting multiple senses). This opens up new directions for investigating the processing properties of abstract concepts given that they appear to be combined with other concepts in quite distinct ways during comprehension, depending on the category and complexity of the senses they are combined with.

If there is cross-linguistic variability in sense frequency across the nominals involved in copredication (as Jezek and Vieu 2014 found for Italian and English), and if the frequency-based accounts of sense order effects are indeed accurate we would presumably find different acceptability profiles for sentences from languages exhibiting distinct frequency profiles. Further research into this would permit a clear adjudication between frequency-based and complexity-based accounts, opening up a number of experimental and theoretical routes.

Lastly, it would be worthwhile in future studies to compare the processing properties of counting effects in copredication (in, for instance, institutional, physical and informational entities) via a lexical decision task, asking such research questions as "Is it easier to count the number of physical objects or institutions?" There may be some correlation between sense complexity and the time taken to count the given number of entities. More generally, future experiments should move to other forms of copredication involving a range of syntactic structures in order to test the applicability and scope of *Simplicity First*.

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CHAPTER 8

Different degrees of abstraction from visual cues in processing concrete nouns

Francesca Franzon and Chiara Zanini

Concreteness has been defined as a semantic property related to physical perception. In this paper we tackle the concreteness issue from the viewpoint of countability by arguing that uncountable expressions (e.g., *some cake*), although concrete, are more abstract than countable ones (e.g., *one cake*) since the former entail the suppression of the reference to shape, which is a salient property in the representation of entities.

We report empirical data collected with preschool children in which we show that the uncountable reference is dispreferred. We discuss possible reasons for this phenomenon, which involve the roles played by shape and by language (and in particular grammar) in early perceptual processing, and we suggest how these factors may relate to our ability to abstract from perceptual experience.

Keywords: abstraction abilities, core knowledge, countability, object representation

1. Introduction

Linguistic literature usually describes concreteness as a binary lexical feature (Marcantonio and Pretto 2001). By definition, concrete nouns denote entities that can be perceived through the senses, whereas abstract nouns denote entities less related to physical perception (Paivio et al. 1986; Crystal 1995; Barsalou et al. 2003). Experimental studies based on such a theoretical perspective seem to confirm this binary view, suggesting an overall advantage in the processing of concrete nouns. Indeed, concrete nouns are acquired earlier than abstract nouns (see, for example, Bergelson and Swingley 2012), and they are recognized and retrieved faster (Allen and Hulme 2006; Bleasdale 1987; Gilhooly and Logie 1980; Schwanenflugel et al. 1988; Walker and Hulme 1999). They are also less frequently impaired in the presence of speech pathologies such as aphasia (Coltheart et al. 1987; Franklin et al.

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1995; Katz and Goodglass 1990; Martin and Saffran 1992; Roeltgen et al. 1983) even though cases are reported of deficits targeting concrete nouns more than abstract nouns (e.g., Papagno et al. 2007; Warrington 1975).

Nevertheless, a definition based on a clear-cut semantic opposition does not seem to fully account for the phenomenon in its entirety (Wiemer-Hastings et al. 2001; Bolognesi and Steen 2018). Quantitative rating studies investigating the clustering properties of concrete and abstract nouns have suggested that concreteness is better defined as a multidimensional semantic space, limited by diverse semantic variables (e.g., Crutch 2012; Troche et al. 2014; 2016). The multidimensionality of concreteness has been claimed to be challenging for experimental studies as well as neural and computational models tackling the representation of the semantic knowledge (e.g., Binder et al. 2016; Crutch et al. 2013; Crutch and Jackson 2011). In fact, the great majority of the experimental work on this issue takes into account only pure abstract nouns and pure concrete nouns, while disregarding ambiguous, and yet frequent, words (Crutch and Jackson 2011).

It emerges that the opposition between abstract and concrete nouns is not so clear-cut; rather, abstract and concrete features represent the two poles of a multidimensional space along which the lexicon is spread. Different features potentially come into play in defining the position of a noun in this ideal multidimensional space, and it is beyond the scopes of the present paper to identify and discuss all of them. However, among these, a primary role is undoubtedly played by the fact that (concrete) nouns may be used to denote entities that are perceived through the sensory systems. In this regard, as already stated at the beginning of § 1, a typical concrete noun is mostly a word denoting an object that we can touch, smell, hear and – most importantly – see. Crucially, the actual encoding of a perceptual feature can also be modulated by the referential context, so that the same lexical word can be linked to different levels of concreteness. For example, an Italian word like *anello* ('ring') has primarily a concrete use (i.e., it denotes a circular object). However, this word can have also more abstract meanings. By suppressing the activation of some perceivable and physical features and highlighting the property by which a ring can be used to connect two parts of a chain, a speaker can use expressions such as *l'anello di congiunzione* ('the linking element, lit. the linking ring'). It may be argued that this is a metaphoric – more than an abstract – use of the noun *anello*. Yet, it is undeniable that at least one aspect of the metaphoric use relies on the suppression of some perceivable features, though not the ones that are relevant in the context. In the terms of Lakoff's theory, metaphor is a phenomenon where a more abstract concept is conceptualized in terms of a more concrete one (Lakoff and Johnson 1980). Hence, metaphorical would always imply some degree of abstractness. Furthermore, it seems trickier to label the concreteness status of nouns referring to just one aspect of the objects such as dimension, size, etc. To what extent are *corner*, *circle*, *cube* concrete nouns and to what extent are they abstract nouns? Notably, diachronic analyses have highlighted that, in almost all languages, nouns of this particular type are the most likely to become units of measurement, quantity expressions (e.g., *pint*) and functional –often negative- elements (e.g., French *pas* from Latin *passum* 'step'; on this topic see, among others: Jespersen 1917; Giusti and Leko 2005).

It is important to notice that differences in concreteness linked to the same noun can emerge not only depending on the referential context, but also depending on the syntactic context. The latter possibility is related to the encoding of another dimension, namely countability. Since its contribution may be not very intuitive, countability has rarely been considered in tackling the concreteness issue. Countability has often been considered 'orthogonal' to concreteness in the description of nouns: in fact, count nouns could be more abstract (*idea*) or more concrete (*chair*), as well as mass nouns could be more abstract (*courage*) or more concrete (*butter*). Nevertheless, it can be shown how denoting a count or a mass reference entails different degrees of concreteness (Langacker 2008; Huddleston and Pullum 2002). For example, no speaker would hesitate in defining cake a concrete noun. However, different syntactic contexts can modulate its concreteness, as in the two examples given in (1):

(1) a. There was still a cake on the table.
    b. There was still some cake on the table.

In both sentences the noun *cake* denotes a concrete entity. In (1a), the reference to the boundaries of the object is pertinent and thus the noun *cake* is used as a count noun. In the second case, the reference to these boundaries is suppressed, the reference is just to the substance 'cake' and the noun *cake* is used as a mass noun. Thus, even if in both sentences the noun *cake* is concrete, in (1b) it turns out to be linked to a more abstract reference. This is because in this case a fundamental perceptive property is suppressed, namely the fact that cakes, slices of cake and crumbles of cake are always perceived within their physical boundaries. As illustrated in more detail in the next section, empirical studies suggest that sentences with a mass reference like (1b) are more difficult to process than sentences with a count reference like the one exemplified in (1a). Intriguingly, more cognitive effort is involved in the processing of abstract nouns, which do not entail the reference to some perceptive properties, as well as in the case of uncountability, which does not entail the reference to one precise perceptive property (see, for example, Frisson and Frazier 2005). Since the difference of concreteness between mass and count references relies mainly on one perceptive feature, we think that the countability dimension can be useful to test whether and how sensory and perceptual information shapes the grammar of natural languages.

The paper is organized as follows. Section 2 illustrates the countability issue by surveying the literature on quantitative, psycholinguistic, and acquisition issues.

In particular, Section 2.3.1 is devoted to describing a study on countability in five-year-old children which is especially relevant to the purposes of this paper. The salience of perceptual properties related to countability will be discussed in Section 3. Some implications for linguistic theory and conclusions will be reported in Section 4.

2. On countability

Similar to concreteness, countability has often been considered as a lexical binary distinction. Nouns referring to substances would be marked in the lexicon as mass, whereas nouns referring to objects would be marked in the lexicon as count (Cheng 1973). The possibility for nouns to occur in different syntactic contexts would be blocked or allowed by such lexical property and operations are postulated to explain 'deviant' expressions such as *a coffee, some stone* (Jackendoff 1991).

However, other theoretical works have claimed that the mass-count distinction may be not as straightforward as it may seem at a first glance (Allan 1980; Pelletier 2012; Rothstein 2010). Indeed, the countability of some nouns cannot be retrieved unambiguously. For example, the sentence in (2) can be paraphrased both by sentence (1a) and sentence (1b).

(2) The cake is still on the table.

In other words, many nouns cannot be labelled as mass or count unless their countability is made explicit in the relevant context; more specifically, countability and uncountability are unambiguously interpreted only in some syntactic contexts, such as the ones illustrated in (1) above. These observations lead some scholars to argue that "the count-mass distinction is not really a distinction between words, but a distinction between ways of using the words" (Bunt 2006).

2.1 The distribution of countability in language use

Quantitative studies tackling the distribution of the words in different languages start from this observation and almost unanimously report evidence against a binary lexical encoding of countability. Kulkarni, Rothstein and Treves (2013) asked 16 informants of six diverse languages (i.e., Armenian, English, Hebrew, Hindi, Italian, and Marathi) to rate the mass and count usage of 1,434 nouns by answering metalinguistic questions on the semantic and morphosyntactic characteristics of these nouns. The authors found that "syntactic classes do not map onto each other, nor do they reflect, beyond weak correlations, semantic attributes of the concepts" (Kulkarni, Rothstein and Treves 2013: 132). Notably, although the questions required a binary answer (y/n), the results pointed to the fact that nouns are continuously scattered along the mass-count dimension.

Data collected from corpora are consistent with such findings. For example, Schiehlen and Spranger (2006) explored a 200-million-token corpus of German assuming a lexically based distinction between mass and count nouns; however, they reported that a great number of noun occurrences were indistinguishable. The authors queried the corpus while taking into consideration the syntactic contexts of noun occurrences and found that nouns were spread on a linear continuum, on which the two extreme poles were represented by 'pure mass' and 'pure count' nouns. In a study conducted on the English UkWaC corpus (Baroni and Ueyama 2006), the syntactic contexts were used as a proxy to retrieve the distribution of nouns with respect to their countability, revealing that the most frequent nouns in a mass context are also frequently attested in count contexts, and vice versa (Katz and Zamparelli 2012).

A similar method was applied to data from the ItWaC corpus (Baroni et al. 2009) to investigate countability in Italian and led to the same results(Franzon, Arcara and Zanini 2016). Taking a closer look at the 100 Italian nouns occurring with the highest frequency in count context, no significant correlation was found between their occurrence in mass and in count contexts (r(98) = .07, p = .47). For what concerns the 100 nouns most frequently occurring in mass context, a positive correlation was found between their occurrence in mass and in count contexts (r(98) = .26, p = .009). This means that while nouns mostly found in mass contexts were found in count contexts as well, very few nouns occur only in mass contexts, as plotted in Figure 1.

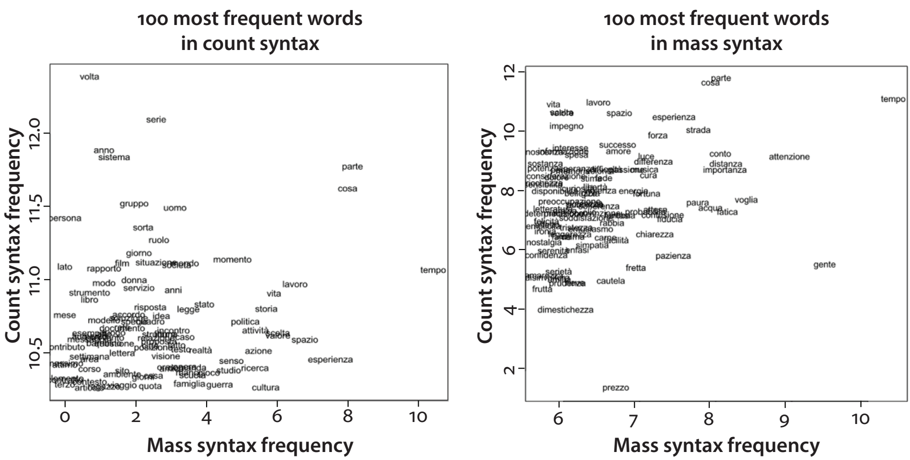

Figure 1. Correlations between frequency of occurrence in mass syntax and in count syntax of the top 100 Italian nouns appearing more frequently in a count context and of the top 100 Italian nouns that appear more frequently in a mass context

More recently, Vermote et al. (2017) obtained similar results for French and Dutch. The authors found a correlation between the mass usage of nouns in corpora and their scores in an acceptability rating: the degree of acceptability of a noun as mass depends on the frequency it is used as a mass noun in discourse. Hence, the authors argued that the mass and count categories are better understood in a probabilistic rather than a strictly categorical sense.

So far, we have seen that the choice between a countable or an uncountable interpretation is encoded by the morphosyntactic context, and that, at least in theory, every noun can be linked both to a mass and a count interpretation. This means that in the case of nouns denoting concrete (physically perceivable) entities, language allows us to express or to suppress the reference to entity boundaries, depending on their salience in the communicative context. Given that entities are always perceived within boundaries, is the processing of the mass reference more demanding than the processing of the count reference in language usage?

2.2 The processing of countability in adults

Behavioral data from lexical decision tasks show an advantage in terms of response times (RTs) for count nouns compared to mass nouns (Gillon et al. 1999; Mondini et al. 2009). However, some studies failed to observe significant RT differences (Mondini et al. 2008).

As for electrophysiological studies, in an implicit lexical decision task, El Yagoubi et al. (2006) reported a very early detection of the mass-count differences (120–160 ms time interval after word onset). In a similar task, Mondini et al. (2008) obtained a comparable result: a very early distinction between mass and count nouns at 160 ms after word onset, with mass nouns eliciting a stronger negativity in left anterior brain regions than count nouns. Bisiacchi et al. (2005) set up a semantic categorization task to directly address the semantic processing level; the authors found that count nouns elicited a stronger early negative component (N150) in comparison in comparison to mass nouns.

Other works tackled the processing of countability in sentence context. In a grammaticality judgement task, Steinhauer et al. (2001) reported that count nouns, when compared to mass nouns, elicited a frontal negativity that was independent of the N400 marker for conceptual semantic processing, and rather resembled anterior negativities related to the processing of grammar. While Steinhauer et al. (2001) concluded that the mass-count distinction is primarily related to syntactic processing, Bisiacchi et al. (2005) and Mondini et al. (2008) claimed that countability could involve either semantic or syntactic processing depending on the type of the task exploited in the experimental design. To address this, Chiarelli et al. (2011) conducted an ERP study in which the same set of mass and count nouns was presented both in a semantic categorization task, in which a N400 effect was elicited, and in a syntactic violation task, in which a LAN-P600 effect was elicited. In light of these results, they suggested that the brain differentiates on both the semantic and syntactic levels. Interestingly, their stimuli set crossed the mass-count feature spectrum with the abstract-concrete feature spectrum. In the semantic task they observed no significant difference between N400 amplitude for abstract mass and count nouns, but a larger negativity for concrete count nouns as compared to concrete mass nouns. They claimed that "increased negativity for concrete count nouns could be due to the combined activation of two different cognitive processes. Both superior associative connections and easier access to mental imagery would contribute to a processing advantages for concrete count nouns over concrete mass nouns" (Chiarelli et al. 2011: 7). This was reflected in behavioral data as well: participants were reported to be faster and more accurate on concrete count nouns with respect to the semantic task.

Furthermore, Chiarelli et al. (2011) observed an overall bias for the count syntactic context, reporting faster RTs for sentences with count nouns, independent of the concreteness factor. A similar effect was also described in an eye tracking study by Frisson and Frazier (2005): when nouns were presented in a context that was unmarked for countability, a longer fixation time was reported for mass nouns to count nouns.

Despite some inconsistency in the experimental literature, we have not found any study reporting longer response times for count vs. mass reference, nor any study arguing that the cognitive processing of count vs. mass reference is more demanding.

2.3 The processing of countability in acquisition

The preference for count over mass reference has been also reported in the literature on acquisition. In fact, young children are susceptible to overextending the count morphosyntax (Gathercole 1985), even in the case they are presented with a peculiar class of mass nouns, namely "object –mass" nouns (e.g., *furniture, luggage*; Barner and Snedeker 2005). Yet, the acquisition of mass and count morphosyntax is independent from children's knowledge of objects and substances, associated (though not completely overlapping) with count and mass references respectively (Imai and Gentner 1997). Soja et al. (1991) reported that two-year-old English children succeeded in distinguishing objects from substances by relying on perceptual information of the entities even if they did not master count or mass morphosyntax. In fact, even if morphosyntax can act as a cue in the acquisition of novel words in 2.5 year old children, the perceptual properties of the referent preferentially modulate its interpretation as an object or a substance over the morphosyntactic properties of the noun (Soja 1992). Discriminating objects from substances is indeed an ability already present by at least 10 months of age, i.e., before most children are producing their first words (Hespos et al. 2009; van Marle and Wynn 2011; for a review: Hespos and van Marle 2012).

Nevertheless, most literature agrees that there is a bias for cohesive objects over non-rigid and non-cohesive stuff (Huntley-Fenner et al. 2002) and while acquiring the lexicon, children likely refer a new word to an object, and not to a subpart of it or to the substance of which it is made (for a review: Bloom and Kelemen 1995; Markman 1990). Some studies investigating similar facts, for example by comparing solid and non-solid entities, failed to observe such preference for substances (Samuelson and Horst 2007). It is worth noticing, though, that at least to our knowledge no study has reported a bias towards substances over objects.

It seems therefore that we face a curious parallelism. On the one hand, prelinguistic children can discriminate objects from substances, but they show a preference for the former. On the other hand, children acquire mass and count nouns as well as mass and count morphosyntax, yet they favor count reference. Is there a link between the bias for objects at the extra-linguistic level and the bias for count reference in language? If so, what does such a predilection originate from?

2.3.1 *A study relating countability and abstraction abilities in acquisition*

Under this perspective, in a study on acquisition we explored the hypothesis that the processing of mass reference can be more demanding from a cognitive point of view. The study is described in detail in Zanini et al. (2017). We started from the idea that the shape, and more generally the boundaries, are a pivotal cue when people generalize a class from an actual instantiation of an entity (Landau et al. 1988, 1992). This holds in particular for count uses (Samuelson and Smith 1999). Conversely, as already sketched in § 1, mass uses do not denote the entity boundaries: since these latter are not expressed, they are not a reliable cue. Given that each occurrence of an entity is perceived within its boundaries, we hypothesized that the mass reference entails a deeper involvement of cognitive processes linked to logical operations such as deduction, abstraction, and conservation. In fact, these operations allow the conceiving of entities (e.g., *milk*) without relying on their incidental shape boundaries (e.g., *a glass of milk, a bottle of milk*). Crucially, the implementation of logical operations becomes efficient only throughout development (i.e., Vianello and Marin 1997); thus, the lack of abstraction abilities should affect the use of mass – but not count – references in young children.

We chose to test five to six-year-old Italian children since at that age they have completed the acquisition of basic grammar structures (Tomasello 2003) and their grammaticality judgements are not biased by a normative approach taught in school. At the same time, though, their abilities concerning conservation and logical operations (henceforth called abstraction abilities for the sake of simplicity) are still developing. Fifty-eight preschool children, whose age was between 62 and 76 months, participated in the study. Their grammatical competence was measured with a standardized assessment for Italian, the Test of Grammatical Comprehension for Children (*Test di Comprensione Grammaticale del Bambino* – TCGB; Chilosi and Cipriani 1995) and results were in line with their age.

Abstraction abilities were measured by administering the Logical Operations and Conservation test for Italian speaking children (LOC; Vianello and Marin 1997). The test is standardized for 4- to 8-year-old children, and it is made up of several difficulty-graduated tasks encompassing Piagetian, post-Piagetian and cognitivist references (e.g., Case 1985; Baddeley 1986; Sternberg 1988 quoted in Vianello et al. 2012). The LOC assesses the ability to comprehend that the rearrangement of material does not affect its numerosity, volume or length. For example, the child is required to recognize whether the amount of an agreed sample of liquid or dough is still the same after the experimenter changed its shape by pouring it in another different container or by remolding it.

The LOC scores were compared with the Mass And Count Test (MACT) scores. The MACT is an ad-hoc designed test to assess the children's ability to judge sentences with mass and count nouns. In order to avoid biases due to arbitrary choices, for the first time in studies about countability the nouns were assigned to the experimental categories by relying on quantitative methods. Corpus queries on unambiguous syntactic contexts performed on It-Wac (Baroni et al. 2009) allowed us to choose nouns mostly used with a mass or with a count reference. In the test, 10 nouns that appear more frequently in a mass context and are not frequent in a count context (e.g., *sand*) were chosen as 'mass nouns'; 10 nouns that appear more frequently in a count context and are not frequent in a mass context (e.g., *ring*) were chosen as 'count nouns', 20 nouns that appear in mass and count contexts with similar frequency (e.g., *cake*) were assigned to the experimental category of 'neutral nouns'. This category was created with the purpose of disentangling effects of frequency of occurrence in a particular context from effects directly related to the processing of countability.

For each noun, two sentences were created. The sentences were identical except for the syntactic context in which the noun occurred: in one the noun appeared in a mass context, in the other one, in a count context (see Table 1).

Thus, mass and count nouns were presented half of the times in congruent contexts and half of the times in incongruent contexts. In congruent contexts a mass noun appeared in a mass syntactic context; a count noun appeared in a count syntactic context. In incongruent contexts a mass noun appeared in a count syntactic context; a count noun appeared in a mass syntactic context. In the case of neutral nouns, both mass and noun contexts were congruent. The experimental conditions are illustrated in Table 1.

Table 1. Experimental conditions of the MACT test

	Mass context	Count context
Mass noun	CONGRUENT *Leo ha tanta <u>sabbia</u> nelle scarpe.* Leo has much <u>sand</u> in his shoes	INCONGRUENT *Leo ha una <u>sabbia</u> nelle scarpe.* Leo has a <u>sand</u> in his shoes
Count noun	INCONGRUENT *La principessa ha un po' di <u>anello</u> al dito.* The princess has a bit of <u>ring</u> on her finger	CONGRUENT *La principessa ha un <u>anello</u> al dito.* The princess has a <u>ring</u> on her finger
Neutral noun	CONGRUENT *Sul tavolo c'era ancora tanta <u>torta</u>.* Lit. There was still ample <u>cake</u> on the table	CONGRUENT *Sul tavolo c'era ancora una <u>torta</u>.* There was still a <u>cake</u> on the table

Children performed equally well in judging mass nouns and count nouns in the congruent condition, a result in line with the observation that neither of the two types of nouns is *per se* more difficult than the other at this age. Though, we found a significant difference between mass nouns and count nouns in the incongruent condition: children widely accepted mass nouns in count context, but not vice versa, showing a predilection for count reference that cannot be explained in terms of frequency effects. If that was the case, an equally bad performance with count nouns in mass context would have occurred. This trend was confirmed in the performance with neutral nouns: even in this case children were significantly more accurate in the count context than in the mass context.

By comparing this performance with LOC scores, a positive correlation between participants' abstraction abilities and their performance on mass contexts was found. The better the children performed in the LOC test, the more they avoided accepting mass nouns in count contexts. Interestingly enough, participants' performance on count contexts did not correlate with the measures of abstraction abilities. Therefore, in absence of cues related to the frequency of occurrence of a noun in a mass or a count context, the ability to process mass references seems to be related to the capability to abstract from the visual boundaries that define the shape of an entity. It follows that the bias for countability observed in the language may have an extra-linguistic link to the saliency of the shape boundary of entities.

The importance of conceptually representing shapes and the perceptual relevance of boundaries will be covered in more detail in § 3.

3. The relevance of boundaries in conceiving referential entities

From a biological perspective encompassing more than our human species, the fact of recognizing boundaries and therefore inferring a shape is crucial for identifying relevant entities, like food, mates or enemies, and adopting a subsequent successful behavior in the environment (Spelke 2000). In fact, the ability to recognize and represent physically perceivable entities is a fundamental ability in the set of the core knowledge systems that underlie the basis of human cognition. Core knowledge systems may be considered as a set of cognitive mechanisms that are responsible of representing significant aspects of the environment and would stand as building blocks for more complex reasoning (Carey 2009; Spelke 2000; Spelke et al. 2010). Such systems would be available soon after birth in humans and would be shared with non-human species. In this sense, the primacy of entities' representation in human cognition is witnessed by its early availability and phylogenetic ancestry, which means that this ability is already available in non-human species such as monkeys and chickens (Agrillo, Miletto Petrazzini and Bisazza 2014; Cantlon and Brannon 2006; Rugani, Vallortigara and Regolin 2013), as well as in human infants (Feigenson, Carey and Hauser 2002; Van de Walle et al. 2000).

The ability to represent entities at a cognitive level accounts for the possibility of recognizing them even when they are partly occluded and of tracking them when they are completely hidden from sight (Uller, Carey, Huntley-Fenner, and Klatt 1999; Wynn 1992). There is no doubt that this conceptual representation is a distinct, higher level operation with respect to perception. However, the representation of an entity is promoted by some of its perceptual properties such as its shape, especially when this is invariant (Huntley-Fenner, Carey and Solimando 2002; Prasada, Ferentz and Haskell 2002). Boundaries are core elements that enable the perception of shape. The detection of boundaries is a basic ability in our visual system, supported by the interaction of a variety of low-level cues of the stimulus, such as luminance, motion, contrast and spatial frequency (Dixon and Shapiro 2014, 2017; Landy and Kojima 2001; Mely et al. 2016; Rivest and Cavanagh 1996, Song and Baker 2007). The involvement of the single cues is not yet completely understood, but it is known that the process of recognizing boundaries takes place at an early level in visual perception (Leventhal et al. 1997; Chichy et al. 2016; Carandini et al. 2005, Yamins et al. 2014).

This early detection of boundaries is the basis for the later, high level operations of recognition and conceiving of entities. Importantly, in the visual perception of the environment, every entity is perceived within a boundary. Even liquids, materials and substances that can assume different shapes appear in a bounded form: every time we perceive them through our eyes, they are contained within boundaries. We see water occupying a region whose edges have the shape of a glass, or of a bottle, or of a lake, pizza appears us in the form of a circle or a slice or a tray. Our experience of the world comes from bounded entities, because every entity we perceive visually is defined by its boundaries.

4. Conclusions

The bias for countability observed in the literature could stem from the fact that visual boundaries are always present in our experience of concrete entities of the referential world, and that these boundaries are one of the earliest available cues in order to represent entities. However, from the conceptual point of view, sometimes visual boundaries are not a relevant cue for every entity, especially for those that can assume different shapes, such as liquid materials or substances. Nouns referring to those entities have more possibility to be found frequently also in syntactic contexts that explicitly suppress the reference to boundaries, namely mass contexts.

The reference to boundaries is in fact handled within the grammatical domain (in the case of Italian and other Indo-European languages, by morphosyntax). A possible cause of this may rely on the fact that natural languages tend to grammaticalize the information represented by the core knowledge systems (Franzon, Zanini and Rugani 2018; Strickland 2017).

In this case, the morphosyntactic opposition between count and mass references allows the speaker to refer to the boundaries as part of the entity, or to omit the reference to them. In this sense, language gives the possibility to avoid referring to a property whose salience can be traced back to the perceptual level. This possibility allows to encode different degrees of abstraction with respect to the same concrete nouns: in the count context, a core perceptual feature is encoded, whereas in the mass context, it is suppressed. The fact that this possibility is allowed within an opposition handled by the grammar suggests that the possibility to conceive some kind of abstraction even for concrete nouns is already available at a core level. Countability may thus be a useful dimension to take into account in order to explore basic modulations of the dimension of concreteness in language.

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CHAPTER 9

Cognitive and linguistic aspects of composition in German particle verbs

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Most German particle verbs (PVs) are composed of a prepositional particle (P) and a base verb (BV). For instance, *anstrahlen* is formed from the P *an* and the BV *strahlen*. The meaning of a PV results from often systematic interactions between the P and BV meanings. But many Ps and BVs are ambiguous and, moreover, a single P meaning and a single BV meaning can be combined in several ways. Finally, the interactions between P and BV meanings depend on the context.

This chapter presents a case study of how two particles, *auf* and *ab*, interact with certain BVs and contextual factors, while focusing on the difference between abstract and concrete BV/PV concepts, and between abstract and concrete contexts.

Keywords: abstract/concrete concepts, complex verbs, meaning shifts, neologisms

1. Introduction

There are many meaning composition processes that cannot be captured with the established methods of formal linguistics. Often these processes involve conceptualizations that have been the target of investigations in cognitive semantics and cognitive psychology, but for which the tools of formal semantics have not been designed. Examples are the meaning shifts involved in German particle verb constructions that have been studied in Springorum et al. (2013b). This study found that sentiment polarity often plays a crucial role in the interpretation of particle verbs. For instance, *strahlen* ('to beam') has a positive connotation and *pissen* ('to piss') a negative one. These connotations persist in the particle verbs *anstrahlen* ('to beam at someone') and *anpissen* ('to attack or criticize someone in an aggressive and hostile manner').

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In this paper we investigate German particle verbs (PVs) that are formed out of (i) a base verb (BV) and (ii) a particle (P) of the kind that can also be used as a preposition. (Crucial about prepositional meanings of German particles, as distinct from other types of particle meaning, is that they express relations rather than properties.) *Anstrahlen* and *anpissen* are examples of such verbs. When the particle *an* that these two verbs share is used as a preposition, its meaning is a sub-relation of the one expressed by the English preposition *on*. Both English *on* and German *an* can be used either to say that something is attached to something else (e.g., 'Das Bild hängt an der Wand', Engl. 'The picture is hanging on the wall') or that something is being moved onto something else ('Sie hängte das Bild an die Wand', Engl. 'She hung the picture on the wall'). In the PV *anstrahlen* the relation between the contributions that *an-* can make to the meaning of the PV is close to these meanings of the preposition *an*. Besides its use as communication verb noted above and illustrated in (1), *anstrahlen* also has a more 'literal' use, illustrated by (2). In (2) the beams that the floodlight sends to the wall are beams of physical light, not the metaphorical 'beams of joy' that Karin sends to her mother when *anstrahlen* is used in the sense of (1). This 'literal' use of *anstrahlen* is also possible when the subject is human, as in (3). The same is true, mutatis mutandis, for *anpissen*, about which we say more in the next paragraph.

(1) *Karin strahlt ihre Mutter an.*
Karin beams her mother 'an'
Karin smiles at her mother.

(2) *Der Scheinwerfer strahlt die Wand an.*
the floodlight beams the wall 'an'
The floodlight illuminates the wall.

(3) *Karin strahlt die Hauswand mit der Taschenlampe an.*
Karin beams the house wall with the torch 'an'
Karin shines light on the wall of the house with her torch.

(4) *Der Innenminister pisst die Kanzlerin an.*
the home secretary pisses the Prime Minister 'an'
The home secretary criticizes the Prime Minster.

(5) *Karin spricht ihre Mutter an.*
Karin speaks her mother 'an'
Karin talks to/addresses her mother.

(6) *Der Hund/Fritz pisst die Laterne an.*
the dog/Fritz pisses the lamppost 'an'
The dog/Fritz pisses against the lamppost.

It is of some interest in this connection to compare *anstrahlen* and *anpissen* with the communication verb *ansprechen*, an example of which can be found in (5). *Ansprechen* differs from *anstrahlen* and *anpissen* in that the preferred contribution of *sprechen* to *ansprechen* is a literal one, whereas the preferred contribution of *strahlen* to *anstrahlen* and of *pissen* to *anpissen* is non-literal. Not only can *strahlen* be used with a meaning that is something like 'beam with happiness'. In addition, this beaming can be interpreted as a kind of message, as it is when *anstrahlen* is used as a communication verb. The difference between *ansprechen* and *anpissen* is perhaps even more telling in this respect. *Anpissen*'s literal use is illustrated in (6). But it can also be used as a communication verb, illustrated in (4). When *anpissen* is used in this second way, the contribution made by the base verb *pissen* is obviously a non-literal one: no actual piss makes its way from speaker to audience. What *pissen* contributes to the meaning of *anpissen* merely has to do with the negative connotations that most of us associate with the activity that literal *pissen* denotes. The effect of these negative connotations is that communications described as cases of *anpissen* come across as hostile and aggressive (and are intended to come across in this way). It is this analogy between 'real piss' and 'verbal piss', and only this analogy, through which *pissen* makes its impact on the meaning of *anpissen*.

Previous studies have shown that PVs formed with the same particle can be classified in terms of the semantic contributions that this particle makes to them (Stiebels 1996; Lechler and Roßdeutscher 2009; Kliche 2011; Springorum 2011). For many particle verbs, moreover, these contributions can be predicted from semantic constraints imposed by their BVs, and the meaning that the given particle contributes to a PV can often be predicted from the meaning of the BV: The BV selects that one from the possible meanings of the particle with which it can meaningfully combine while excluding all other meanings because they are not compatible with it. As a matter of fact, however, PV composition is usually more complex than this and less neat. The examples (7) and (8), involving the particle *auf-*, are good illustrations of this.

(7) *Karin setzt den Hut auf.*
Karin puts the hat 'auf'
Karin puts her hat on.

(8) *Das Flugzeug setzt auf der Landebahn auf.*
the plane sets on the runway 'auf'
The plane is landing on the runway.

Among the different meanings that *auf-* can contribute to PVs there are in particular (i) a meaning that is, like one of the already mentioned meanings of *an-*, included in the meaning of English 'on', but complementary to the meaning of *an-*:

that of one thing being on (top of) another; and (ii) ‘upwards’, as said of movements. It is the first of these two meanings that gets selected when *auf*- is combined with the BV *setzen* (‘to put’, ‘to set’). A felicitous use of this PV is shown in (7). The contribution that *auf*- makes to the PV *aufsetzen* as used in (7) is its ‘on’-meaning. Perhaps the most common way in which particles combine with base verbs is that in which the particle characterizes the result states of the events described by the base verb (Stiebels & Wunderlich 1994; McIntyre 2007). This pattern is especially common when the base verb is a result state verb in its own right, in which case the particle should be interpretable as giving additional information about the result state that is part of what the BV describes. This applies in particular to the case of *setzen*, which is a result state verb that describes events with result states to the effect that the direct object is sitting somewhere. The ‘on’-meaning of *auf*- can be understood as giving additional information about these result states: it says of the direct object – the hat in (7) – that as a result of the event described by *aufsetzen* the direct object is on top of something else.

It is not so clear whether the ‘on top of’ meaning of *auf*- is the only one with which *setzen* can combine. There do not seem to be compelling reasons why the other meaning of *auf*- should be unable to make a contribution to the meaning of *aufsetzen* in (7) as well. After all, the movement that an agent has to make when she puts a hat on is typically one that is upward for the most part. True, the movement cannot be upward all the way, since eventually the hat must be lowered onto the head. But perhaps it is nevertheless conceptualized as upwards, and perhaps this conceptualization is also part of what *auf*- contributes to *aufsetzen* in (7). Even if that may be so, however, upward movement is not part of the meaning of *aufsetzen* in all of its uses. This is illustrated by (8): *aufsetzen* as used for airplanes means ‘to land’. But typical landings involve movements that are downwards all the way, and that are surely conceived as downward movements. These considerations point towards the conclusion that the ‘on top of’ meaning of *auf*- is always part of the meaning of *aufsetzen;* but whether the upward movement meaning of *auf*- also reverberates in at least some of its uses is less clear and remains a matter for further exploration.

We argued above that the contributions that *strahlen* and *pissen* make to the meanings of *anstrahlen* and *anpissen* have more to do with the positive and negative associations of the BVs than with their actual application criteria (those that determine whether something is a beam, or piss). A second example of how associations rather than satisfaction criteria for base verbs can become defining factors for the meanings of PVs that are constructed from them is another communication verb, but with *auf*- as particle rather than *an*-. This is the verb *aufbrummen*. The base verb in this case is the sound verb *brummen*. The sounds described by this verb are sounds produced by certain animals – in particular by bears. (*brummen* is the standard denotation for the sounds that bears make, like 'growl' is in English.) The sounds that are describable as cases of *brummen* are always low pitch, often loud and penetrating in the way rumbling sounds can be, and they carry a connotation of heaviness on the one hand and of potential threats on the other. The association with heaviness appears to be an instance of a general tendency to conceive of certain distinct scales as aligned in one way rather than another (cf. Tversky 2011). Low pitch goes with heaviness (and with darkness of light or color), high pitch goes with lightness in the sense of weight (and with brightness of light or color). We conjecture that it is the association of low sound with heaviness that confers upon the particle *auf-* in *aufbrummen* the connotation of a heavy burden: the 'on'-relation that *auf-* contributes is not just that of one object resting on another, but one in which it is pressing down on what it is resting on, like a heavy load. For instance, in (9) the result state contributed by *auf-* is that of the task that Karin has imposed on Fritz weighing heavily on him, in the way that onerous and unwanted tasks tend to do.

(9) *Karin hat Fritz das Fahnen-Lesen des gesamten Manuskripts aufgebrummt.*
Karin has Fritz the proof reading of the entire manuscript 'auf'-growled
Karin has ordered Fritz to proof-read the entire manuscript.

Aufbrummen and *anpissen* are not isolated cases. A verb that is similarly constructed and has got its meaning via the same interpretation strategy as *aufbrummen* is *aufdonnern*, from *auf-* and *donnern* ('to thunder'). This verb can also be used to describe events in which one person imposes a task on another. Likewise, a PV with the same meaning as *anpissen* is *anscheißen*, from *scheißen* ('to shit'). There are more such verbs – not many, but enough to strongly suggest that we are dealing with productive patterns of PV formation and interpretation and not with mere idiosyncrasies (Springorum et al. 2013b).

The verbs *aufbrummen* and *aufdonnern*, and likewise *anstrahlen*, *anpissen* and *anscheißen*, also illustrate another important and widespread feature of PV formation: PVs often have a richer argument structure than their BVs (Stiebels & Wunderlich 1994). The verbs *brummen*, *donnern*, *strahlen*, *pissen* and *scheißen* are all intransitive verbs. But *anstrahlen*, *anpissen* and *anscheißen* are transitive. For these PVs the direct object denotes the recipient of the communication, whereas the theme – the communicated message – is an implicit argument, which is not realized by a separate argument phrase. (It presumably is the BV that fills this argument at the semantic or conceptual level. Recall what we said about the excretions described by *pissen* being reinterpreted as the messages in *anpissen*.) *Aufbrummen* and *aufdonnern* also have a richer argument structure than their BVs. In fact, for them the difference between the argument structure of the BV and that of the PV is even greater. *Aufbrummen* has both an explicit direct and an explicit indirect object. These additional arguments are the two that enter into the characterization of the result states of the events described by these verbs.

We already noted that the particles *an-* and *auf-* that occur as constituents of these communication verbs are prepositional in the semantic sense that they contribute 2-place predicates, and also that they are often interpreted as contributing result state descriptions. This is true in particular for the five PVs of the last two paragraphs: for each of those verbs *auf-* and *an-* are interpreted as saying something about the result states of the events described by them. But the difference between the *auf-* and the *an-*verbs is that for the *auf-*verbs considered here both arguments of the result state predication are explicit, whereas for the *an-*verbs one of the arguments is explicit and the other implicit. One question we are currently exploring is what the ways are in which the argument structures of PVs can be related to those of their BVs and to what extent these relationships can be seen as a reflection of the conceptualizations behind different modes of particle verb formation.

Our aim in this introduction has been to give an impression of some of the principles that guide the derivation of the meanings of particle verbs from the meanings of their particles and base verbs. We have been especially at pains to show what kinds of aspects of particle and base verb meanings may find their way into the meaning of the particle verb, and to make clear that not only truth-conditional aspects are relevant – those aspects that determine what belongs to the extensions of particle and base verb – but also connotational aspects of the sort that, so far, formal semantics has set aside (Stiebels & Wunderlich 1994; McIntyre 2007; Lechler & Roßdeutscher 2009; Kliche 2011; Springorum 2011).

Our ultimate aim in this paper is to discuss a small class of verbs that have been selected from an experiment in which subjects were asked to provide contexts, consisting of one or more sentences, for familiar and unfamiliar particle verbs (Springorum et al. 2013a). The sentences we examine consist of a very small selection of those responses, pertaining to four PVs built from the particles *auf-* and *ab-* and the BVs *stricken* ('to knit') and *reden* ('to talk'). That discussion will come in Section 3. Before that, we will develop in Section 2 the beginnings of a framework for the semantic analysis of PVs and their constituents.

2. More data and some hypotheses

The first part of this section discusses the conceptual origins of the meaning contributions of the particles *auf* and *ab*. The second part formulates hypotheses about different forms that PV composition can take. The focus of these hypotheses is on the question that we take to be of particular interest to this volume: how the concreteness or abstractness of a PV is related to the concreteness or abstractness of its constituents.

2.1 Particles: Core concepts and specific meanings

As mentioned in Section 1, we take the core meanings of the particles we discuss in this chapter to be concepts that are grounded in perception. We assume that the more specific meanings that particles contribute to particular PVs, as identified in the studies by Stiebels, Springorum and others we mentioned in Section 1, are in principle derivable from these core meanings via interpretation processes that depend on the truth-conditional meanings of the BVs of those PVs, on connotations associated with those meanings, and also on further 'contextual' aspects. But see the last paragraph in this section.

One of our primary interests is in these derivation processes: How do language users arrive at meanings for PVs given what they know about the core concepts denoted by particle and base verb (and other relevant aspects of the context)? This is a conception of PV meaning (and of the meanings of composite lexical items more generally) that may be described as a *dynamic* one: the emphasis is on the processes through which the meanings of such expressions are computed in production and interpretation. As implied by the discussions in Section 1, the core concepts associated with *ab* and *auf* are examples of perception-based concepts in which gravity plays a pivotal role. (For discussion see Franklin and Tversky (1990), who show how perception is shaped by the body and its relation to the world, and who describe the special role that is played in all this by gravity.) Let us from now on refer to the direction defined by the pull of gravity as 'Down' and to the opposite direction as 'Up'.

The core concept of *ab* is that of the downward direction Down. It is found, not surprisingly, in PVs denoting downward motion, such as *ablaufen* ('to run down') in (10). (Note: The BV *laufen* means 'to run' or 'to go on foot'. But *ablaufen*, as used in (10), describes what is in essence a downward movement: a liquid can 'run off' only when gravity pulls it down. The downward direction of events described by *ablaufen* is contributed by *ab*-.)

(10) *Das Wasser läuft ab.*
the water runs 'ab'
The water runs off.

(11) *Die Blätter fallen vom Baum ab.*
the leaves fall from the tree 'ab'
The leaves are falling from the tree.

(12) *Der Zug fährt von Bahnsteig 5 ab.*
the train drives from platform 5 'ab'
The train departs from platform 5.

Many downward motions are forms of 'falling': movements that are the result of the thing that moves having lost its support and with that the resistance to the force of gravity. It is because of this, we assume, that *ab*- has acquired 'separation' (of the theme from the place at which it was located or attached) as a secondary meaning. We find this meaning of *ab*- on the one hand in verbs like *abfallen* ('to fall from', see (11)), which can only be used to describe physical movements that are downward, and on the other hand in verbs like *abfahren* ('to leave by driving', see (12)) that describe movements in the horizontal plane. In (12) the 'separation' meaning of *ab*- has lost any direct connections with downward movement.

The core concept we assume for *auf* is the direction Up (also see Frassinelli et al. (2017) for psycholinguistic experimental support of our assumption). This concept has connotations that are very different from those associated with movements in the Down direction. Upward movements typically involve the exertion of force to overcome the downward pull of gravity. Hence exertion of force or the making of an effort is part of the meaning of a number of PVs with *auf*-, see Examples (13)–(14).

(13) *Das Wasser schießt auf.*
the water shoots 'auf'
The water shoots up.

(14) *Karin steht auf.*
Karin stands 'auf'
Karin is getting up.

We conclude Section 2.1 by noting that the general picture of P-concepts and their contributions to the meanings of PVs needs to be qualified. We suggested above that the separation meaning of *ab*- is connected with the core meaning Down because downward movements often are the result of loss of support. Likewise, it may conjectured that the 'on top of' meaning of *auf*- is connected with Up because upward movements often lead to the gain of support, at a higher position than the starting point. Think again of Karin putting her hat on in Example (7); or, for another example, of lifting a jar and putting it on a shelf. That *ab*- can be understood in terms of separation, or *auf*- in terms of support, may be something that speakers have to learn as distinct bits of information about these particles. If so, then the computations that are involved when language users produce or interpret particle verbs will typically not start from what we have identified here as the core concepts of *auf* and *ab*, but from sets of 'derived' meanings from which a choice has been made in the determination of each individual PV. What we have to say about PV interpretations as instances of concept formation is compatible with either of these two options – the meaning determination process starts with the core concept determined by the particle or it starts with the set of derived meanings.

2.2 Concepts and Domains

In this section we define and illustrate four hypotheses about the ways in which particles and base verbs can combine. The general setting in which we formulate these hypotheses is as follows. We assume that the world is made up of different Ontological Sorts – or 'Domains' as we will call them. Some of these Domains are assumed to be concrete and some to be abstract. The distinction between concrete and abstract Domains is a difficult one, for intrinsic reasons but also because of considerable diversity and confusion in the ways in which these terms have been used. For these reasons we do not feel we are in a position to propose a precise definition of the demarcation between 'concrete' and 'abstract'. But we have a number of things to say about the distinction as we go along.

There are a couple of distinctions that have to do with the demarcation between the concrete and the abstract, however, that can and should be made right here. First, we need to distinguish between (i) the notions 'concrete' and 'abstract' as applied to ontological Domains and (ii) the application of these notions to concepts. Second, when the notions 'concrete' and 'abstract' are applied to concepts, we need to distinguish between concepts that are abstract by virtue of applying abstract criteria to elements from concrete Domains and concepts that are abstract because the Domains to which they are applied are abstract. (As far as we can see, these two ways in which a concept can be abstract are not independent, for when the application Domain of a concept is abstract its application criteria will be abstract as well.)

Although we do not present a formal definition of the demarcation between concrete and abstract, neither for Domains nor for concepts, let us give a few examples so that the reader has some idea of how we think of the distinction.[1] Concrete Domains for us are Domains of physical objects: people, animals, plants, cells, rocks, rivers, mountains, seas, chemical substances, atoms and molecules,

1. Unfortunately we are not in a position to provide proper definitions of the distinctions between concrete and abstract Domains and between concrete and abstract concepts. Precise definitions of the concrete-abstract distinction would have made this paper easier to write and easier to understand. Without such definitions the best we can do is to give some examples of what we consider concrete and abstract concepts and Domains, and formulate a few general criteria for distinguishing them. Following advice from the editors, we have kept the examples to a minimum.

artifacts of various kinds. (A linguistically sensitive ontology has to distinguish between many such Domains.) Among the abstract Domains are: numbers, thoughts, symbolic systems of various sorts and the expressions belonging to them (including natural languages and linguistic expressions), meanings, propositions, tasks, contracts. Examples of concrete concepts applicable to concrete Domains are: concepts of size, weight, color, shape, position (upright vs. prostrate), surface texture, smell and taste. Among the abstract concepts applicable to concrete Domains are all psychological concepts that can be applied to creatures equipped with consciousness: being angry, being afraid, being content, and also social concepts like being liked or hated, being famous or remembered or forgotten, political concepts such as being Samoan, North-Korean or American, or belonging to the Socialist Party. Concepts applicable to abstract Domains are abstract by virtue of the Domains they apply to. Think, for instance, of the arithmetrical concepts 'even', 'odd', 'prime' and so on that are applicable to the natural numbers, or the concept of truth for propositions.

So far we have only been speaking of 1-place concepts, concepts that correspond to properties, and not about more-place concepts, which correspond to relations of two or more arguments. Given that we have to deal with transitive and ditransitive verbs, restricting attention to 1-place concepts won't do. We take it to be beyond controversy that concepts expressed by transitive and ditransitive verbs are not 1-place. But as a matter of fact the inadequacy of confining attention to 1-place concepts when dealing with verbs is a more general one, which concerns intransitive verbs no less than transitive ones. In linguistics it is by now more or less universally accepted that the role of verbs is to describe events[2] (Davidson 1967). This means that even intransitive verbs represent relations, between the event that a given use of an intransitive verb describes and the entity or entities denoted by the subject phrase that accompanies this use. In short, any intransitive verb (with the exception of weather verbs) denotes a 2-place concept, which relates events to the entities that fill its subject argument position, a simple transitive verb denotes a 3-place concept and a ditransitive verb a 4-place concept.

We also need some more terminology. Since verbs are treated as descriptions of eventualities, the concepts they express must be assumed to have an argument position for the eventualities they are used to describe. We refer to this argument slot of the verb, which is for the eventuality it describes, as its *referential argument slot* and to the eventuality that is described by a particular use of the verb as its *referential argument* (for that use). The argument slots that are filled by separate phrases which accompany the verb when it is used as part of a well-formed

2. More accurately: to describe events or states – or 'eventualities', using the cover term that subsumes both states and events.

sentence – the subject phrase for an intransitive verb, the subject and direct object phrases for a simple transitive verb and so on – we call *non-referential argument slots* and the entities that these argument phrases contribute to the meaning of the sentence we call the *non-referential arguments* (of the verb as used in this sentence).

Furthermore, let *C* be an n-place concept with n > 1. We assume that the Domains to which *C* can be applied are part of *C*'s identity. In other words, each n-place concept determines an n-tuple $<D_1,D_2,..,D_n>$. When the concept is expressed by a verb V, then we assume that D_1 is the Domain of its referential argument and that the remaining $D_2,..,D_n$ are the Domains of its non-referential arguments. So D_1 is a Domain of eventualities. What kinds of Domains $D_2,..,D_n$ are varies from verb to verb and even between different uses of the same verb.

When *C* is the concept expressed by a verb, then, we just said, D_1 is always a Domain of eventualities. But which eventuality Domain? That too varies from one verb use to the next. One of our ontological assumptions is that there are many different eventuality Domains, just as there are many different Domains of other types of entities. In particular, we distinguish between eventuality Domains that are concrete and eventuality Domains that are abstract. Examples of concrete event Domains are: spatial movements of physical objects, events of physical causation such as that of one individual bumping into another, or one individual killing another or of someone making something (e.g., baking a cake or building a house). Among the examples of concrete state Domains we count spatial location states, such as that of one physical object sitting on top of another object, or of two objects standing back to back. Examples of abstract event Domains are types of psychological events such as that of one person falling in love with another or of someone looking for something. Among the abstract event Domains are also those Domains that consist of events involving abstract participants, e.g.,the rising or falling of shares on the stock market[3] or the rising of the death toll of some natural calamity (which is to be distinguished from the deaths of the individuals that the death toll is counting). We assume, as a general principle, that events whose participants are abstract are themselves abstract. The following sample sentences, all involving the verb *steigen*, should help to see more clearly what these assumptions and terminology come to. Concrete uses of *steigen* are illustrated in (15) and (16). The third use, illustrated in (17), is abstract.

(15) *Karin steigt auf den Berg.*
Karin climbs up the mountain.[4]

3. We consider shares, like other financial products, to be abstract objects.

4. In this and the next examples gloss and translation coincide.

(16) *Das Wasser steigt.*
The water rises.

(17) *Die Aktie steigt.*
The share rises.

The concept expressed by *steigen* in (15) is 3-place, with the climbing event as referential argument and Karin and the mountain as non-referential ones. This concept determines a triple $<D_1,D_2,D_3>$, in which the Domain D_2 consists of human beings, the Domain D_3 of climbable objects and D_1 of events that are climbings of members of D_3 by members of D_2. In this case the events that make up D_1 are also concrete, in line with the examples of concrete events given above. In (16) *steigen* is used as an intransitive verb and the concept expressed by it determines a Domain pair $<D_1,D_2>$, where D_2 consists of bodies of liquid (whose surfaces can rise or fall) and D_1 consists of events that are risings or fallings of such surfaces. Here too both Domains are concrete. Finally, the use of *steigen* in (17) expresses a concept that determines a pair $<D_1,D_2>$, where both D_1 and D_2 are abstract Domains, with D_2 consisting of shares (and perhaps other financial products) and D_1 consisting of events that are risings and fallings of the financial values of abstract objects of this sort. According to what we have been saying, these events are abstract, by virtue of the fact that they have abstract participants.

These examples point towards a general feature of the relation between the referential Domain of the tuple determined by a given use of the verb *steigen* and the non-referential Domain(s) of that tuple: when it is a liquid that is said to rise, then that is one kind of rising event, if it is a person climbing a mountain, then that is a different kind of going up, and if it is shares that are said to rise, then that is yet another kind of event. More generally: for a given verb V the tuple $<D_2,\ldots, D_n>$ of non-referential Domains that characterizes a certain use of V determines what kind of eventuality such uses of V describe. In particular, there is a correlation between the concreteness or abstractness of the referential Domain and the concreteness or abstractness of the non-referential Domain or Domains: If the latter are concrete/abstract, then so is the former. More precisely, we assume that the referential Domain D_1 counts as abstract as soon as at least one of the non-referential Domains $D_2,..,D_n$ is abstract and that D_1 counts as concrete when all of $D_2,..,D_n$ are concrete.

The intuition that for a given verb the kinds of eventualities that a given use of it describes are determined by the non-referential arguments involved in this use motivates the following general notion of the *context* for a given verb use. Suppose a verb V is used as an n-place verb, that is, its use is characterized by the n-tuple $<D_1,D_2,..,D_n>$. Then the *context* for this use of V is the tuple $<D_2,..,D_n>$ of non-referential Domains. (Note that not all the arguments represented in the tuple $<D_2,..,D_n>$ need to be *explicit* arguments, in the sense that they are realized by argument phrases. Some may correspond to implicit arguments of the verb.) The general intuition, then, is that given V and <D_2,..,D_n> it is possible to predict what kinds of eventualities can be members of D_1. In line with the assumptions of the last paragraph we call a context <D_2,..,D_n> *concrete* if each of its members is concrete and *abstract* if at least one of its members is abstract.

The one but last paragraph addressed the question how the concreteness or abstractness of the referential Domain of the use of a verb depends on the concreteness or abstractness of its non-referential Domains. But the *concrete-or-abstract* question can also be raised for the concepts expressed by the verb uses themselves. Perhaps it would be expected at this point that the status of the concept expressed by a verb use depends on the status of its Domains in the same way that the status of its referential Domain depends on that of its non-referential Domains. But that, we want to maintain, would not be right. In particular, the concept expressed by a verb (use) can be abstract even though all its Domains are concrete. Examples of this are the concepts expressed by uses of intentional verbs all of whose Domains are concrete. An example is the verb *suchen* ('to search for'), when used to describe situations in which a person is looking in a certain place for a concrete things such as a handbag or wallet. See Example (18) below.

2.3 Hypotheses about PV formation

At long last we are ready to turn to the main topic of this chapter, the relation between the meanings of PVs and the meanings of their P and BV constituents. The central assumption we are making here is that the concept expressed by a given use of a PV is determined by the meanings of their P and BV constituents together with the context <D_2,..,D_n> of this use. If these three factors – the semantics of the particle, the semantics of the base verb and the context – are what the concept denoted by the PV depends on, then a further question is how the concreteness or abstractness of the concept denoted by a PV on a given occasion may be related to the concreteness or abstractness of those factors. The Hypotheses 1–4 below make predictions about this dependence. We state the Hypotheses first and then explain how they should be read.

1. **P-concept + concrete BV + concrete context → concrete PV**
2. **P-concept + concrete BV + abstract context → abstract PV**
3. **P-concept + abstract BV + abstract context → abstract PV**
4. **P-concept + abstract BV + concrete context → abstract PV**

These hypotheses express constraints on the results of the possible interpretations of PV occurrences that fit their protases. For instance, Hypothesis 1 says that when the base verb and the PV context are both concrete, then any use of the PV in which its arguments are as specified by the context must be concrete too. But some clarifications are needed. First, by 'concrete/abstract PV' we mean that the concept expressed by the PV in the context mentioned in the protasis of the hypothesis is concrete/abstract. In contrast, we assume that whether a BV concept is concrete or abstract is determined independently of its context. (This assumption may have to be qualified eventually.)

Second, what should we understand by the 'P-concepts' referred to in Hypotheses 1–4? This is a question about which much more can and should be said than can be said here. In fact, there are two main questions in this connection that ought to be addressed. The first is whether the lexical entries of particles should be treated as consisting of single core meanings, which are transformed into more specific concepts when the particle is combined with a particular BV and the resulting PV is then used in a particular context, or as sets that typically consist of several concepts, from which one gets selected when the particle is combined with a BV and the resulting PV is used in a given context. But no answers to it are needed here, as noted in the last paragraph of Section 2.1. The second question is whether lexical P-concepts can be meaningfully classified in terms of 'concrete' and 'abstract'. In our view such classifications do not make sense. To see why consider, by way of example, the particle *auf*-. The concept Up (see Section 1) is part of its lexical entry and we assume that Up is involved in the semantics of the verb *aufsteigen,* in particular as it applies to planes, balloons and the like, and the verb *aufwerten* (= assigning to something a higher value than it had before). To the given use of *aufsteigen* Up contributes the predicate of spatially upwards movement. For us this is a concrete concept. On the other hand, the events described by *aufwerten* are events of value change and these are, by our standards, abstract events. Here Up contributes the predicate that the change is one of value increase rather than decrease. By our criteria this concept (of 'value increase') is an abstract one. This feature of Up – that it can turn into a concrete concept when *auf*- is combined with one verb-context pair and into an abstract concept when *auf*- is combined with another pair – is typical for lexical P-concepts. In and of themselves such lexical P-concepts are neutral between concrete and abstract; they take on either property as a function of the BV they combine with and the context for the resulting PV.

To get a better feel of what kinds of constraints on PV interpretation are stated by the four Hypotheses we provide examples for each of them.

1. *P-concept + concrete BV + concrete context → concrete PV*

Examples of PV interpretation processes of this type are the two examples of concrete interpretations of *anstrahlen* (2) and (3) briefly discussed in Section 1, and repeated below:

(2) *Der Scheinwerfer strahlt die Wand an.*
The floodlight illuminates the wall.

(3) *Karin strahlt die Hauswand mit der Taschenlampe an.*
Karin shines light on the wall of the house with her torch.

In both (2) and (3) the BV is the concrete verb *strahlen*. But according to what we see as the best ways to analyze these two examples the contexts are different. In the case of (2) the context is the tuple <D_2,D_3>, where D_2 is the Domain of radiation emitting devices and D_3 the Domain of physical objects (more specifically: physical objects that radiation can be shone on or beamed at; but that is true of pretty much all macroscopic physical objects). For (3) we take the context to be the tuple <D_A,D_2,D_3>, where D_2 and D_3 are the same as for (2) and D_A is the Domain of (human) agents. The events that these uses of *anstrahlen* can be used to describe are all instances of *strahlen* with its concrete meaning. The difference between the concrete use of *strahlen* and the uses of *anstrahlen* in (2) and (3) is merely that the latter say more about the events they describe. In (2) the additional information is a specification of the target or recipient of the emitted radiation. The extra information conveyed by (3) is the specification of the agent, with or without a specification of the radiation-producing device that the agent is using. (In (3) the device is mentioned as well, but the prepositional phrase *mit der Taschenlampe* could also be omitted.)

Caveat: The central point of the discussion of *anstrahlen* in Section 1 was that it can be understood as communication verb (see (1)). Used in this way *anstrahlen* counts as an abstract PV (since the events it describes are acts of communication and we have made a commitment to classify those as abstract verbs). But then, isn't the possibility of interpreting *anstrahlen* in this abstract way a counterexample to Hypothesis 1? The right answer to this question, we claim, is 'no'. In fact, there are two ways in which the construction of the communication verb use of *anstrahlen* can be described, both of which invalidate it as a counterexample to Hypothesis 1. The first is to assume that the communication verb *anstrahlen* is not constructed from the same BV as the concrete interpretations in (2) and (3), but rather from the abstract use that *strahlen* also has: that of a person beaming with a happy expression on her face. According to the second way the tuple of non-referential arguments of the communication verb *anstrahlen* includes the message that the subject sends to the recipient – that conveyed by the beaming expression on her face – as a third, implicit argument. If this is how we specify the context involved in the formation of this use of *anstrahlen*, then this use is no longer an instance of the protasis of Hypothesis 1, but rather of that of Hypothesis 2. These two analyses of the communication verb interpretation of *anstrahlen* could also be combined, which would make this use of the verb an instance of Hypothesis 3.

2. *P-concept + concrete BV + abstract context → abstract PV*
From the perspective of this chapter some examples of PV formation that fit the protasis of Hypothesis 2 are among the most intriguing possibilities that German particle verb formation allows for. These formations are cases in which a concrete base verb has to be reinterpreted in the setting provided by an abstract context. The central cases discussed in Section 1 – *anpissen*, *aufbrummen* (and arguably also *anstrahlen*, see the caveat at the end of the discussion of Hypothesis 1) are examples of this. (Note that these can be described as instances of Hypothesis 2 by assuming that the 'theme' argument Domain of the PV is abstract.) In the case of *aufbrummen* we see this as uncontroversial, since the theme – the task that the subject imposes on the indirect object – is one of the PV's explicit arguments (viz. its direct object). But in the case of *anpissen* this argument is only implicit: There is a sense in which the piss that is involved in any concrete instance of *pissen* has to be reinterpreted as the nasty bits of information that the subject directs at the direct object of *anpissen*.

As we did for the two cases of concrete *anstrahlen* in our discussion above, we begin our informal analysis of the verbs *anpissen* and *aufbrummen* by specifying what we take to be their contexts. For both verbs we assume the context to be the tuple $<D_2,D_3,D_4>$ where D_2 and D_4 (the Domain of the possible subjects of these verbs and the Domain of the arguments that play the part of recipients) are both identical with the Domain of human agents, and where D_3 is the Domain of bits of (verbally encoded) information. The two PVs are instances of Hypothesis 2 because D_3 is abstract, so by our stipulation in Section 2.2 the tuple $<D_2,D_3,D_4>$ as a whole counts as abstract as well.

When we discussed verbs like *anstrahlen* and *aufbrummen* in Section 1 we drew attention to the questions how the argument structure of a PV may relate to that of its BV and how the arguments of PV and BV are syntactically realized. Our Hypotheses ignore these aspects of PV formation. This is in tune with the central aim of this chapter, which focuses on the concrete-abstract opposition that is the central theme of this volume. But as we stressed before, in a more probing study of PV formation these questions should of course not be ignored. One important reason why they should be taken into account is that many cases of PV formation (and especially those falling under Hypothesis 2) can be seen as special, linguistically controlled instances of metaphor: PV formations that involve meaning transfer from one set of Domains – those for the arguments of the base verb – to some other set of Domains, those for the arguments of the PV. For PV formations that fit the protasis of Hypothesis 2 the former Domains are all concrete; this follows from our general assumptions about the concreteness/abstractness of eventualities and the concreteness/abstractness of their participants. On the other hand, among the Domains for the PV there must be at least one that is abstract. In order to arrive at the meaning of a PV that has arguments belonging to the second set of Domains the base verb often has to undergo a meaning shift in which those aspects of its meaning are retained that make sense for the new set of Domains, whereas other features, which cannot be made sense of in this new 'context', are dropped. *Anpissen* and *aufbrummen* are telling examples of this. But they are just two from what we must assume is a large and varied set of possible PV formations. Figuring out what meaning shifts involved in PV interpretation are possible (Springorum et al. 2013b; Köper & Schulte im Walde 2018; Schulte im Walde et al. 2018) is not only important for our understanding of German particle verb formation. We also expect that it may reveal aspects of metaphorical language use in general, and aspects that it would be hard to discover in any other way.

3. *P-concept + abstract BV + abstract context → abstract PV*

For both this and the next hypothesis it is surprisingly difficult to find uncontroversial instances. But here is an example of Hypothesis 3: *rechnen* ('to calculate') is an abstract intransitive verb. It is abstract since the events it describes are intellectual processes. But its one non-referential argument Domain consists of human beings (as well, perhaps, as computational devices such as calculators and more sophisticated computing machinery: *Rechner* is the German word for 'computer'). The particle verb *anrechnen* (roughly: 'to acknowledge the benefits that someone has earned or has a right to', as in the sentence 'Wir rechnen Ihnen die Flugmeilen für diesen Flug doppelt an' ('We double the air miles you earn for this flight') is also abstract. But its prominent contexts are abstract as well: *anrechnen* is a ditransitive verb, which typically describes events that consist in the subject assigning to the indirect object such abstract things as 'points earned' (like air miles or overtime). We take it to be beyond controversy that air miles and overtime belong to ontological categories that are abstract. So the context of the PV *anrechnen* is a triple $<D_2,D_3,D_4>$, in which D_2 and D_4 may both be identified with the Domain of human beings and in which the theme Domain D_3 is some abstract Domain (even if it may not be immediately clear exactly how this Domain should be described).

4. *P-concept + abstract BV + concrete context → abstract PV*

Once more, it takes some effort to find good examples that fall under this Hypothesis. But here is one. *Suchen* ('to search', 'to look for') is a transitive verb that by our standards qualifies as abstract because it describes intentional actions. We take the core meaning of *suchen* to be that where both the subject and the direct object are concrete, as in (18).

(18) *Karin sucht ihre Handtasche.*
Karin is looking for her handbag.

We assume that this concrete use of *suchen*, in which all its referential domains are concrete, is the BV for the PV *absuchen*. *Absuchen* denotes a 4-place relation, as illustrated by (19).

(19) *Karin sucht den Garten nach ihrer Handtasche ab.*
Karin is searching the garden for her handbag.

The context for this PV is the triple $<D_2,D_3,D_4>$, where D_2 is the Domain of human beings, D_3 is the Domain of physical locations and D_4 is the Domain of physical objects. There are two aspects of the transition from the meaning of *suchen* to that of *absuchen*. The first is the contribution of *ab-*. We assume that this contribution is an instance of the separation meaning of *ab-*: as Karin is searching the garden, a part of the garden – that which has been searched – gets separated off, as the part that has been 'dealt with'. Second, we note in passing that this is another striking and puzzling example of argument realization. The formation of *absuchen* makes the location that is being searched into the direct object. The direct object position is therefore no longer available for the thing that is being sought, so this argument has to be realized in some other way. But what explains that this argument can and must be realized as a prepositional phrase whose preposition is *nach*? This is yet another story that cannot be told here. We limit ourselves to the observation that the BV *suchen* can also be used with *nach*-PPs, as in *Sie suchte nach ihrer Handtasche* ('She was looking for her handbag').[5]

It may be argued that Hypothesis 4 covers two distinct cases, one in which the BV is abstract but its context – the tuple $<D_2,..,D_n>$ of its non-referential argument Domains – is concrete (and thus each D_i is concrete), and one in which $<D_2,..,D_n>$ is abstract in that it contains at least one abstract Domain. The formation of *ab-suchen* from *ab-* and *suchen* is an example of the first kind. But what would be an example of the second kind? We conjecture that the answer to this is that there are no such examples. An example would be one in which the interpretation went from a BV with a context involving one or more abstract Domains to a PV all of whose non-referential Domains are concrete. This would amount to a transfer of meaning from the abstract to the concrete. We do not believe that such meaning transfers are part of the way in which cognition works – at least not where its inputs and outputs are concepts denoted by linguistic expressions. This conjecture may be seen as one form of the embodiment view of linguistic meaning: meaning

5. The use of *nach* in complements of *suchen* and *absuchen* is similar to that of *after* in a sentence like *He was pining after her*. The reassignment of the direct object position in the transition from *suchen* to *absuchen* – the direct object of *suchen* is the 'figure' (the handbag in this case) and the direct object of *absuchen* is the 'ground' (the garden) – is a well-attested pattern in verb formation, known as 'ground promotion', see e.g., Roßdeutscher (2012).

extension can start from concrete domains and move from there to Domains that are abstract; but not in the opposite direction.

We conclude Section 2.3 with a couple of remarks at a methodological level that is well above that at which our discussions have been conducted so far. In our formulation of Hypotheses 1–4 and in the subsequent discussions of PVs that instantiate the different Hypotheses, we have been adopting the stance of someone who is confronted with a PV that he encounters as part of an actual sentence or discourse. Part of the context that such an interpreter gets from the linguistic environment within which the PV is embedded are the argument phrases that provide non-referential arguments for the verb. It is usually possible to infer the Domains to which those arguments belong from the head nouns of their argument phrases. Given this assumption, the clues that are available for making sense of the encountered PV include: (i) the particle, (ii) the base verb and (iii) the context, in the technical sense in which we have been using the term (i.e., the tuple $<D_2,..,D_n>$ of non-referential Domains). Our formulation of the Hypotheses is to be understood as implying that the interpreter has the task to infer the meaning of the PV from these three inputs.

Note well, however, that as a general characterization of the interpreter's task this is unrealistic. In practice, the interpreter of a PV nearly always has more clues to go on than just these three: the over-all context – not the restricted sense in which it is the (n-1)-tuple of non-referential Domains – will contain additional information that helps him to identify the intended meanings of PVs. The general principles that guide PV interpretations that are based on such additional information are different, and more complex, than the principles stated by our Hypotheses.

This last qualification of how interpreters arrive at what they take new PVs to mean when they meet them is important in connection with the next observation, which takes up a point made all too briefly in Section 1. PV formation can also be viewed from an opposite perspective, that of creating new complex word senses rather than interpreting unknown words. A speaker may have a certain concept *C* in mind, and may be groping for the right word to express *C* and end up with a certain particle verb PV that she feels does a good job in capturing *C* in the given setting in which she wants to deploy it; or at any rate, which does at least as good a job as any other word that occurs to her. What may make the PV look like a good candidate for what the speaker needs may stem to a significant extent from the transfers that are needed to mould the PV into an expression for *C*. Particle and base verb may contribute features that owe their salience to what happens when particle and base verb meaning are transferred from their original Domains to the intended application Domain tuple $<D_2,..,D_n>$ for the PV. On the face of it these transfers have much in common with those that have been the topic of extensive debates with metaphor (Gentner 1983; Lakoff et al. 1991; Wisniewski 1996; Evans 2010).

An implication of this last paragraph is that the PVs that speakers choose need not denote what the speakers want them to denote on the basis of linguistic principles alone. On the other hand, what we said in the one but last paragraph implies that this isn't always necessary either. When a particle verb PV is selected by a speaker in order to make clear to her audience what concept *C* she has in mind, there is usually no need for *every* aspect of *C* to be captured by the general principles that govern the syntax and semantics of PV formation. The context in which the speaker is using the PV – again, in the non-technical use of 'context' – will, as noted, often enable the interpreter to zero in on *C* even though the general principles of PV formation do not *uniquely determine C* as the concept denoted by the PV. And when this works often enough – when there is a sufficiently dense stream of utterance events in which a PV is used to express *C* and understood as expressing *C* – then this PV may become 'lexicalized' as an expression that can be used to denote *C*, thus becoming a dead metaphor.

If this is right, then there is no reason why it should always be possible to reconstruct the meanings of PVs from their particles, base verbs, Domain contexts and the general principles that govern particle verb construction. When a PV is first created, the speaker's cognitively driven imagination can play a crucial part, while linguistic principles only define a framework within which this imagination must operate.

3. Discussing data from the experiment

Evidence for the Hypotheses of the last section comes from an experiment in which subjects were asked to provide sentences in which they thought given particle verbs could be felicitously used (Springorum et al. 2013a). Some of these particle verbs were 'known': they occur in dictionaries or in large-scale corpora. Others were 'neo-PVs', particle verbs that were made up from a fixed set of particles and a fixed set of base verbs. In what follows we discuss a very small part of the yield of this experiment, a small number of sentences that subjects came up with for the four particle verbs that can be formed from the particles *auf*- and *ab*- and the base verbs *stricken* ('to knit') and *reden* ('to talk'). Consistently with the criteria we have been applying *stricken* counts as concrete and *reden* as abstract. All four particle verbs are neo-PVs.

Before we discuss some of the data from this experiment, one word of caution: The task that was given to the participants of the experiment doesn't perfectly match either of the two roles mentioned at the end of the last section. The task of having to make up a sentence or little discourse with an occurrence of a given particle verb PV is largely that of the first of those roles – that of an interpreter who encounters an instance of PV in some utterance and has to determine its meaning in terms of particle, base verb and argument Domain tuple. But the participants in the experiment were in a different situation in that they did not get the Domain tuple as input, but had to make this part of the context up as part of the sentences that they were asked to produce. On the other hand, they could think of suitable meanings for the PVs they were given in any way they liked, and in that regard their situation was more like the second role, that of a speaker who is looking for a verb to fit the concept she wants to express.

We do not think, however, that the lessons that can be learned from the results of the experiment are compromised by these differences. In particular, we believe that the particle verb interpretations that can be inferred from the sentences and discourses that the experiment has yielded are good reflections of how the verbs in question might be used by a speaker to get her thoughts across and might be understood by those that hear what she says or read what she has written.

The first set of examples from the experiment that we examine are (20)–(23).

(20) *Ein Schal ist zu kurz, deshalb werden noch einige Zentimeter aufgestrickt.*
one scarf is too short therefore will be still some centimeters 'auf'knit
One scarf is too short. Therefore some more centimeters will be knit onto it.

(21) *Der Pullover hat mich so viel Zeit gekostet und nur wegen einer*
the pullover has me so much time cost and only because of one
Fehlmasche muss ich nun alles wieder abstricken.
wrong stitch must I now everything again 'ab'knit
The pullover has taken me so much time and only because of one wrong stitch I now have to undo everything.

(22) *Ich habe dir eine Lüge aufgestrickt.*
I have you a lie 'auf'knit
I sold you a lie.

(23) *Nach dem was Du gerade angestellt hast, kannst Du Dir den*
after what you just done have can you yourself the
Theaterbesuch aber abstricken.
theatrevisit but 'ab'knit
After what you just did you can forget about the theatre visit.

Sentence (20) is an example of a composition of the particle *auf-* with a concrete BV in a concrete context $<D_2,D_3>$ where D_2 is the Domain of human beings and D_3 a Domain consisting of some kinds of physical objects, which must at a minimum include shawls. To see whether this occurrence of the VP *aufstricken* is in accordance with our Hypotheses we must first determine its context. The *aufstricken* of (20) has three non-referential arguments, its subject (implicit in the second sentence of (20) because of its passive mood), its direct object and a third object which is also implicit but understood as the scarf referred to in the first sentence and which could be realized as a dative or a prepositional phrase. So its context consists of three Domains: (i) the subject argument Domain D_2, the Domain of human agents that it shares with its BV *stricken*, (ii) the implicit argument Domain D_3 consisting of knitwear and the like, and (iii) a third Domain D_4 containing the entities that can be realized as direct object arguments. What is this third Domain? The direct object phrase of *aufstricken* in (20), *einige Zentimeter*, may have an abstract ring to it, but that could easily be misleading. *Einige Zentimeter* is a measure phrase, which is used to denote an amount of something. This something is not expressed explicitly in (20), but it is intuitively clear what is intended: some stretch of knitting, which is to be added to the shawl as it currently exists. On this assumption D_4 is also concrete, it consists of the physical results of knitting events. This renders the context $<D_2,D_4,D_3>$ for *aufstricken* in (20) concrete, and makes this occurrence of *aufstricken* an instance of the protasis of Hypothesis 1. So according to what Hypothesis 1 predicts, this occurrence of *aufstricken* should be analysed as expressing a concrete concept. This is consistent with our intuitions about what concept is expressed by *aufstricken* in (20): By our criteria this is a concrete concept, of events that are concrete since they are events of someone doing some knitting. What kind of contribution is made by *auf-* to the interpretation of *aufstricken* in (20) seems fairly clear: this is an instance of one thing being on top of another. *auf-* makes this contribution as part of the result state description it adds, that of the bits of knitting that end up 'on top of' the shawl as it has been knit so far.

The occurrence of *abstricken* in (21) is in many ways like that of *aufstricken* in (20). Here too the context of the PV is concrete – it consists of two Domains D_2 and D_3, for the subject argument and the direct object argument. As before, D_2 consists of human agents and D_3 of bits of knitwear, those that *abstricken* describes as being undone. This means that *abstricken* in (21) is another example of a PV that falls within the jurisdiction of Hypothesis 1. So if Hypothesis 1 is right, then the PV should be concrete as well. But is this true?

The answer to this question may be obvious enough. But before we actually state it, let us address the question of how *abstricken* in (21) can come by the meaning it has. The role of *ab-* in this occurrence of *abstricken* is that of describing events that are the reversals of events described by the base verb *stricken* which it modifies. In other words, the *ab-* of this *abstricken* describes events that are the reverse of events described by *stricken* in that they undo the results of some earlier *stricken* event. Note that this is a difference between the *abstricken* of (21) and the *aufstricken* of (20): events described by the given use of *aufstricken* are events describable as events of *stricken*, events described by *abstricken* as it occurs in (21) are not events of *stricken*. In order to undo a bit of knitting, you have to do something that is not knitting: pull at the thread that has been knitted into stitches.[6] This settles the answer to the question that we asked two paragraphs back. The events described by the *abstricken* of (21) are not events describable as cases of the concrete verb *stricken*. But they are strictly physical actions all the same, and therewith are concrete events. So given our general assumptions it is consistent to assume that the concept expressed by *abstricken* in (21) is concrete. And by our criteria, which we haven't made fully explicit in this chapter, it is.

In contrast with the participants that came up with (20) and (21) the producers of (22) and (23) interpreted *aufstricken* and *abstricken* as abstract verbs, with meanings that seem significantly further removed from the base verb *stricken*. First *aufstricken*. The idea behind the interpretation of *aufstricken* that manifests itself in (22) is that of one person selling a lie to another person and doing that in such a way that the second person doesn't realize he is being told a lie – as if the first person was wrapping the second within some tissue from which the second cannot extricate himself. We confess that we are making this up as we are trying to describe this case, and may be accused of trading fantasy for sober analysis. But it is difficult to know where to draw the line in cases like the one that is now before us, for this is just the kind of imaginative exercise that the participant who came up with (22) must have engaged in too. Perhaps the participant was clutching at straws when trying to find a use for *aufstricken* and among the straws clutched at may have been certain analogies with uses of related expressions that are an established part of the language as the participant knew it. In particular, among these straws may have been the expression 'a tissue of lies'.

The analogy with the verb *aufschwatzen* may have played its part too. The verb *aufschwatzen* (from *auf-* and *schwatzen*, 'to talk in an unserious way') is a card-carrying member of the German vocabulary; it is used to describe acts in which one person talks to another in an unserious way, so as to get the other to do something that is against his interests and to the advantage of the one who is doing the talking. And typically (if perhaps not always) the talking that the first person does to achieve this is 'unserious' in being specked with falsehoods or half-truth, as in Example (24).

(24) *Karin schwatzt ihrem Bruder das Auto auf.*
Karin chitchats her brother the car 'auf'
Karin talks her brother into taking the car.

6. It is a good question, but one to which we do not know the answer, whether the reversal use of *ab-* always entails, for linguistic or conceptual reasons, that for every well-formed PV *ab*-V, *ab*-V events are never V events.

It shouldn't be surprising that relying on such analogies, even loose ones, is something that you cannot avoid when trying to make sense of a word that does not exist and that perhaps does not exist for good reasons. But we believe that this is not just an artifact of the special conditions of the experiment, but that it also plays an important part in the creation and interpretation of hitherto unknown words in normal language use. A better understanding of the role of analogy in the creation of novel words (Wisniewski 1996; Costello & Keane 2000; Gagné 2002; Springorum & Schulte im Walde, under revision), and also in sense extension of existing words, is one of the things we need, not only as part of a better theory of particle verb formation and interpretation, but also as a step towards a better grasp of the principles that govern the use and meaning of compound words in general.

The case of *abstricken* in (23) shares with the *aufstricken* of (22) that, as far as we are able to tell, analogy plays an important part in its meaning. In this case the analogy is with the existing non-literal use of the verb *abschminken*, which is formed out of *ab-* and *schminken* ('to put make-up on') and is used non-literally to describe just what *abstricken* seems to be meant to convey in (23): the subject is told that there is no hope that the plan or desire that is being referred or alluded to has a chance of realization. In (23) this plan is to go to the theatre. In other words, (25) is a canonical German sentence, with the same meaning that we attribute to (23).

(25) *Karin muss sich die Reise abschminken, da sie nicht genug Geld hat.*
Karin should forget about the trip, because she doesn't have enough money.

It is an interesting question, but one that we can do no more than mention as a possibility, whether a 'literal' interpretation of *abstricken* like the one found in (21), enters into our understanding of (23) too. But whether or not this 'literal' interpretation of *abstricken* plays a part in the interpretation of (23), it seems a safe bet that the contribution that *ab-* makes to the interpretation of *abstricken* in (23) is that of separation: the subject is told to get rid of a certain plan or desire since there is no hope of realizing it. (The colloquial translation with 'forget about' aims to do justice to this aspect of the meaning of (23).)

What is the concrete-abstract status of the concepts expressed by the verbs *aufstricken* and *abstricken* in (22) and (23)? Intuitively, the contexts provided in (22) and (23) make clear that the verbs describe intentional actions, and most likely speech acts, or actions involving speech acts. As noted earlier, for us the concepts expressed by such verbs count as abstract. Is that compatible with Hypotheses 1–4? That depends on how we classify the base verb *stricken*. If we take *stricken* to express an abstract concept (by virtue of its describing intentional actions), then there can be no conflict with our Hypotheses. But when the concept expressed by *stricken* is taken to be concrete, then there could be a conflict, for instance in a sentence like 'Karin hat ihrem Bruder ihr Auto aufgestrickt', in which each of the three non-referential Domains is concrete. (Such a sentence with *aufstricken* isn't among the data from the experiment, but it seems not unreasonable to suppose that speakers could come up with such a context for *aufstricken*, given what is found among the data.) If the BV *stricken* is assumed to express a concrete concept, then the abstractness of *aufstricken* in this last example contradicts the prediction of Hypothesis 1. Such violations of Hypothesis 1 can be expected more generally in cases where particle verb formation involves a metaphorical reinterpretation of the BV. The relationship between Hypotheses 1–4 and the metaphorical dimension of many PV formations requires further exploration.

The remaining verbs we discuss here, *aufreden* and *abreden*, are only represented by sentences in which they are used with non-literal readings. The sentences from our data we consider are given in (26) and (27). The uses of *aufreden* and *abreden* in these sentences also seem to have been conceived in analogy with established verbs, in this case the verbs *aufschwatzen* and *abschwatzen*, the first of which has crossed our path already.[7] And here too the results of substituting *aufschwatzen* and *abschwatzen* for *aufreden* and *abreden* in (26) and (27) yield canonical German sentences with the same meanings, see (28) and (29).

(26) *Eigentlich wollte sie das Kleid nicht kaufen; sie hat es sich aufreden lassen.*
really wanted she the dress not buy she has it her 'auf'talk let
She didn't really want to buy the dress; she was talked into it.

(27) *Ich habe gestern meiner Schwester das Haus abgeredet.*
I have yesterday my sister the house 'ab'talked
Yesterday I talked my sister out of her house.

(28) *Eigentlich wollte sie das Kleid nicht kaufen; sie hat es sich aufschwatzen lassen*.
She didn't really want to buy the dress; she was talked into it.

(29) *Ich habe gestern meiner Schwester das Haus abgeschwatzt.*
Yesterday I talked my sister out of her house.

One striking feature of the uses of *auf*- and *ab*- in (26) to (29) is that the contribution made by *ab*- is the reverse of that made by *auf*-, but that this affects only the truth-conditional content of these verb uses and not their emotive connotation. The earlier (24), repeated below, and its *ab*-counterpart in (30), illustrate the point clearly and concisely. We noted that *schwatzen* carries the negative connotation that the subject is engaged in talk that does not stand up to general standards of veracity. This negative connotation is inherited by *aufschwatzen*, to the effect that the action described is one in which the subject takes advantage of the indirect

7. Also recall the earlier discussions of *aufbrummen* and *aufdonnern.*

object. So the deal described in (24) comes across as a bad one for Karin's brother and a good one for Karin. *auf-* is responsible for telling us what the deal consists in: The car that the sentence refers to is Karin's at first and the sentence describes its transfer to Karin's brother. The reason why *auf-* makes this contribution is once again that it serves to describe the result state of the event that is described by the verb. This is the state of the car being 'on top of' the indirect object (i.e., Karin's brother). (That the second argument of the relation contributed by *auf-* must be the indirect object of *aufschwatzen* and not its subject is part of a further story, which we cannot tell here.) *abschwatzen* in (30) differs from *aufschwatzen* in (24) only in that the role of *ab* in the description of the result state is the opposite of that of *auf-*: the result is now that the car is 'separated' from the indirect object. In the context that is suggested by (30) this means that Karin's brother no longer has the car as result of the event. This doesn't strictly entail that the car ended up in the possession of the subject Karin and in fact it is not too difficult to imagine scenarios in which the car ends up in the possession of someone else, e.g.,in that it is donated to some charity. But that the car ended up with Karin is nevertheless a natural default inference, driven by our general views of human society and prejudices about human nature.

(24) *Karin schwatzt ihrem Bruder das Auto auf.*
Karin chitchats her brother the car 'auf'
Karin talks her brother into taking his car.

(30) *Karin schwatzt ihrem Bruder das Auto ab.*
Karin chitchats her brother the car 'ab'
Karin talks her brother into ceding him her car.

The noteworthy thing about this comparison of (24) and (30) is that the negative connotation of *aufschwatzen* and *abschwatzen* is the same even though the described transfers are each other's opposite. This indicates that the 'sentiment' contribution made by *schwatzen* ('to chitchat', 'to talk in an unserious way') operates independently of the truth-conditional contributions made by the particles *auf-* and *ab-*. We believe this is an important feature of the architecture of particle verb compositionality more generally.[8] The story that we have told about *aufschwatzen* in (24) and *abschwatzen* in (30) also applies by-and-large to *aufreden* and *abreden* in (26) and (27). But what also deserves notice is that these uses of *aufreden* and *abreden* carry the same negative connotations as *aufschwatzen* and *abschwatzen*, and this in spite of the fact that their BV *reden* does not seem to carry

8. We suspect, but have not explored in depth, that what is illustrated by the comparison of (24) and (30) resembles the kind of independence between truth-conditional and non-truth-conditional meaning contributions at the supra-lexical level, as explored by Potts (2005).

such a connotation. It seems a reasonable assumption that *aufreden* and *abreden* inherit their negative connotations from the analogy with *aufschwatzen* and *abschwatzen* together with all else they inherit from them. But there may be more to this. For some speakers we have asked it appears to be well-neigh impossible to understand the PVs *aufsprechen* and *absprechen* in the same sense as *aufschwatzen* and *abschwatzen*, and this even though *sprechen* is an intransitive verb that at least in first approximation seems to describe the same events as *reden* and in a similarly emotion-free manner. As things stand, we do not know what the difference between *sprechen* and *reden* could be that accounts for this apparent difference between *auf-/ab-sprechen* and *auf-/ab-reden*.

To conclude this section we want to mention a couple of methodological issues. First, there is a certain tension between the level at which we have formulated our central Hypotheses 1–4 and the level that would be needed for a systematic account of how the meanings of PVs can be constructed from the meanings of their constituents and their contexts. Those discussions in this section that related the PVs from our small choice of sample sentences to the Hypotheses will have made this tension clearly visible. Still, even at the level at which we have stated and discussed the Hypotheses there is, we believe, a point to stating and discussing them. General assumptions about PV compositionality have been few and far between and the proposal we have made is one way of getting a foot in the door, but only a beginning.

The data of the experiment from which we have shown no more than a minute selection here is a valuable guide in the development of such a theory.[9] But to mine these data for all the important clues they contain is a task of major proportions, and one that is still in its early stages. The informal descriptions of the present section are the spin-offs of some of the things that we ourselves have learned from looking closely at some of these data, and that we ourselves have come to believe must become input to such a more general theory of PV composition.

This brings us to another respect in which the present chapter must be seen as preliminary. The use we have been making of the results of the experiment to which the discussions in this section have been devoted has been minimal. All that we have done has been to argue for a very small number of the PV uses that the participants of the experiment have come up with can be analyzed in ways that are consistent with the predictions made by our Hypotheses 1–4. But we also found reasons for doubt, specifically in connection with Hypothesis 1 when PV formation involves a transition from an intuitively concrete BV to an intuitively abstract PV. Many more data that exemplify transitions of this kind will have to be looked at.

9. The collection is publicly available from www.ims.uni-stuttgart.de/data/pv-neo-data.

4. Conclusion

The central aim of the present chapter has been to draw attention to one place where concrete and abstract concepts meet: Many German particle verbs express abstract concepts, although they are built from BVs that express concrete concepts. Some of these PVs, we saw, involve a metaphorical transfer from concrete to abstract Domains. But we have also seen that by no means all PV formations are like this; some PVs express concrete concepts and in other cases the BV of a PV expresses an abstract concept already. Implicit in the observations we have made about concrete and abstract BVs, PVs and contexts is the challenge of a theory in which these aspects of PV formation are treated in conjunction with others, such as argument structure and argument realization.

One important feature of many of the concepts we have been looking at is that they are not 1- but 2- or more-place concepts. The need to consider 2- and more-place concepts arose directly from our topic: investigating the concrete-abstract distinction in relation to particle verbs and their base verbs. But 2- and more-place concepts are important in language and cognition far more generally, and some of the notions that have been essential to our discussion of PV formation – such as the relations between concepts and their referential and non-referential Domains – will be indispensable to the analyses of those other 2- or more-place concepts as well.

As a final word we want to return to the remarks about interpretation and production we made towards the end of Section 2.3. The compositional principles that govern the formation of PVs from Ps and BVs, we noted there, are relevant to both. They help the interpreter of a novel PV to identify what the verb is intended to mean and they constrain the producer in her choice of a PV for the concept she wants to express. But as often as not the compositionality is perfect; the meaning of the PV cannot be computed rigorously from the meanings of its constituents. Nor need it be. It is enough if the compositional principles constrain the possible meanings of the PV such that the interpreter can recover the intended meaning by an act of imagination that tracks the imagination that the producer exercised in coming up with the PV as a good way to express her concept and an effective means to get her concept across. The ultimate challenge we see for a theory of PV formation is to bring these two sides, imagination and the checks imposed upon it by cognition and linguistic rule, together within a single framework.

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CHAPTER 10

Metaphor in action

Action verbs and abstract meaning

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Embodiment plays an essential role in both concrete and abstract semantic representation. As a consequence, action verbs are extensively involved in the conceptualization and linguistic encoding of figurative meanings. In the light of several theoretical frameworks, this chapter aims to investigate the mechanisms that enable verbs to acquire new abstract meanings. The analysis we present focuses specifically on the metaphorical variation of a cohesive group of five Italian action verbs codifying a movement along the vertical axis (*alzare*, *abbassare*, *salire*, *scendere*, *sollevare*). The results confirm the Invariance Principle worked out by Lakoff: the metaphorical mapping of an action verb is strictly constrained by the image schemas involved in its core and concrete meaning.

Keywords: image schema, invariance principle, semantic variation, verticality

1. Introduction

The meaning and the semantic structure of many abstract concepts (e.g., Changes, States, Causes, and Purposes) are cognitively grounded in the metaphorical mapping of concrete embodied schemas such as Force and Motion (Lakoff and Johnson 1980; Lakoff and Johnson 1999; Gibbs 2006; Barsalou 2008). Action verbs are extensively involved in mechanisms by which we conceptualize and linguistically codify figurative and abstract meanings, mostly exploiting the high-level conceptualization provided by a cognitive metaphor. In this regard, a considerable number of works have highlighted the role of embodiment in the representation of language (and therefore also action verb semantics) and their metaphorical extensions from different methodological perspectives, including neuroscience (Gallese and Lakoff 2005; Pulvermüller 2005; Aziz-Zadeh and Damasio 2008; Desai et al. 2011; Kiefer and Pulvermüller 2011; Barsalou 2016).

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This chapter aims to investigate the relation between the two dimensions of the semantic variation of action verbs, i.e., the physical and the figurative dimension. How is the metaphorical meaning linked to the physical representation of the events? And, more specifically, how do the concrete senses enable and condition the emergence of new abstract meanings?

As we will see, languages refer to actions in an extremely entangled way (Majid and Bowerman 2007; Kopecka and Narasimhan 2012; Moneglia 2014). First of all, there is no one-to-one correspondence between a single action concept and a lemma that encodes it. The most frequent action verbs are usually *general*, in the sense that they can refer to different actions, belonging to distinguishable cognitive categories. Moreover, each language categorizes the action space in its own way.

This study focuses on the metaphorical variation of a cohesive group of five action verbs codifying, in their basic meaning, a movement along the vertical axis: *alzare* (*to raise*), *abbassare* (*to lower*), *salire* (*to rise*), *scendere* (*to descend*), *sollevare* (*to lift*). The analysis we present is part of a broader ongoing annotation project aimed at categorizing the figurative usage of high-frequency general action verbs within the framework of the IMAGACT ontology of action (see Section 2). The work started with a corpus-based analysis and continued with the collection of the same metaphorical usages in a single semantic type, characterized by specific properties and features. Each metaphor type can be related to more than one verb, thus identifying a cognitive process of abstraction that is productive within the lexicon.

Section 3 will briefly introduce the theoretical framework we used to account for the cognitive models emerging from the corpus analysis: Conceptual Metaphor Theory and Image Schema Theory (Lakoff and Johnson 1980; Johnson 1987; Lakoff 1987; Lakoff and Johnson 1999).

In Section 4, we focus on three specific case studies. In line with the *Invariance Principle* (Lakoff 1990 1992; Turner 1991), we argue that the mapping process retains the conceptual structure of the source domain (the image-schematic structure contained in the basic meaning of a verb), so that it preserves the same structural components in the target domain (the abstract usage of the verb). In this respect, image schemas are the basic elements that constrain the metaphorical transfer, enabling semantic mapping to occur or preventing it.

2. IMAGACT: Ontology of actions

2.1 General verbs and their semantic representation in IMAGACT

IMAGACT[1] is a multilingual and multimedia linguistic ontology of action concepts, which are visually represented by means of prototypical 3D animations or brief videos (Moneglia 2014; Panunzi et al. 2014). The action concepts were categorized on the basis of intensive annotation of spoken language corpora in English and Italian, the process of which is described in detail by Moneglia et al. (2012).[2]

The IMAGACT multilingual ontology contains 1,010 scenes linked to the verb lexicon of the included languages (more than 500 lemmas for each one). In addition to English and Italian, Chinese and Spanish were also processed in the first phase of the project. Since action concepts are represented in the universal language of images, the ontology can be easily mapped onto any language. Currently, extensions to Arabic (Syrian), Danish, German, Hindi, Japanese, Polish, Portuguese, and Serbian can already be searched in an online interface.[3]

Given the referential nature of general action verbs, each lemma in the IMAGACT ontology is typically connected to more than one scene. Each scene prototypically represents a single action concept, namely an action type. This allows us to define the Primary Variation of a verb as the set of different action types to which a verb can refer in its proper sense.

The other way around, each scene can be described by more than one verb, thus creating classes of lemmas that share a common referent within the ontology. The verbs included in such classes are called equivalent verbs.[4]

Let us consider the example of the general Italian verb *alzare* (typically similar in meaning to the English verb *to raise*). *Alzare* can refer to all the actions described by the Examples (1)–(4):

(1) *Maria alza una scatola*
'Mary raises a box'

(2) *Maria alza l'asta del microfono*
'Mary raises the microphone'

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1. http://www.imagact.it

2. 38,462 occurrences were processed in the English corpus, and 42,723 in the Italian one.

3. http://imagact.it/

4. We wish to emphasize that equivalent verbs are not necessarily synonymous: they are not supposed to share a common meaning, or some meaning components. Two verbs are considered equivalent with respect to a specific action type only if they can both refer to it, even from different perspectives.

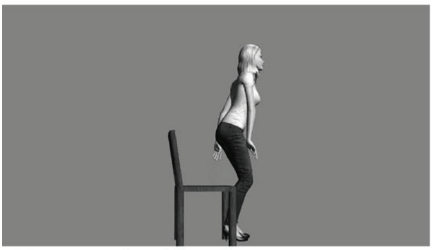
(3) *Maria si alza dalla sedia*
‘Mary rises from her seat’

(4) *Il palloncino si alza in cielo*
‘the balloon rises’

These sentences can be taken as representative, at least in part, of the Primary Variation of the verb *alzare*; IMAGACT contains a scene for each of these action types, as represented in Figure 1.

(1) Maria **alza** una scatola
‘Mary raises a box’

(2) Maria **alza** l’asta del microfono
‘Mary raises the microphone’



(3) Maria si **alza** dalla sedia
‘Mary raises from her seat’

(4) il palloncino si **alza** in cielo
‘the baloon rises’

Figure 1. Primary Variation of the Italian verb *alzare* in IMAGACT (simplified)

With respect to this variation, we can notice that relevant linguistic and cognitive traits change from class to class. Table 1 shows, for each example (numbered in the left column), the classes of equivalent verbs in Italian and in English, and some differential cognitive properties.

Each action type is characterized by a different set of equivalent verbs, both in Italian and in English. Moreover, in Italian there is at least one verb (specifically *alzare*) that can refer to all four types. In contrast, this is not the case for English: we need at least two main translation equivalents, namely *to raise* and *to rise*. This fact corresponds to a high-level cognitive property: in action types (1–2), the [trajector] is dislocated by an agent, while in action types (3–4), its movement is self-propelled.[5]

5. We use lowercase words for image schemas and conceptual metaphors, and lowercase words within brackets for semantic components.

Table 1. Linguistic and cognitive properties of the action types of *alzare*

Action type	EQ verbs (IT)	EQ verbs (EN)	Differential properties
(1)	*alzare*, *sollevare*, *tirare su*	*to raise*, to *lift*, to *pick up*	[dislocation] (obj. moving)[force on the object] [removal of the object] [telic]
(2)	*alzare*, *allungare*, *tirare su*	*to raise*, to *reposition*, to *extend*	[dislocation] (obj. moving) [modification of the object] [processual]
(3)	*alzare*, *mettersi*, *tirarsi su*	*to rise*, to *stand*, to *stand up*	[movement] (subj. moving) [telic]
(4)	*alzarsi*, *salire*	*to rise*	[movement] (subj. moving)[processual]

2.2 Marked variation and starting data

IMAGACT only contains the physical actions described by action verbs, ignoring any non-literal interpretations. Therefore, the first step in the corpus annotation process was to select those occurrences in which verbs refer, in their basic meaning, to physical actions.[6] In this phase, the annotator uses an operational test *à la Wittgenstein*: he or she should judge whether it is possible to point to a certain (perceptible) event and say to someone who does not know the meaning of a given verb that *this action and similar events are what we refer to with this verb*.[7] If this is possible, the occurrence is classified as *primary*. Otherwise, it is classified as a marked variation, i.e., the set of uses in which the action verb refers to abstract/figurative concepts (Panunzi and Moneglia 2004; Moneglia et al. 2012). For instance, if we point to any of the events described in (1–4), we could say that *this is what 'alzare' means*. In contrast, the sentences in (5)–(8) do not instantiate the basic meaning of the verb *alzare*. Consequently, they are considered marked variations:

(5) *Maria alza il volume*
'Mary turns up the volume'

(6) *Maria alza gli occhi dal giornale*
'Mary takes her eyes off the newspaper'

(7) *Maria alza la cornetta del telefono*
'Mary picks up the phone'

6. Respectively 50% and 38% of the occurrences in the English and the Italian corpora were considered non-physical (Brown 2014).

7. See Wittgenstein (1953) about the meaning of the word *game*.

(8) *l'azienda alza il tiro*
'the company steps up its game'

It is interesting to notice that the English equivalent of the Italian verb *alzare* in any of these sentences is neither *to raise* nor *to rise*. As a matter of fact, each occurrence needs a specific phrasal verb in English (*to turn up*, *to take off*, *to pick up*, *to step up*), none of which correspond to the basic meaning of the Italian source verb. This fact confirms the importance of the basic semantic distinction between the Primary and Marked Variations of a verb, especially when we face the problem from a multilingual perspective. Translations that hold between verbs of different languages in their Primary Variation do not necessarily extend to their metaphorical usages. In other words, metaphoric equivalents are less productive and predictable than primary ones.

The annotation process and the online interface used for the classification of marked variation of the IMAGACT corpus is described in Brown (2014). Following this model, we processed almost 2,000 marked expressions with the help of the IMAGACT interface, firstly distinguishing between verb metaphors, metonymies, and idioms (Vernillo 2015). As a second step, we gathered the occurrences of the same metaphorical type in a single class, and annotated its cognitive properties, including: (a) the underlying conceptual metaphor in Lakoff's Master Metaphor List (Lakoff et al. 1991); (b) the set of equivalent verbs; (c) an optional link to the prototypical scene to which the metaphorical usage is connected.

After these stages, we conducted a qualitative analysis of a smaller group of verbs, which is presented in detail in Section 4 of this chapter.

3. Metaphors: Theoretical frameworks

3.1 Conceptual metaphor theory

The main claim of Conceptual Metaphor Theory (CMT; see also Lakoff and Johnson 1999; Lakoff 1987, 1993) is that the nature of metaphors is primarily conceptual, rather than linguistic. Metaphor is conceived of as a cognitive phenomenon based on a systematic transfer (mapping) of information from a source domain, which is accessible through experience, to a target domain, which goes beyond physical experience. In such a scenario, metaphors in language are intended to be the superficial reflection of this deeper cognitive process. As such, language is believed to be one of the ways by which higher mind structures can be accessed, which we use to represent and shape abstract concepts.

Let us consider the following metaphorical expressions:

(9) The quantity of waste produced each year keeps going up

(10) You might want to lower your voice

(11) The value of the painting went down year after year

(12) The donor age threshold has risen

These Examples (9)–(12) are the linguistic reflections of a single conceptual mapping, in which one domain (i.e. quantity) has not been simply organized in terms of another (i.e. vertical axis) but has also been organized in a way to involve spatial relationships. This structure, that is part of a higher-level system of orientational metaphors (among the others, happy is up/sad is down, rational is up/not rational is down, control is up/lack of control is down), can be formulized as more is up/less is down. As a matter of fact, the changes in values in (9)–(12) are represented in such a way as to have upward (9), (12) or downward (10), (11) orientation.

An interesting point here (9)–(12) is that, although the examples refer to the same conceptual structure (e.g. more is up/less is down), each of them carries a different kind of informational load: each of them refers to measurable values of a different sort (i.e. physical amount, sound intensity, economic value, human age). We could say that all these metaphorical expressions exemplify the way we linguistically express the correlation between the increasing or decreasing of a quantity and the dislocation of the value along the vertical axis. In particular, the vertical axis is conceived of as a scale, where the increase in quantity is represented as a motion toward the higher end of the axis, and its opposite as a motion toward the lower end of the same axis. Looking at (9)–(12), it is evident how each predicate projects its own core semantic onto the mapping, thus unveiling how our experience can affect the way in which we build and represent the same abstract concept. Verb selection makes clear which spatial orientation we activate within each metaphorical mapping (i.e. upward or downward), the kind of action schema we use when quantity has given a spatial structure, and, finally, the specific type of abstract event we evoke in our mind.

To conclude this very brief presentation of CMT, we think it is worth stressing the crucial role that metaphors play in human cognition. The study of metaphors can shed new light on the way we make sense of highly abstract aspects of our experience. Because the present study is concerned with the metaphorical use of action verbs, we believe that it is of absolute importance to pay attention to the diverse ways in which these lexical extensions can disclose the existing relation between our conceptual and our sensory motor system.

3.2 Image schema theory

The idea of image schemas was introduced in 1987 by Johnson (1987) and Lakoff (1987) as an essential means to explain the strong relationship between bodily experience and human cognition. Since then, many researchers have used the concept of image schemas and a considerable number of multidisciplinary studies has been produced (among others, Brugman 1988; Quinn 1991; Turner 1991; Gibbs and Colston 1995; Lakoff and Johnson 1999; Feldman and Narayanan 2004; Gallese and Lakoff 2005).

In general terms, image schemas are conceived of as structures of sensory-motor experience, by means of which we also model abstract concepts and our way of reasoning. According to Johnson (1987:33), an image schema is a «recurring dynamic pattern of our perceptual interaction and motor programs that gives coherence and structure to our experience».

The intrinsic vagueness of the original definition has often led to a misunderstanding of the concept. The main consequence of this, is that the term has also been used to refer to phenomena of a different nature (i.e., image schema and image-schematic structures). Moreover, the vagueness inherent in the idea of the image schema caused a series of problems in the identification (and often uncontrolled proliferation) of these semantic components (Clausner and Croft 1999). In addition to this, Johnson's original list of image schemas (1987), has never been thought of as a closed and definite set. At any rate, although there is no agreed-upon definition of image schemas, it seems possible to isolate some of their shared properties. In particular (Johnson 1987; Lakoff 1987; Cienki 1997; Hampe 2005; Hampe and Grady 2005; Gibbs 2006):

1. Image schemas recur across many different experiences (they do not seem to be bound to a very specific context of experience and knowledge);
2. Image schemas are preconceptual primary components (they have a non-propositional or non-truth-conditional nature);
3. Image schemas have a gestaltic structure (they contain a small number of related parts), which have to be taken as the outcomes of human sensory-motor experience;
4. Image schemas tend to co-occur in groupings (superimposition), since they seem to be experienced together;
5. Image schemas show an orientation towards the positive or negative sense when used in metaphorical mappings (plus-minus or axiological parameter)
6. Image schemas have both a static and dynamic nature (they can represent either a state of being or processes);
7. The internal structure of image schemas has a logic that support inferences;
8. Image schemas operate beneath the level of our conscious awareness.

Image schemas are presented as conceptual building blocks that are normally operative in our perceptual interactions, bodily movements and physical manipulation of objects since early infancy (Mandler 1992; Mandler and Pagán Cánovas 2014). A broad range of our daily actions is based on this kind of spatial schematization (e.g., the semantic network of over in Lakoff 1987; verticality in Ekberg 1995 – in our terms, vertical orientation; straight in Cienki 1998; smooth-rough in Rohrer 2006, etc.). However, image schemas do not only work as containers for compressed spatial information, but also as a basis for the modelling of highly abstract concepts. Indeed, they also play a central role within CMT. Image schemas constrain the metaphorical mapping in order to guarantee that the topology of the source domain topology is coherent with the internal structure of the target domain (Invariance principle; Lakoff 1990, 1993; Turner 1991). As Oakley sums up (2010), they map the spatial structure onto the conceptual one. The same conceptual building block, indeed, could be metaphorically projected from a very physical domain to a non-concrete one and be accordingly used to point to events, states, or abstract entities.

For the present paper, we approached the study of image schemas from a purely semantic perspective. We used them to analyze the semantic core of five action verbs to extract the properties necessary to the application of this group of predicates in metaphorical contexts. In order to purse this aim, we used an integrated list of the main image schemas discussed in the literature (Johnson 1987; Lakoff 1987; Mandler and Canovas 2014). We collected image schemas belonging to four schematic groups: a Spatial/Motion group, a Force group, a Balance group, and Others (see Table 2).

Table 2. Image schemas integrated list

Spatial/Motion group	**Force group**	**Balance group**	**Other**
Container	Compulsion	Axis balance	Scale
Above	Counterforce	Point balance	Surface
Across	Blockage	Twin-pan balance	Full-empty
Contact	Diversion	Equilibrium	Merging
Covering	Restraint removal		Matching
Center-periphery	Enablement		Mass-count
Near-far	Attraction		Iteration
Vertical orientation			Object
Length			Splitting
Path			Part-whole
Endpoint			Superimposition
Starting point			Process
Cycle			Collection
Cyclic climax			Link

4. Abstraction processes along the vertical axis: Three case studies

In the following section, we present three case studies, extracted from the IMAGACT database, which relate to the marked variation of five Italian action verbs, i.e., *abbassare*, *alzare*, *salire*, *scendere*, and *sollevare*. This group of verbs creates a sort of semantic node, in which the *vertical axis* can be seen as a shared and central factor in their core meaning. In Section 4.1 in particular, we provide a short introduction of the vertical axis concept; in Section 4.2 we focus on some types of common orientational metaphors (e.g., MORE IS HIGH, LESS IS DOWN) within the marked variation of *abbassare*, *alzare*, *salire*, and *scendere* (but not in *sollevare*); in Section 4.3 we only consider the verb *sollevare* and part of its metaphorical network; finally, in Section 4.4 we describe some fictive instances of motion within the marked variation of *salire* and *scendere*.

4.1 Centrality of the vertical axis

There are many things in the world that we would not be able to speak of without resorting to metaphorical models. But where do these conceptual structures come from? Or, rather, which are the external factors influencing the way we build them? As we have already underlined, metaphorical concepts are not completely abstract, but are based on our physical and bodily interaction with the external environment. In this section, we focus on a specific kind of experiential factor, which seems to be decisive in our way of building metaphorical concepts, namely the *vertical axis*. Verticality is one of the most commonly recurring source domains, as it is able to operate with a considerable number of target domains. This is mainly due to its centrality in our physical experience (Langacker 1987). We generally use the [up/down] orientation features to refer to a large array of abstract concepts such as Events, States, Changes or Purposes.

Our everyday experience justifies the concrete correlation between the amount and the level of a substance and, consequently, also justifies the mapping between the verticality and the quantity domains in the conceptual metaphorical structures MORE IS UP and LESS IS DOWN (Lakoff and Johnson 1980). In an abstract scenario, this relation usually identifies the measurable increase or decrease of a value, force, or intensity (temperature, prices, volume, etc.). Likewise, the universal bodily experience leads to the emergence of another conceptual metaphor, namely the HAPPY IS UP/SAD IS DOWN metaphor, which is a very common model in several languages (e.g., English, Mandarin Chinese, and Hungarian, among others). This conceptual structure is indeed based on the configuration of our bodies within space (Lakoff and Johnson 1980; Kövecses 2000, 2015). As a matter of fact, when we are happy, we stand up straighter and taller, with an erect posture. In contrast, sadness and similar emotional states lead to an opposite change in our posture: it drops, and the body and its parts go down as if they are being crushed by the force of gravity. More generally, the vertical axis is often found in association with the quality target domain (GOOD IS UP, BAD IS DOWN) and it is used to convey a positive or negative evaluation. This last correspondence is productive in our conceptual system, as this may be extended to several contexts: we can *raise* the level of our performance or *lower* our ranking position, we can buy a *high*-definition display or produce *low*-quality academic work. As the last examples show, the [up/down] orientation vectors have undergone a pervasive process of symbolization, after which the far ends of the vertical axis have acquired diametrically opposed meanings, interpretations and values. Moreover, the same is quite evident in metaphorical structures such as HARMING IS LOWERING, HIGH STATUS IS UP, CAREER PROGRESS IS VERTICAL MOVEMENT, RATIONAL IS UP, MORAL IS UP, etc. (Lakoff et al. 1991). In the field of Cognitive Linguistics, this evaluative factor, which seems to be generally preserved in metaphorical (especially orientational) extensions, is known as *plus–minus/axiological* parameter and is conceived of as an essential component of most image schemas (Krzeszowski 1993, 1997; Cienki 1997; Hampe 2005). In Krzeszowski's formulation (1993), for instance, the vertical axis denotes a sort of default evaluation, where the positive and negative polarity are fixed (and absolute) values dependent on our bodily experience.[8]

Ekberg (1995) clearly shows that the vertical axis is anything but an inflexible domain. On the contrary, its characteristic plasticity enables us to manipulate the basic schema, so that we can continuously produce a broad range of new conceptualizations. In our daily experience, we frequently use linguistic expressions that refer to transformations of the vertical axis. Consider the following cognitive processes: (i) the horizontal transformation in (13); (ii) the fictive effect resulting from the transformation of a real entity tracing a path into a static extended entity simulating the path itself, as in (14); (iii) the mapping from the physical to the temporal space, formalized in the TIME IS SPACE metaphor, as in (15).

(13) he walked up and down the corridor (Ekberg 1995: 70)

(14) the tree reached up to the roof/the dress reached up to the ankles (Ekberg 1995: 71)

(15) down to the present day (Ekberg 1995: 79)

In the following sections, we present a pilot study for an ongoing project which aims at modeling types of metaphorical verbs in the IMAGACT corpus. We hereby

8. To deepen the issue of plus–minus parameter, see Hampe (2005).

focus on verbs encoding a movement along the vertical axis in Italian, i.e., *alzare*, *abbassare*, *salire*, *scendere*, *sollevare*.

4.2 Common orientational metaphors

Orientational metaphors enable the representation of a concept (or of an entire system of concepts) by means of spatial vectors, e.g., [in/out], [front/back], [up/down]. This analysis focuses on a very common type of orientational metaphors, based on the conceptual mapping between the verticality and the quantity domain. This group points to the existence of the conceptual metaphor MORE IS UP/LESS IS DOWN and it contains metaphorical expressions related to the increase or decrease of a quantitatively measurable value. Among the various options provided by our language, this metaphorical concept could linguistically be described by the application of action verbs. In particular, we look at four Italian action verbs that encode movement along the vertical axis, i.e., *alzare*, *abbassare*, *salire*, and *scendere*. Below we report a short list of sentences extracted from the IMAGACT corpus:

(16) *Marco alza il volume del televisore*
'Marco turns up the volume of the television'

(17) *l'insegnante alza il voto allo studente*
'the teacher raises the student's grade'

(18) *la temperatura si alza*
'the temperature rises'

(19) *le punture abbassano la pressione a Fabio*
'the injections lower the pressure'

(20) *il prezzo si abbassa*
'the price drops'

(21) *la febbre sale*
'the fever rises'

(22) *il numero di malattie sale*
'the number of diseases rises'

(23) *l'affitto sale*
'the rent rises'

(24) *il valore della moneta scende*
'the value of the currency goes down'

(25) *la frequenza delle piogge scende*
'the rain frequency is decreasing'

(26) *l'inflazione scende*
'inflation drops'

As the examples show, Italian speakers frequently resort to the verticality domain to express the same semantic concept related to the quantity domain in a wide range of contexts. The metaphorical transfer is possible since each of the action verbs used in the listed expressions has: (i) the vertical orientation schema as the focal domain of its primary and physical meaning; (ii) the scale image schema as the semantic core in its secondary and abstract sense. As a matter of fact, the four Italian predicates used in their marked variation in these examples share a common metaphorical type, which is characterized by the same underlying conceptual mapping, the same equivalent verbs (*aumentare* or its opposite *diminuire*), and the same image schemas.

The metaphorical process we propose to explain the examples in (16)–(26) includes the following steps: (i) the verb always modifies a [value], which is conceptualized as a [concrete entity]; (ii) the scale within which the [value] increases or decreases is projected onto the vertical orientation schema; (iii) the result of the action consists of a metaphorical dislocation or self-propelled motion of the [value] along the metaphorical vertical axis. Moreover, it is worth pointing out that isomorphism exists between the structure of the abstract events named in (16)–(26) and the structure of the concrete events demonstrated by the same verbs when they are used in their physical sense. In the examples shown in (16)–(20), the event structure focuses on the endpoint component of the Motion schema, since the salient feature is that the [trajector] assumes a different (higher/lower) location after the event is accomplished. In the instances in (21)–(26), the event structure is not focused on the event result, but, rather on the process itself, namely the oriented movement of the [trajector] along an imaginary [path/scale].

Furthermore, the identification of the image schemas involved enables us to better understand the restrictions on the application of the abstract concepts and to highlight the metaphorical potential of action verbs. As a matter of fact, in this specific case, our model can account for the reason why the use of the verb *sollevare* (*to lift*) is not allowed within this specific metaphor, although it is largely equivalent to *alzare* (to raise) as for its Primary Variation. What keeps *sollevare* from linguistically codifying the conceptual metaphor MORE IS UP (and its variants) is that its semantic core does not belong to the Spatial/Motion group, but to the Force group. We will examine this in further detail in the next section.

4.3 The case of *sollevare*: Image schema constraints

As we have just claimed, the verb *sollevare* cannot evoke the common orientational metaphor based on the mapping between the verticality and the quantity domains. We suggest that this is the case because of the semantic properties of this verb, which generate constraints as to its applicability. If we look at the possible actions described by the primary variation of *sollevare*, we notice that they always refer to events that contain the image schema *restraint removal*, which is part of the Force group. This schema is triggered by the fact that the theme of *sollevare* must have [weight], which is actually a gravitational restraint. For instance, Table 1 shows that *alzare* and *sollevare* are equivalent in type 1 (*Mario alza/solleva una scatola*), but not in type 2 (*Mario alza l'asta del microfono*): while the gravitational restraint is evident in the former case, there is no [weight] that restricts upward movement in the latter.

In a study on the applicability of these two verbs to different action types, Moneglia (1998) noted that *sollevare* can never be used to refer to events in which there is zero gravity, as in (27):

(27) # *l'astronauta solleva una scatola nella stazione spaziale*[9]
'the astronaut lifts a box in the space station'

By contrast, the verb *alzare* is applicable in this case. In Moneglia's account, the reason of this is that the meaning of *sollevare* contains the necessary component [removal of the gravitational steady state of the object]. This means that we cannot use *sollevare* to refer to an event in which someone raises an object that has no [weight] to a higher position.

Given this frame, what are the direct consequences for the metaphorical potential of this verb? The marked variation of *sollevare*, as has been suggested on the basis of the IMAGACT corpus, shows two main metaphorical types, each represented by a *best example*, i.e., an example chosen from among others in order to represent the whole metaphorical type:

(28) *il cinema solleva dai problemi*
'cinema is a source of relief'

(29) *Marco era molto sollevato*
'Marco was very relieved'

Example (28) points to a situation in which something or someone makes someone else feel less sad or burdened. Here, the cinema affects a generic (implicit)

9. We use the symbol # to mark the non-acceptability of a sentence from the point of view of semantic competence (in contrast to *, which represents an agrammaticality judgement).

patient, relieving him from his initial state. This scene could be conceived of as a situation in which something (such as a heavy object) affects another participant in the event (i.e., the patient), constraining his/her physical and (on a more abstract level) emotional state. This metaphorical mapping specifically allows the activation of the restraint removal image schema, and, consequently, proves the applicability of the verb *sollevare*. Example (29) is quite similar to the previous one (someone starts to feel better): in both cases, relieving problems or worries is equated to the removal of a condition that anchors the subject to something heavy. The main difference is that the latter example does not express the entity that causes the change of state. In a CMT scenario, one could analyze these expressions by referring to the specific conceptual metaphors PROBLEMS/WORRIES ARE HEAVY OBJECTS, tied up with the most general ones HAPPY IS UP/SAD IS DOWN and HELPING IS RAISING/HARMING IS LOWERING.

4.4 Fictive vs. factive motion

The Italian verbs *salire* (*to rise*) and *scendere* (*to descend*) describe a movement along the vertical axis. As the IMAGACT ontology shows, *salire* can refer to four main dynamic events: (i) type 1, a gradual and continuous upward movement, e.g., by means of an elevator, steps, or along a slope (30)–(31); (ii) type 2, a discrete upward movement performed by raising the foot and setting it down to move up something (32)–(33); (iii) type 3, an upward climbing movement (34)–(35); (iv) type 4, an upward movement of unanimated objects or substances (36)–(37).[10]

(30) *Fabio sale le scale*
'Fabio climbs the stairs'

(31) *Fabio sale per il sentiero*
'Fabio climbs along the path'

(32) *Fabio sale sulla sedia*
'Fabio climbs on the chair'

(33) *Fabio sale sul cavallo*
'Fabio climbs on the horse'

(34) *Marta sale sull'albero*
'Marta climbs the tree'

10. Once again (see Table 1 and the subsequent discussion), the action categorizations in Italian and in English are not equivalent. While the Italian language uses the same predicate to express the four motion types, English language selects different lemmas and constructs (*to climb, to climb on, to rise*).

(35) *Marta sale la parete rocciosa*
'Marta climbs the rock wall

(36) *le bolle salgono in superficie*
'bubbles rise to the surface'

(37) *il palloncino sale*
'the balloon rises'

With respect to *salire,* the verb *scendere* shows similar action types, but opposite direction, i.e., [down]. When *salire* and *scendere* are not used in their literal sense, they produce a broad range of metaphors related to several kinds of abstract concepts, e.g., comparisons (MORE IS UP/LESS IS DOWN), emotions (HAPPY IS UP/SAD IS DOWN), and states (STATES ARE LOCATIONS). In addition, the two verbs can activate a different and particular kind of extension, which has been called *fictive motion* (Talmy 1983, 1996; Matlock 2004).[11] Fictive motion is a linguistically pervasive phenomenon, in which the motion of an object through space is entirely simulated. As a result, the semantics of the verb elicit the simulation of mental movement along an imaginary trajectory, even though the verb depicts a static scene. In this respect, within the IMAGACT corpus, we found a wide variety of representative sentences. Below, we present a brief list, extracted for uses of *salire* and *scendere* that belong to the framework of fictive motion:

(38) *la strada sale*
'the road goes up'

(39) *la linea sale*
'the line goes up'

(40) *la scala sale al piano di sopra*
'the ladder goes up'

(41) *la linea scende sul foglio*
'the line descends along the paper'

(42) *la linea del collo scende*
'the neck line goes down'

(43) *la cucitura scende lungo i pantaloni*
'the stitching moves down along the pants'

(44) *il guinzaglio scende lungo i pantaloni*
'the leash hangs down beside the pants'

11. Talmy (1983) uses the term *virtual motion*. Other terms have been coined: *abstract motion* in Langacker (1986), *subjective motion* in Matsumoto (1996).

(45) *la stoffa scende dalla manica*
'the cloth comes down from the sleeve'

Sentences (30)–(37) reflect the more common action schema referred to by *salire* and *scendere* in their primary variation, namely a continuous movement in physical space. The potential for motion (which is an intrinsic component of the semantics of *salire* and *scendere*) is the exact reason why we can trace the path of a continuously moving object here (38)–(45) and allow the transformation from a real motion schema (*Fabio sale le scale*) into a fictive one (*La scala sale al piano di sopra*). This is to say that the potential for motion, shared by these two verbs, enables the conceptualization of the scene, involving a sort of implicit type of motion. In fact, to be correctly represented, the scene requires the conceptualizer to mentally simulate a movement along a path, from its starting point to its endpoint.

Image schemas identification enables us to display how the schema is projected from the primary variation to the marked variation of a verb. In all the cases above, the prominent spatial component is length, causing the object to be perceived as an extended object (*la strada*, *la linea*, *la cucitura*, *il guinzaglio*). In the metaphorical interpretation, this extended object acts like a [trajector] moving along a path (strictly corresponding to its actual length; e.g., *sul foglio*, *lungo i pantaloni*) in a certain direction, i.e., [up] or [down]. The presence of an endpoint (e.g., *al piano di sopra*) or a starting point (e.g., *dalla manica*) is optional.

Interestingly, the phenomenon of fictive motion concerns only the marked variation of *salire* and *scendere,* but not those of the other vertically oriented verbs that we have investigated (*abbassare*, *alzare* and *sollevare*). We could argue that the main reason lies in the activation of an inherent property of *salire* and *scendere* (and of all the pure Motion verbs), namely the path image schema. This same property, happens to impinge on the event structure as well. *Salire* and *scendere* focus on a different event time point than the other action verbs: they do not encode the resulting state of the object, as in *abbassare*, *alzare,* nor the initial state of the event, as in *sollevare*. Rather, they apply to the process of Motion itself.

By contrast, the path schema is not a focal property of the semantic core of *abbassare*, *alzare* and *sollevare*. This is shown by the non-applicability of a linguistically explicit path 'marker' in the coreferential types among *alzare* and *salire*, i.e., in the action type instantiated by Example (4). As a matter of fact, expressing the path schema by means of an explicit constituent generates the non-acceptability of *alzare* in (46) and (47), while the use of verb *salire* is appropriate in both examples:

(46) *la bandiera sale/#si alza lungo l'asta*
'the banner rises along the pole'

(47) *il palloncino sale/#si alza lungo il grattacielo*
'the balloon rises along the skyscraper'

As in the cases analyzed above, fictive motion requires that specific semantic properties of the verb be expressed. The emergence of these focal semantic facets (i.e., path schema) explains why only two verbs of our set (i.e., *salire* and *scendere*) could be used to encode fictive motion, while the other ones (i.e., *alzare*, *abbassare*, and *sollevare*) do not possess this metaphorical repertoire.

5. Conclusion

The results of this study support the claim that a large number of abstract concepts are grounded in our physical and spatial experience of the world. Our interaction with the space that surrounds us is related to shared sensory motor processes, which screen external inputs and provide us with information about our body and other physical entities. Action verbs encode this information and label the types of movements that we perform with our body and the types of actions that we engage in with the objects around us. Moreover, action verbs do not only encode concrete meanings, but also develop abstract ones. They constitute linguistic anchors which make clear how the realm of sensory-motor experience is mapped to the conceptual realm and how this gives structure to the representation of highly abstract concepts. Hence, the analysis of the marked variation of action verbs contributes to an enhanced understanding of the way in which we transfer information obtained by means of our bodily interactions to our language. In particular, the analysis of the image-schematic structure of the semantics of these predicates provides us with precise details on the processing of abstract concepts in natural language.

This study started with the analysis of a cohesive group of five Italian verbs within the verticality domain (*abbassare, alzare, salire, scendere*, and *sollevare)* and showed that, in some cases, these predicates could be applied in the same pragmatic contexts as equivalent verbs, e.g., in Example (1) (*alzare/sollevare una scatola*). Nevertheless, these verbs do not share the same inner semantic structure. Verb meaning contains semantic features which constrain and, consequently, determine the type of event that the verb itself can refer to. For instance, the verb *sollevare* only applies to contexts in which the theme has [weight], while all the other verbs have verticality features as necessary components, i.e., [up/down] orientation. As we have seen, *sollevare* cannot be applied to events in which gravity does not constitute a focal semantic property. We could argue that, in the case of *sollevare*, vertical movement is just a contextual property, since upwards motion is always required to overcome gravity and to remove the stationary configuration of an object. Upwards motion is not, however a sufficient condition for the use of *sollevare*.

As our analysis suggests, the three 'classes' that we identified tend to focus on different time points of the event in question. *Alzare* and *abbassare* focus on the resulting state of the object, i.e., on the endpoint component of the Motion schema, since the salient feature is that the [trajector] assumes a different (higher/lower) location after the event is completed. *Salire* and *scendere*, on the other hand, focus on the Motion process itself, on the path followed by the [trajector] during the event. *Sollevare* does not focus on Motion at all, but rather on a necessary property of its object in the initial state of the event: it has a [weight], which currently forms a restraint that is going to be removed.

Our study does not only show that the link between our conceptual and perceptual systems is real, but above all how our semantic competence, especially that relating to the use of action verbs, mirrors the way in which we build and shape metaphorical concepts. As a matter of fact, the differential semantic properties that characterize the five predicates in our analysis strictly reflect on their metaphorical potential. Although these local equivalent verbs partially share their marked extension, they do not encode exactly the same kind of metaphorical concepts. When there is a divergence in their semantic network, two questions automatically arise: First, how is it possible that some metaphorical concepts can be accessed by some verbs and not by others? Second, is it possible to determine the key operational factors in the metaphorical shift of the verb? In this paper, we showed that for a metaphor to be expressed in a specific context, the predicate must belong to specific schemas pertaining to that context. More specifically, given the basic meaning of a verb: (i) orientational metaphors are enabled by the presence of the vertical orientation image schema; (ii) fictive motion metaphors are enabled by the presence of the path image schema; (iii) the PROBLEMS ARE HEAVY OBJECTS metaphor is enabled by the restraint removal image schema.

Based on our analysis, we can draw up an application matrix demonstrating the relationship between the semantic verb classes and their metaphorical potential, as showed in Table 3.

Table 3. Metaphor application via image schemas

Metaphors	**Required image schemas**	**Verbs**		
		alzare abbassare	***salire scendere***	***sollevare***
Orientational metaphor	vertical orientation	+	+	–
Fictive motion	Path	–	+	–
PROBLEMS ARE HEAVY OBJECTS	restraint removal	–	–	+

The intersection of the semantic traits of the verbs and the schemas required to apply a metaphor led us to a model that is able to explain why, for instance, *salire/scendere* is the only pair that can generate fictive motion metaphors, whereas dislocation verbs such as *alzare/abbassare* cannot generate such metaphors. It also clarifies why *sollevare* does not extend to the common orientational metaphor mapping: its application requires the presence of the restraint removal schema. More generally, the analysis of semantic components and images schemas makes it possible to substantiate the usability of a verb within a certain metaphorical framework, and also to draw the limits and highlight the differences between (partially) equivalent words in terms of their actual applicability.

To conclude, our analysis confirms the Invariance Principle hypothesis, according to which metaphorical mapping is strictly constrained by the image schemas that are involved in the core meaning of a word. In Lakoff's own words (1993: 215), "metaphorical mappings preserve the cognitive topology (that is, the image- schema structure) of the source domain, in a way consistent with the inherent structure of the target domain."

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PART III

Abstract concepts in communication

Corpus analyses and spontaneous production of words referring to abstract concepts

CHAPTER 11

Abstract concepts in development

Spontaneous production of complex words in Swedish child language

Maria Rosenberg

For young children, grasping abstract concepts and words poses a challenge. This chapter reports a case-study in which I discuss the abstract concepts expressed by complex words (440 types) by a Swedish girl (1–3 years). The data show that complex adjectives expressing evaluative content emerged prior age 2. These types of adjectives might thus be one step towards the learning of abstract concepts. The child's novel compounds, combining concepts on several variables, are proof of her ability to gradually abstract away from perception-based reality. They can therefore be another means in the process of building abstract representation. In conclusion, this study confirms a view of abstract representation being built up gradually by relying on multiple factors such as linguistic, experiential, and contextual information.

Keywords: abstract concepts, conceptual combination, diary data, language development, Swedish child language, word-formation

1. Introduction

In contrast to concrete concepts that refer to spatiotemporally bound entities, entities referred to by abstract concepts are neither perceivable nor spatially constrained (Barsalou and Wiemer-Hastings 2005). However, concepts vary along a continuum, ranging from more concrete to more abstract (Wiemer-Hastings et al. 2001). Concrete concepts, which pick out entities that share intrinsic properties, call upon experiential information, whereas abstract concepts, which pick out relational patterns, or extrinsic properties, have a less clear relation to embodied experience (Jamrozik et al. 2016). Hence, abstract concepts pose a challenge to embodied accounts that share "the core assumption that the representation and processing of semantic information recruit the same neural systems that are

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engaged during perception and action" (Kousta et al. 2011: 23). Still, different embodied accounts arguing for a multiple representation that combines sensorimotor, emotional, and linguistic information have been proposed for abstract concept representation.

For young children, the learning of abstract words and concepts presents a challenge (Maguire et al. 2006; Bergelson and Swingley 2013). Whereas concrete referents can be detected through joint visual attention, abstract words have few correlated perceptual cues such as shape, size, color, movement, etc. (e.g., *ball* vs. *idea*). Abstract words are thus acquired later than concrete words, and their mastering is not achieved until adolescence (Schwanenflugel 1991; Caramelli et al. 2004).

Lynott and Connell (2010; Connell and Lynott 2011) advance a theory of embodied conceptual combination (ECCo). Their theory, which largely agrees with Barsalou and Wiemer-Hastings (2005) and Kousta et al. (2011), assumes that linguistic, perceptual, motor, affective, introspective, and social experiences interact in complex ways when combinations of concepts (abstract and/or concrete) are constructed or interpreted.

The objective of the present study, based on diary data from a Swedish child, is to trace the emergence and development of complex words that involve abstract concepts. Morphologically complex words are here delimited to word formations consisting of two or more parts, such as compounds, combining two lexemes, or derived formations that can be split into a lexeme plus one or more affixes. The way the child deals with combined concepts in spontaneous speech in the diary data was assumed to reveal details about the development and representation of abstract concepts and words. More specifically, the following research questions were investigated: (i) To what extent do the complex words that involve abstract concepts reflect affective and sensorimotor information? (ii) What is the relation between the novel complex words and the perceptually available reality?

The chapter is organized as follows. The theoretical background is presented in Section 2, and the diary data in Section 3. The qualitative analysis of the complex words attested in the data is provided in Section 4, followed by some concluding remarks in Section 5.

2. The grounding of abstract concepts

Concrete words have a cognitive advantage over abstract words (the concreteness effect), as evidenced *inter alia* by faster lexical processing (cf. Altarriba et al. 1999; Kousta et al. 2011). Two influential accounts that explain this effect both assume that concrete words have a richer representation compared to that of abstract words. The dual coding theory (Paivio 1986) suggests that concrete concepts rely on a verbal, language-like code as well as an imagery code, whereas abstract concepts rely solely on the verbal code (see Bolognesi and Steen 2018 for a recent debate on this issue). The context availability theory (e.g., Schwanenflugel and Shoben 1983) assumes that both concrete and abstract concepts are represented in the verbal system, but that abstract words are much more dependent on context for their understanding compared to concrete words. However, if appropriate contexts are provided for abstract words, they are understood as easily and quickly as concrete words.

Contextual constraints are thus more critical for abstract concepts than for concrete concepts (Schwanenflugel 1991, Barsalou and Wiemer-Hastings 2005; Zwaan 2016). In order to account for variations in abstractness (cf. Altarriba et al. 1999), Wiemer-Hastings et al. (2001) propose that abstract concepts relate to particular events or circumstances in a situation that constrain their application. In other words, a lack of contextual constraints tends to imply a high degree of abstractness, whereas abstract concepts that are constrained by concrete objects or situations are likely to be judged as less abstract.

Assuming that conceptual processing activates modality-specific systems (Barsalou et al. 2003), a concept can be seen as a simulator, that is, as “a distributed collection of modality-specific memories captured across a category’s instances” (2003: 88). Hence, both concrete and abstract concepts depend on situational content, but while concrete concepts focus on objects and their properties within situations, abstract concepts focus on event and introspective properties that are distributed across situational content (Barsalou and Wiemer-Hastings 2005). When people are asked to give unconstrained information about a concept (concrete or abstract), they tend to retrieve and describe different situations in which the concept has occurred or can occur. The situations display various content (e.g., entity, setting, event, introspective, personalized) that stems from individualized interactions with instances of the concept (Barsalou and Wiemer-Hastings 2005; see also, Chapters 1, 2, 4, and 5 in the present volume that present different accounts on the grounding of abstract concepts).

Barsalou emphasizes that abstract concepts “constitute a major challenge for all theories” and that our theoretical understanding of them is “shockingly modest” (2016: 1136). Because they have a multifaceted character and are heavily dependent on language as well as on background situations, we might learn more about abstract concepts if we study a few of them more deeply and in specific situations (Barsalou 2016).

2.1 Abstract and internal state words in language development

Knowing the meaning of a word implies having a representation of a concept that is paired to a form (Bloom 2000). However, it is important to bear in mind that words are arbitrary and do not necessarily straightforwardly reflect concepts (Borghi et al. 2014: 11). As Gentner and Boroditsky point out, the meaning of an abstract word is "linguistically embedded" (2001: 216). Although children often use abstract words (e.g., *uncle*, *know*) at an early age, they do not have a full, adult-like understanding of them (Wellman et al. 1995; Maguire et al. 2006). The learning of abstract words requires linguistic, cognitive, and social skills that evolve over time (Maguire et al. 2006; Bergelson and Swingley 2013; see also Wauters et al. 2003).

Words for emotional states emerge early, around 20–24 months (e.g., *happy, sad, mad*, *scared*), and children as young as 2 years understand emotions as inner states of persons (and of pretend subjects) (Wellman et al. 1995). An order of acquisition of words for internal states was traced in Bretherton and Beeghly's (1982) study of 30 children at age 28 months. Overall, terms for volition, physiology, and perception were the most common, words for affect and moral obligation came next, and finally, common cognition words appeared (Bretherton and Beeghly 1982; as also confirmed by Wellman et al. 1995). Between ages 2 to 5 years, both the stock of emotion terms and the complexity of emotion utterances increase (Wellman et al. 1995).

In the work of Caramelli, Setti, and Maurizzi (2004), knowledge about concrete and abstract concepts was elicited from children aged 8–12. Their study proposed that concrete concepts mainly activate physical characteristics or qualities of objects (i.e., intrinsic properties) and thematic relations to objects co-occurring in the same event or situation (i.e., extrinsic properties), whereas abstract concepts mainly activate thematic relations. In their study, taxonomic relations were activated to a minor extent for both types of concepts. Their finding confirmed previous studies (e.g., Wiemer-Hastings et al. 2001) indicating that abstract concepts are characterized by situational information and contextual constraints that are gathered from experienced events (e.g., 'sadness' evokes information about situations that make people sad rather than taxonomic information of 'sadness' being an emotion) (Caramelli et al. 2004: 21).

In the theory of Kousta et al. (2011) (see also Vigliocco et al. 2013), concepts are grounded in linguistic and experiential (sensory, motor, and affective) information. However, whereas sensorimotor information is central for concrete concepts, both linguistic and affective information (introspective, social, and event) are central for abstract concepts. Kousta et al. (2011) provide evidence of an abstractness effect in which words with affective associations (positive or negative) are processed faster than words with a neutral association. This finding lays the foundation for their theory, which holds that abstract concepts can be grounded in affective information. Seeing that emotion words emerge before age 2 (Bretherton and Beeghly 1982; Wellman et al. 1995), such words can bootstrap the acquisition of abstract representation (Kousta et al. 2011).

2.2 Embodied conceptual combination in language development

Conceptual combination (of which noun-noun compounding is one expression) builds on cognitive processes to create and understand "new meanings from old referents" (Lynott and Connell 2010: 1). In the ECCo theory (Lynott and Connell 2010; Connell and Lynott 2011), conceptual combination reconciles linguistic distributional information (e.g., knowledge of lexical associates) with embodied information (in which perceptual information is central). The linguistic distributional information system is optimal for quick superficial judgment, while the simulation system is optimal for deeper conceptual processing (cf. Barsalou 2016; Zwaan 2016). In conceptual combination processing, both systems interact to enhance the likelihood that the two concepts will be successfully meshed (Connell and Lynott 2011). The new combined concept is thus a situated, simulated entity that depends on a wider context for its interpretation (Lynott and Connell 2010; cf. Barsalou et al. 2003).

Two basic types of interpretation processes for conceptual combinations are proposed in the ECCo theory – destructive (i.e., one or both concepts are reduced, e.g., a *cactus beetle* being a spiky beetle) and non-destructive (i.e., both concepts remain intact, e.g., a *cactus beetle* being a beetle that eats cacti) (Lynott and Connell 2010; Connell and Lynott 2011). Because it would be easier to process combinations of two intact concepts, destructive interpretations are predicted to be slower.

Lynott and Connell (2010) suggest a developmental trajectory that builds on previous studies (e.g., Gottfried 1997; Krott et al. 2010) that explore children's comprehension of novel compounds.[1] According to this trajectory, young children (age 3 and younger) prefer to combine two intact concepts. By the age of 3, children often still have difficulty in interpreting compounds where one of the concepts is extensively reduced (e.g., *zebra shells* for shells with black-and-white stripes) or can exist only potentially (e.g., a *baby bottle* does not require the presence of a baby in the context of the utterance) (Lynott and Connell 2010). Hence, future studies should investigate "the factors that enable children to develop their destructive combination skills" (Lynott and Connell 2010: 13).

2.3 Word-formation in language development

Language acquisition is a gradual process. Young children analyze complex words both as wholes and as consisting of parts, and by gradually starting to combine

1. Braisby, Dockrell, and Best (2001) emphasize that children need to use new words in different contexts in order to exhibit lexical knowledge. Experimental settings concerned with comprehension might therefore reflect only selected parts of children's lexical knowledge.

parts they acquire word-formation patterns (Elsen and Schlipphak 2015). In this process, children draw on analogical reasoning and previous knowledge about word meanings and forms, as well as on general organizing tendencies (Clark 2016; Dressler et al. 2003; Krott 2009). When children actually start to create novel compounds, they master the basic compound structure of head and modifier (Nicoladis 2007; Dressler et al. 2010). A more difficult task for children is to grasp the semantics of complex words, such as the semantic relation between the two concepts in a compound.

In Swedish, compounding, in particular noun-noun (NN) compounding, is a frequently used word-formation pattern, but derivation (prefixation and suffixation) is also available.[2] Many objects and activities in the daily life of Swedish children are expressed through complex words (e.g., *förskola* 'before-school' and *dagis* 'day-*is*', a short form of *daghem* 'day-home', both of which are used to refer to 'pre-school').

High token frequency in the input is an influential factor for early emergence in children's production (cf. Dressler et al. 2003; Berman 2009; Elsen and Schlipphak 2015). Children that acquire languages such as English or Swedish, where compounds frequently occur in the input, start to produce novel compounds already around age 2 (Becker 1994; Mellenius 1997). A view that is complementary to the focus on frequency of occurrence in the input is Elbers' (2000) output-as-input hypothesis. This hypothesis proposes that the child's own output is central for their linguistic analysis. For the aim of the present study, this hypothesis is taken to assume that young children can produce forms filled with some idiosyncratic meaning, but will, progressively, grasp a richer meaning of the underlying concept. It can also be extrapolated from the hypothesis that children might use strategies for self-stimulation and scaffolding in their language development. This latter assumption is in keeping with abstract words serving as pointers in memory that activate sensorimotor representations if the context is sufficiently rich (Zwaan 2016) and/or with abstract concepts starting out as underspecified placeholders (Jamrozik et al. 2016).

3. Diary data

Spontaneous production data can add detailed, qualitative aspects of children's language development that complement experiment-based data. Diary data have several strengths, especially when it comes to the earlier stages of language

2. Compounds in Swedish are right-headed, have a particular prosodic contour, can include liaison forms, and are written as one word.

development. Such data can, for instance, capture infrequent items, such as novel words and internal state language, and they permit a rich interpretation of the child's utterances, in which context and deep familiarity with the child and their daily life are also considered (Bretherton and Beeghly 1982). As Elsen and Schlipphak remark: "Only thorough diary studies provide us with a sufficient number of examples [i.e., of creative word-formation], but this sampling method is out-of-date. Thus, the data base for word-formation in language acquisition is meager" (2015: 2118).

Diary data can be judged as reliable (Bretherton and Beegly 1982), although their validation would have to be obtained through other methods. Wellman et al. (1995), aware of the fact that systematic sampling of natural language often contains limited instances of children's emotion language, consider extended, longitudinal recordings of children's speech to be the optimal method. However, there are few if any longitudinal data of this type available in Swedish.

The present study is thus based on spontaneous production data. The data for this study were gathered by the author through diary notes from her typically developing, monolingual Swedish child (F) with three older brothers (five, seven, and nine years older). The data consist of various utterances produced in daily settings between the ages of 1;9 and 3;6. The utterances were noted down immediately on computer or paper, mostly regularized to normal spelling but keeping non-target-like features. Contextual and semantic information, as well as age specification (year;month;day, e.g., 1;9;21), were included along with the utterances.

For the present study, the diary notes were searched manually in order to extract all complex words produced by the child. A total of 440 different complex words (612 tokens) were attested. Of these 440 types, 295 were novel and 231 were NN compounds. The complex words were then analyzed qualitatively in order to trace the development of abstract concepts and representation as expressed by those words.

4. Analysis

The qualitative analysis consists of two parts. The first part deals with the child's abstract complex words that reflect affective and sensorimotor information. The second part accounts for the child's novel complex words and their relation to perception-based reality. Asterisks (*) are used to mark non-adult-like formations.

4.1 Abstract complex words reflecting affective and sensorimotor information

The data reveal one noteworthy evaluative word-formation pattern involving an adjective preceded by an intensifying item, *jätte-* 'very' (lit. 'giant').[3] The pattern [*jätte*-A]$_A$ emerged at age 1;9 and expresses sensorimotor or affective, introspective content. As shown in Table 1, the child combined this augmentative item with 30 different adjectives, two adverbs (*-mycket* 'much', *–fort* 'fast'), one pronoun (*-många* 'many'), and one novel noun (-**host*$_N$ 'cough', the correct target would be –*hostning*$_N$ 'cough') to convey experience-based evaluations about things and situations on several occasions. Table 1 also shows the classification of these complex words according to whether they convey sensorimotor content (perceivable, e.g., heat, pain, quantity) or affective content. The affective content is split into three labels – positive (e.g., joy, excitement), negative (e.g., anger, fear, disgust), and neutral (e.g., surprise) (cf. Tomkins' 1984 affect theory). The first occurrence of each type is shown in Table 1.

Table 1. The 34 complex words containing *jätte-* 'very'

Sensorimotor	**Affective, introspective**		
	Positive	**Negative**	**Neutral**
jättevarmt (1; 9; 8) 'very-hot'	*jättefin* (1; 9; 26) 'very-fine'	*jättefarligt* (1; 10; 1) 'very-dangerous'	**jättefärdigt* (2; 2; 2) 'very-done'
jätteblöt (1; 9; 18) 'very-wet'	*jättegott* (1; 10; 9) 'very-yummy'	*jätteäckligt* (2; 0; 7) 'very-disgusting'	*jättetokig* (3; 6; 20) 'very-crazy'
jätteont (1; 10; 1) 'very-painful'	*jätteskönt* (2; 0; 0) 'very-comfortable'	*jättedum* (2; 0; 20) 'very-mean'	
jättehalt (1; 10; 7) 'very-slippery'	*jättesöt* (2; 0; 0) 'very-cute'	*jättejobbigt* (2; 0; 22) 'very-laborious'	
jättemycket (2; 0; 23) 'very-much'	*jättebra* (2; 1; 22) 'very-good'	*jättesvårt* (2; 9; 21) 'very-difficult'	
jättekissnödig (2; 1; 1) 'very-pee-needing'	**jättebättre* (2; 2; 3) 'very-better'	*jätteläskig* (3; 0; 14) 'very-scary'	
jättesnabb (2; 1; 4) 'very-quick'	*jättesnäll* (2; 2; 17) 'very-kind'		
jättemånga (2; 1; 8) 'very-many'	*jätteduktig* (2; 9; 9) 'very-good/able'		

3. In contemporary Swedish, *jätte-* can either be classified as a prefix or a combining form the present study takes no stance on this issue. Note also that adjectives ending in –*t* can function as adverbials in Swedish.

Table 1. (*continued*)

Sensorimotor	**Affective, introspective**		
	Positive	**Negative**	**Neutral**
jättetörstig (2; 2; 17) 'very-thirsty'			
jättekallt (2; 2; 18) 'very-cold'			
jättestor (2; 4; 9) 'very-big'			
jättefort (2; 5; 11) 'very-fast'			
jättemörkt (2; 6; 11) 'very-dark'			
jättetrångt (2; 9; 15) 'very-tight'			
**jättehost*$_N$ (2; 11; 4) 'giant-cough'			
jättehög (3; 0; 24) 'very-high'			
jättetung (3; 5; 26) 'very-heavy'			
jättetjock (3; 6; 20) 'very-thick'			

We see that the complex adjectives expressing sensorimotor content appear slightly before those expressing positive or negative affective content, whereas the complex adjectives conveying a neutral content are rare and appear at a later age. This piece of evidence is thus in keeping with previous studies (Bretherton and Beeghly 1982; Wellman et al. 1995; Kousta et al. 2011) that suggest that affective abstract words appear earlier than neutral abstract words. However, few of these complex words with introspective content refer strictly to emotions. Instead, they express subjective evaluations. In language development in general, adjectives are acquired later than nouns (e.g., Booth and Waxman 2009). This fact depends partly on the greater conceptual complexity of adjectives compared to that of nouns because adjectives denote properties, often gradable ones, instead of object categories (cf. Tribushinina et al. 2015). The grammatical category of adjectives could thus be argued to lie at the abstract end of the concrete-abstract continuum. Adjectives, and complex adjectives in particular, can thus constitute a stepping stone for children to get hold of abstract representation.

Three of the early utterances below (1)–(3) contain the bare adjective immediately followed by a combination with the augmentative *jätte-*. These cases could be interpreted as involving a strategy of self-stimulation and scaffolding in the child's language learning. At an early stage, the child starts by retrieving a single adjective, and then she constructs the more complex item by adding *jätte-*. Having done so a couple of times, she might progressively grasp that there is a difference in meaning between the bare adjective and the combined one. Still, it is not possible to claim that she fully understands the abstract, augmentative value of *jätte-*. Furthermore, the utterances below show that the child uses the adjectives both to describe concrete objects and particular situations:

(1) *blöt, jätteblöt* (1;9;18) (1;9;22)
'wet, very-wet' (her socks)

(2) *ont, jätteont* (1;10;1)
'painful, very-painful' (has hurt her hand)

(3) *är halt, är jättehalt isen* (1;10;7)
'is slippery, is very-slippery the ice'

(4) *äta bebisgröt, jättegott, jättegott* (1;10;9)
'eat baby-porridge, very-yummy, very-yummy'

(5) *är det jättejobbigt?* (2;0;22)
'is it very-laborious?' (she asked when I needed to pick up small things that were spread out)

In the data, there are two non-target-like coinages (6)–(7) produced by the child within the same week, probably due to overgeneralization of the [*jätte*-A] pattern. These coinages indicate a mismatch between form and semantics. The child does not seem to realize that the semantics of the single, abstract adjectives makes them impossible to combine with the augmentative item:

(6) *är *jättefärdigt* (2;2;2)
'very-done' (done with filling water into the porridge)

(7) *mamma spillde *jättebättre* (2;2;3)
'mommy spilled very-better' (i.e., I spilled more milk than she did)

The utterances (8)–(13) produced later on, between ages 2 to 3, are more elaborated. They seem to point towards an experience-based grounding of the complex adjectives, seeing that they refer to situations or typical objects exhibiting or evoking these properties. In this respect, they provide support for accounts suggesting that abstract concepts depend on distributional linguistic representations as well as situational information that derives from experience (Wiemer-Hastings et al. 2001; Caramelli et al. 2004; Lynott and Connell 2010; Barsalou 2016; Zwaan 2016).

(8) *elak mamma, du är jättedum* (2;0;20)
'mean mommy, you are very-mean' (because I do not want to give her a carrot after she has brushed her teeth)

(9) *det är jättefarligt, knivar* (2;2;17)
'it is very-dangerous, knives'

(10) *gör jätteont i Berna* (2;2;17)
'does very-painful in Berna' (it would hurt Berna very much if a mosquito were to bite her)

(11) *det är mörkt ute, jätte- jättemörkt, det är illmonstret där ute* (2;6;11)
'it is dark outside, very- very-dark, it is the evil-monster there outside'

(12) *jag är jätteduktig på att laga saker, jag är jättebra på att laga saker* (2;10;5)
'I am very-good/able at repairing things, I am very-good at repairing things'

(13) *spöken är jätteläskiga, de är ruskiga och hemska* (3;0;14)
'ghosts are very-scary, they are shivery and terrible'

The Examples (8), (12), and (13) are noteworthy in that they show that the child spontaneously uses synonyms (something that she does on other occasions as well). This phenomenon could be interpreted as yet another type of self-stimulation strategy that actually favors her learning and structuring of lexical associations between words and concepts (abstract and concrete).

In addition to the *jätte*-cases, there are 29 complex words that involve abstract, evaluative properties of objects or situations, mostly concrete ones. The Examples (14)–(16) could be analyzed as a nearly sensorimotor-like (or iconic) grounding of quantity. The first two examples make use of non-target-like reduplication. The last example again contains *jätte*- and is accompanied with a reinforcing gesture:

(14) * *tungt tungti tungti tungti* (2;0;9)
'heavy heavy-*i* heavy-*i* heavy-*i*' (i.e., very-heavy)

(15) * *onti onti* (2;0;20)
'aching-*i* aching-*i*' (i.e., very aching)

(16) *mamma, jag drömde drömmar, jag drömde jättemycket drömmar, så här jättemycket* (3;5;15)
'mommy, I dreamt dreams, I dreamt very-much dreams, like this very-much' (she spreads her arms wide)

Apart from the *jätte*-pattern, an additional, evaluative construction pattern, [N-*is*], is frequently attested in the data. The productive Swedish suffix –*is* can attach to nouns and adjectives, and it usually has a naming function (Mellenius 2003: 91). Some highly frequent words in the input of Swedish children contain this suffix (e.g., *godis* 'good-*is*', i.e., candy, as well as the aforementioned *dagis* 'pre-school'). Consequently, Swedish children coin complex words with –*is* to denote familiar entities, signaling an affective evaluation. The 11 formations in the data mostly concern her toys, such as:

(17) *mammis* (1;10;13) (*mamma* + *is*)
'mommy-*is*'

(18) *bollis* (2;11;13)
'ball-*is*'

(19) *kaninis, kattis, hundis* (3;4;11)
'rabbit-*is*, cat-*is*, dog-*is*'

(20) *nallisbjörnis* (3;4;12) (*nalle* + *is*)
'teddy-*is*-bear-*is*'

(21) *grodis* (3;4;21) (*groda* + *is*)
'frog-*is*'

(22) *ankis* (3;4;29) (*anka* + *is*)
'duck-*is*'

(23) *blommis* (3;5;26) (*blomma* + *is*)
'flower-*is*' (for a toy pony with a flower print)

This use of –*is* could probably be analyzed in analogy with small children's diminutive formation, explained as being "more iconic than other morphological rules" (Dressler and Barbaresi 1994: 408). By using such words, children add a positive, abstract value to a familiar object. Another possibility would have been to use the ordinary, more neutral term.

The remaining 16 cases that involve evaluative complex words are of various types. All of them express introspective content insofar as they either attribute evaluative or imaginary properties to objects (24), (25), (31) or refer to imaginary situations (26)–(30). The earliest one (24) is produced before age 3, the other ones, such as (25)–(31), are produced after age 3:

(24) *favoritklossar* (2;9;15)
'favorite-blocks' (referring to her soft toy blocks)

(25) *nä, det var inte gröt som var <u>iskall</u>, det var mitt te* (3;0;11)
'no, it was not (the) porridge that was ice-cold, it was my tea'

(26) *mamma jag är* * *infången* (3;2;19)
'mommy I am in-trapped' (she pretends to be trapped in her play house)

(27) *nu är jag* * *badsäker* (3;4;13)[4]
'now I am bath-safe' (she feels ready to take a bath)

(28) *godismys* (3;4;22)
'candy-coziness' (she wants to have a cozy pretend picnic with her cake made of LEGO® blocks)

(29) *när man är* **innegjord*, *då kommer drömmarna när man sitter i en bur, och sen kommer drömmarna ut* (3;4;23)
'when one is in-made, then the dreams come when one sits in a cage, and then the dreams come out'

(30) *jag är* * *infast* (3;5;8) (3;5;16) (3;5;17)
'I am in-caught' (she pretends being caught by her toys)

(31) *kom nu lilla tomathund* (*är det en tomathund?* Undrar jag), *ja, han älskar tomater, kom nu lilla idiothund, kom nu lilla idiothund* (3;5;15)
'come now little tomato-dog (Is that a tomato-dog? I wonder), yes, he loves tomatoes, come now little idiot-dog, come now little idiot-dog' (she calls her big stuffed toy dog by different names in the same situation).

Finally, there is one utterance in the data that specifically addresses an emotion, namely *ledsen* 'sad'. Although there is no complex word involved here, the utterance is interesting in that it seems to indicate that the child grounds 'sad' in a more concrete situation (cf. Wiemer-Hastings et al. 2001; Barsalou et al. 2003; Barsalou and Wiemer-Hastings 2005). The utterance is introduced by a question that the child answers herself by providing a self-made definition (perhaps they had talked about emotions in preschool):

(32) *Mamma, vet du vad ledsen är? Ledsen är, när man är ledsen vill man inte leka, när man inte är ledsen då vill man leka* (3;5;8)
'Mommy, do you know what sad is? Sad is, when one is sad one does not want to play, when one is not sad then one wants to play'.

In sum, the complex words that involve subjective evaluation express both affective and sensorimotor content. They emerge early, already before age 2, and could, along the lines of Kousta et al. (2011) and Vigliocco et al. (2013), be seen as a possible path towards developing abstract representation. The child's contextual anchoring of these complex words, as shown in some of the examples above, fits

4. At age 4;1;30, she uses the more target-like word-formation *badfärdig* 'bath-ready' for a similar situation.

nicely with the view of concepts as memory storages of different interactions with instances of a given concept and bearing thematic relations to other objects or situations (Wiemer-Hastings et al. 2001; Barsalou et al. 2003; Caramelli et al. 2004).

4.2 Novel complex words and their relation to perception-based reality

The extent to which the child's novel complex words denote perceptually available referents or not is explored in this second part of the analysis. It thus indirectly addresses the hypothesis that "initially acquisition is mainly perceptual [enabling the learning of concrete terms], later it is mainly linguistic [enabling the learning of abstract terms]" (Borghi et al. 2014: 3; see also Wauters et al. 2003). The child's novel NN compounds are first investigated in relation to Lynott and Connell's (2010) developmental trajectory of conceptual combination, highlighting the role of perception. Recall that this trajectory stipulates that children start to combine two intact concepts (both being perceivable and present in the context of the utterance). Only later on do children become capable of combining two concepts where one is perceivable in the context and the other exists potentially or is much-reduced.

As will be shown below, the diary data do not lend support to this trajectory. If we look at the four very first novel compounds in (33)–(36), created by the child before age 2, none of them can be said to strictly combine two intact concepts. In (33) the concept of *baby* is abstracted and transferred to a dog. In (34) *baby* can be argued to exist potentially (porridge for babies). As to (35), *baby* and *daddy* are merged, and in (36) the concept of dog is reduced to a print on a diaper. Lynott and Connell (2010), leaning on Gottfried (1997), suggest that different types of reduction would be easier or more difficult to process. A concept reduced to a print would be easy because there are still many visual features left (as in (36)). Compounds where the modifier concept is reduced to a single visual feature (e.g., basic shape or pattern) would be difficult for 3-year-old children (but see (46)–(47) below):

(33) *bebishund* (1;9;11)
'baby-dog' (sees a picture of a puppy)

(34) *ja, ha* <u>*bebisgröt*</u> (1;10;09)
'yes, have baby-porridge' (for oatmeal porridge that she and her brothers eat for breakfast)

(35) *bebispappa* (1;10;13)
'baby-daddy' (sees a picture of daddy when he was a baby)

(36) *hundblöja* (1;10;20)
'dog-diaper' (for a diaper with a dog print)

Clearly, there are also novel compounds among the earliest ones, where both concepts are intact and observable in the situation of the utterance, such as:

(37) *ostbit* (1;10;13)
'cheese-piece', (wants a slice of cheese)

(38) *päronbitar* (1;10;20)
'pear-pieces' (normally, she wants apple-pieces)

(39) *det är min yogisglass* (1;11;13)
'that is my yog(urt)-*is*-ice cream'

(40) *duschbad* (1;11;28)
'shower-bath' (a bathtub with shower)

However, among the novel compounds produced after age 2, there are additional examples, such as (41)–(42), indicating that she has grasped the fact that novel compounds can combine concepts where one of the concepts does not need to be present in the context of the utterance. The utterance in (43), produced after age 3, manifests that the child in fact interprets the conceptual combination according to this parameter:

(41) *soppasked* (2;0;14)
'soup-spoon' (the soup ladle in the kitchen drawer)

(42) *ljuslampa* (2;0;26)
'light-lamp' (a torch that is turned off)

(43) *mamma titta, en bebisflaska, inte för barn, bara för bebisar* (3;5;15)
mommy look, a baby-bottle, not for children, only for babies' (she sees a dropped baby-bottle outside, and she defines herself as not being a baby anymore)

Hence, the data cannot confirm the developmental trajectory proposed by Lynott and Connell (2010). Instead, many of the early conceptual combinations could be taken to indicate that the child is on her way to constructing abstract representations that are partly detached from concrete perception.

If we address other cases found in the data, additional processes seem to be involved. The child quite often names entities for which she has not yet learned the target label by drawing on metaphorical processes, where shape similarity (cf. 'the shape bias' of Landau et al. 1988) as well as imagination constitute possible sources, as shown in (44)–(50):

(44) *jag vill inte ha godiskaviar* (2;4;9)
'I do not want candy-caviar' (hazel nut spread on her toast)

(45) *titta en luftballong, man flyger* (2;4;14)
'look an air-balloon, one flies (she holds her two necklaces and pretends that they are a hot air-balloon)

(46) *ormbajs* (2;4;17)
'snake-poop' (for fish poop, which looks like a long snake)

(47) *hallonkorv* (2;5;20)
'raspberry-sausage' (a jam packaged in the form of a long plastic roll)

(48) *och jag vill ha blommor, blomkanel* (2;10;1)
'and I want flowers, flower-cinnamon' (she wants the flower-shaped sprinkles)

(49) *jag har sockarvingar* (3;0;8)
'I have socks-wings' (she puts her socks on her hands and pretends to fly)

(50) *jag är en flygande gorilla, jag har gorillafötter* (3;5;9)
'I am a flying gorilla, I have gorilla-feet' (she puts her mittens on her feet and runs, pretending to fly)

In some cases, it is not possible to trace any perceptually available referent of the novel compound in the situation of the utterance. Here we have to do with purely abstract concepts, such as (51)–(58). They are driven by imagination but can nevertheless be considered to be situated in specific situations. Such compounds are attested from quite early on, although not as early as the more firmly perceptually anchored coinages in (33)–(43). In this respect, the data support the hypothesis that early acquisition is perceptual (and concrete) but that it gradually becomes more linguistic (and abstract) (Borghi et al. 2014).

(51) *så inte illmonstret kommer och slår mig, dom kan slå bebisar* (2;4,30)
'so not the evil-monster comes and hits me, they can hit babies'

(52) *kom, vi ska göra ballongtävling* (2;5;14)
'come, we will do balloon-competition' (she wants to arrange this with her older brother: "one throws balloons up", she explains)

(53) *det är pickickdags* (2;8;25)
'it is picnic-time' (it is time to have a pretend picnic, she thinks)

(54) *jag bara låtsasäter, det är socker* (2;8;25)
'I only pretend-eat, it is sugar (she pretends to eat a LEGO® block)

(55) *ett klosshus* (2;9;22)
'a block-house' (she wants us to build a house out of the soft toy blocks)

(56) *det var bara ett låtsasmonster där* (3;3;2)
'it was only a pretend-monster there'

(57) *jag drömde om ett monster, jag drömde ett stengubbemonster* (3;4;16)
'I dreamed about a monster, I dreamed a stone-oldster-monster'

(58) *lekpölar, som vattenpölar som man leker i* (3;4;29)
'play-pools, like water-pools that one plays in' (she explains the meaning to me)

The child also coins some abstract novel compounds in order to describe the particular activity she is about to perform or actually performs. Through this coining she combines a sensorimotor experience (bath, jump) with an abstract linguistic word (time):

(59) *nu är det * badendags* ! (3;2;24)
'now it is bath-*en*-time!' [5] (she is actually on her way to take a bath in the lake; in contrast to (53) above)

(60) ** hoppendags* (3;4;21)
'jump-*en*-time' (she comments on her own jumping on the stairs at kindergarten)

To sum up the analysis, the child's complex word coinages manifest many creative aspects that fit well with theories assuming that linguistic and situated experience interact in complex ways, enabling children to develop abstract language. Evaluative words that express affective, introspective properties appear almost as early as evaluative words expressing sensorimotor experience. It could therefore be suggested that evaluative adjectives, expressing various, more or less abstract properties, might be one step towards children's learning of abstract concepts. The novel compounds combine concepts on several variables to fit various contexts and are proof of the child's ability to gradually abstract away from the perception-based reality, thus constituting yet another means to grasp abstract concepts.

5. Concluding remarks

In sum, the earliest complex words created by the child rely on perceptual anchoring to a greater or lesser degree. However, many abstract features seem to be in

5. This non-target-like derivation with *-en-* probably has some iconic value for the child.

use from early on, although we cannot assume that the child has established an adult-like understanding of them. It thus seems plausible to suggest that abstract representation is being built up gradually along with the development of more advanced linguistic representation. Moreover, as the analysis intends to show, the child's novel compounds can be said to be grounded in situations, and linguistic and experiential information interplay in their coining (Barsalou et al. 2003; Caramelli et al. 2004; Wiemer-Hastings et al. 2001). Hence, from a developmental perspective, the present study lends support to a view of abstract concepts, starting out as underspecified placeholders and containing a rather underspecified representation that is gradually being built up with information gathered from linguistic contexts and experienced events (cf. Jamrozik et al. 2016).[6]

Finally, the study supports the assumption that by producing abstract words that are anchored in particular situations and are associated with other more concrete words, the child can progressively build abstract representations by creating links between words and situations. In future research, the extent to which children make use of strategies of self-stimulation and scaffolding in their language development merits deeper study.

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CHAPTER 12

The development of the abstract scientific concept of *heat energy* in a naturalistic classroom setting

Sally Zacharias

Science aims to understand the physical and living world around us. To do this, it requires us to develop abstract ways of thinking. The aim of this chapter is to describe and explain how the abstract concepts of *heat energy* and *heat transfer* emerge and evolve during two secondary (high) school science lessons, by providing an account of how they are linguistically represented in discourse using a cognitive discursive framework. The analysis of a teacher-led demonstration, a group writing task, and an interview, during which pupils externalize their mental images in speech, writing, and in visual representations, shows how the discourse as well as the social and concrete here-and-now physical contexts, affect the development of these abstract concepts.

Keywords: classroom discourse, cognitive discursive framework, heat energy

1. Introduction

One principal aim of education is to develop learners' understanding and use of abstract concepts. In science, for example, learners are required to develop very discipline-specific understandings of concepts such as *life*, *force* and *energy*. Acquiring such concepts can be challenging for learners and consequently much research has been carried out to locate and explain the social and cognitive processes involved in bringing about changes to the abstract conceptual understandings learners bring to the classroom. Constructivist approaches, generally favored by conceptual change researchers, aim to explore the nature of learners' pre-instructional concepts and how they differ from concepts after instruction (see Duit and Treagust 2003 for an overview). With the assumption that these concepts are relatively stable and transferrable from one learning context to

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another, the often-preferred methodological approach to investigating learners' conceptions is interviewing learners in experimental settings to uncover their underlying conceptual understandings.

In contrast to this approach, the research presented in this chapter aims to describe and explain *how* abstract concepts emerge and evolve in a situated context of learning, by examining how they are linguistically represented in discourse. It examines the development and conceptual architecture of the abstract concepts of *heat energy* and *heat transfer* in a naturalistic setting of a secondary school classroom using principles from Text World Theory, a cognitive discursive framework. In so doing, the emphasis is on how the discourse, the knowledge frames of the participants, and the social and concrete here-and-now physical structures of the classroom affect the development of the concepts during a series of learning episodes. As Giovanelli notes in his application of the text-world framework to the teaching and learning of reading, the model can provide a valuable insight into ways of thinking about aspects of structure and meaning in a classroom context (2016). Drawing on this view, the research presented in this chapter applies this framework to understand how the perceptual experience of the pupils affects the development of the concepts in a naturalistic classroom setting. Furthermore, it aims to understand the role of classroom discourse in this process. This chapter begins with a brief theoretical overview of some of the basic principles of the Text World Theory model (see Gavins 2007 for a comprehensive overview), before describing and explaining the methodological approach taken. It then presents the cognitive discursive analysis of three learning episodes: a teacher-led demonstration, a group writing activity and a stimulated recall interview task.

2. Theoretical framework: Text World Theory

Text World Theory is a cognitive discourse grammar that provides a model of how discourse can be experienced and understood (Werth 1999). It belongs to a group of analytical approaches that claim that as we encounter texts, we construct mental representations of states of affairs (Gavins and Lahey 2016: 3). These mental representations are termed differently, however, depending on the theoretical framework they belong to. Possibly the framework that has had the widest application is Fauconnier and Turner's (2002) Conceptual Integration Theory in which these mental representations are referred to as mental spaces. Text World Theory draws upon many key principles of cognitive linguistics, including those from Conceptual Integration Theory and Mental Space Theory (see Gavins 2007: 146). However, what singles it out against other cognitive linguistics frameworks is that it provides a plausible account of how both the physical and social contexts affect text comprehension. The two key questions that Werth set out to answer were: "How do we make sense of complex utterances when we receive them (as readers and listeners)?", and "How do we (as writers and speakers) put together a complex utterance to express particular concepts?" (Werth 1999: 7). Although text-world theorists have predominantly applied the model to written texts, this study, in line with recent developments in Text World Theory research (see van der Bom 2016; Peplow et al. 2016; and Giovanelli 2017), extends the theory to face-to-face interactions, writing and the use of visual representations for pedagogical purposes. Text World Theory can be seen to belong to the attentional view of cognition and language as it provides an explanation of why particular aspects of an event are expressed in language whilst others are not (van der Bom 2015). The underlying assumption, here, is that language reflects what is perceived to be relevant in the real world (Ungerer and Schmid 2006: 2–3). That said, Text World Theory draws upon other key constructs of cognitive linguistics, most notably in this analysis image schemas. These constructs highlight how language can provide insights into our shared embodied experience of the world, a perspective on cognition and language referred to as the experiential view of language (Ungerer and Schmid 2006: 1–2). Given the model's sensitivity to context, it can be regarded as a very powerful framework for describing and explaining how abstract concepts are both experienced and understood in discourse.

Central to Text World Theory is the notion of a text-world which, in brief, is a mental scenario that contains just enough information required to understand the utterance it corresponds to (Werth 1999). As already mentioned, text-worlds are mental representations and are very similar to Fauconnier's (1994) mental spaces. The text-world, however, is a deictic mental space, the boundaries of which are negotiated by the participants, teacher and pupils, during the ongoing discourse event and are defined by deictic and referential elements of the text. Supplied by the discourse are the deictic and referential elements. These elements, known as world-builders, specify details about the characters, objects and time and place of the scenario. The text-worlds are then fleshed out with 'function advancing propositions' that advance the discourse to fulfill whatever purpose it is meant to have (Werth 1995: 59). These propositions are divided into two groups: one that represents changes in states whilst the other represents steady states. The changes of states propositions, or predications, represent an action or process; a 'path statement' (Langacker 1985, 1987a, 1987b) that maps movement from a path to a goal, while steady states modify existing world-building elements. Text-world theorists use Systemic Functional Linguistics terminology (Halliday and Matthiessen 2004) to denote these predicate types; changes of states predications are referred to as material processes. In a science classroom, material processes are typically used to describe events e.g., *the heat is traveling along the metal rod*.

The second group of function advancing propositions are further divided into state, circumstance and metonymy modifications. As with the changes of state predications, steady state predications are referred to by using Systemic Functional terms, namely, intensive, possessive and circumstantial relational processes respectively. Steady state predications, relational processes in Hallidayan terms, specify how two or more entities in the text-world relate to each other (Gavins 2007: 43). Intensive relationships are expressed as x is y, possessive as x has y, and finally circumstantial as x is in/on/with y. These steady state predications may be either attributive (i.e., when one entity is an attribute of another e.g., *the rod is brown*) or identifying (e.g., *this is heat transfer*). The deictic and referential elements, and function advancing propositions activate relevant parts of the memory, knowledge structures and frames that refer to an 'individual's representation of a specific context' (Werth 1999: 112). These structures are used to interpret the discourse and are consequently modified during the process.

An important aim of the research presented in this chapter is to describe and explain how the context, in which the classroom language is situated, affects the development of abstract concepts. A Text World Theory analytical framework is well suited to this task as built into the model is a plausible account of how 'the situational context surrounding the speech event itself' (Werth 1999: 83), known as the discourse-world, is part of this process. The discourse-world consists of all the participants who steer the discourse, the text and all the surrounding physical elements that the participants can perceive. However, as Werth maintains, this not only consists of sense input but also 'what the participants can work out from their perceptions' (ibid.). This implies that the participants draw from their knowledge frames, also part of the discourse-world, to conceive (perceive, remember and imagine) a coherent 'state-of-affairs' (1999: 84). Both this discourse-world level and the text-world level of the framework are, as Gavins notes, 'constitutionally equivalent', implying that a text-world is as detailed as the discourse-world from which it originates (2000: 20). This central position of the discourse-world in the creation of a mental representation can be seen as one of the defining features of the Text World Theory approach. The framework also offers the possibility to track developments over an extended period of time, unlike Conceptual Integration Theory which focuses more on the online processing of short texts (Semino 2003: 89).

When communicating, participants, including members of a classroom engaged in learning, need to construct and manage multiple mental scenarios often within a short space of time. These complex representations, known here as world-switches, are formed by shifts in time and space. Other text-world types include modal constructions (attitudes, beliefs, forcing of obligation and necessity) and hypothetical and imaginary situations. Participants may also create new knowledge by blending different scenarios (Fauconnier and Turner 1996, 2002, 2003).

The rationale for using this framework is that it has proven to be well suited to the investigation of mental states in a naturalistic setting, such as a classroom, as it provides a plausible account of how the mind organizes and structures knowledge, including abstract knowledge, during classroom interactions. Thus, it offers the possibility to fulfill the aims of this chapter, which are to establish the relationship between the participants' conceptualizations of their concrete social and physical worlds of the here-and-now, and the development of the conceptual content of the abstract concept under investigation. To do this, it explores the relationship between the development of how abstract concepts are linguistically represented in discourse, and the perceptual experience and actions of the participants in a naturalistic setting, therefore systematically describing and explaining the role language plays in these processes. However, in addition to exploring the perceptual experiences of the learners, it acknowledges how their social experience is involved in the process within the learning context.

3. Methodology

The context of the research was a class of first year secondary (high) school pupils in a mainstream school situated in a large city in the UK. The class consisted of twenty mixed ability pupils from various social and cultural backgrounds, representative of many urban schools in the country. Central to this research is an understanding of the complex world of human experience in a learning situation. To gain proximity to this experience, a longitudinal case study design was adopted to allow for an in-depth exploration of the interactions between the events of the classroom, the actions and linguistic structures produced by the pupils in the situational context of the lesson. The data explored in this chapter focuses on extracts from two consecutive lessons, which form part of a wider six-month longitudinal study (Zacharias 2018). These two lessons were selected as the concepts of *heat energy* and *heat transfer* were introduced and then subsequently referred to several times during the lessons, while the pupils carried out a series of pedagogical tasks. The sequence of learning episodes provided an opportunity to track the development of the pupils' understandings of the concepts across a variety of different social groupings and learning activities in the classroom. Due to limitations of space, this chapter specifically focuses on a teacher-led demonstration during which the abstract concepts are introduced into the discourse for the first time, and a small group activity in which three pupils plan, discuss, and write an explanation of the *heat transfer* process. The data presented in this chapter was collected using the following methods: (1) observations of the whole class and group work, (2) a stimulated recall session with a small group of pupils, one week after the lesson took place.

Each lesson was video recorded, with two cameras; one facing the teacher, Mr. Dale (pseudonym), and the other the class. Because of the high level of background noise during group work, the three participants' discussion was also audio recorded. As the researcher was present during the lessons, it was possible to take field notes recording details and observations about the classroom environment, which could not be detected in the video and audio recordings. The field notes were used during the analysis as an additional source of information, thus providing an extra layer of criticality during this process.

The purpose of the recordings was twofold. First, a selected section of the recordings was used in a stimulated recall session that took place with a small group of pupils one week after the lessons. The recording lasted approximately two minutes and showed a critical moment during the learning task. This chapter presents the dialogue that took place immediately after the pupils had watched themselves carry out the writing task, in addition to the visual representations they were asked to make to illustrate their understandings of the abstract concepts taught. Obtaining the pupils' perspective on the classroom events strengthened the credibility of my own text-world analysis of the lessons. Moreover, by carrying out a cognitive discursive analysis of the transcripts and visual representations obtained from the recall session, it was possible to gain an insight into the pupils' individual conceptual worlds (see Section 5.2).

The visual and audio data of the lessons and stimulated recall sessions was transcribed into written format using Conversation Analysis notation (ten Have 2007), thus representing on page the spoken data in a form that was close to its original. The process of transcribing and attending to details of the transcripts revealed many of the fine-grained, socio-interactional aspects of the data. The main text-world analysis, presented in the following section, results primarily from my response to reading the transcripts after the events took place. The interpretation of these transcripts was strongly influenced, however, by my deep immersion in and engagement with the lessons and interviews by observing and listening to the events on the video and audio recordings, reconstructing them from field notes and comparing my own version of the events with the pupils' versions.

4. Class demonstration of heat transfer

The concepts of *heat energy* and *heat transfer* are introduced for the first time by means of a demonstration that took place at the side of the classroom on a work bench situated near the window. The teacher was standing next to the apparatus facing the pupils who were either standing or sitting on chairs close to the bench. The physical arrangement of the classroom together with the memories, knowledge structures and frames the participants brought to the situation constitute the initial conceptual level of the analysis, namely the discourse-world. The following analysis acknowledges the existence of this background knowledge that the pupils brought to the situation. Aspects of this knowledge were revealed through the observations made of the pupils prior to the demonstration. Other aspects of the pupils' background knowledge, such as memories formed by the pupils outside the classroom, could not be known directly but only assumed to exist. The apparatus (Figure 1) used in the demonstration consists of two metal rods (one copper and one steel) that had four paper clips attached with Vaseline. As Mr. Dale heated the end of the metal rods, the pupils watched how the paper clips fell off in turn.

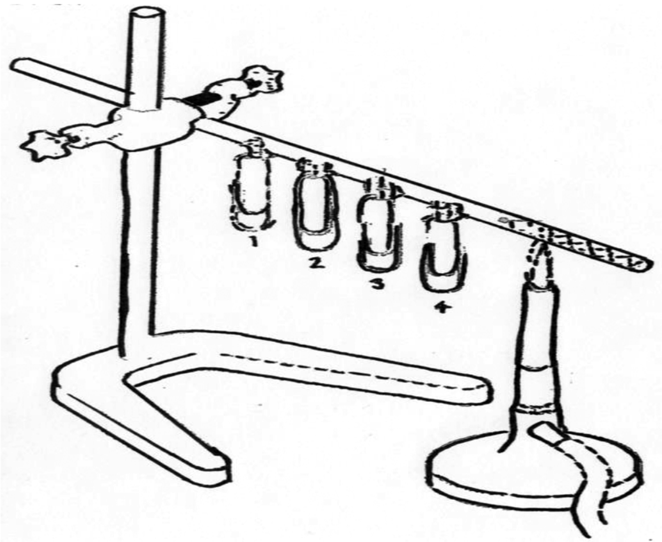

Figure 1. Apparatus used in demonstration Key: T = teacher, P = pupil

Extract 1. Teacher-led demonstration

1	**T:** ↑	*come to the back here gu:::ys (4.0) come to the back come to the back everyone stop what*
2		*you are doing. (4.0) right boys and girls (.) I've got ↑ one ro:d rod here. what's a rod, a rod*
3		*is just a straight bit of something. (.) this one's made of mEtal, does anyone know what sort*
4		*of metal it is*
5	**P1:**	*copper*
6	**T:**	*copper how do you know. what color's copper.*
7	**P1:**	*it's browny red*
8	**T:**	*it's browny red. (.) right that's copper. copper rod. (.)*

		↑ see that there? (2.0) that's not a
9		*copper rod (.) it's a rod (.) it's another metal (.) does anyone know what sort of metal*
10	**P2:**	*iron?*
11	**T:**	*yes, iron (.) that's an iron rod? ok? understand? an iron rod. (1.0) and a↑copper rod, [0.5]*
12		*does anyone know what ↑this stuff is? (3.0) anyone seen that before. (2.0)*
13	**P3:**	*jelly*
14	**T:**	*yeah petroleum jelly? has anyone ever used it before. (.) what do you use it for*
15		*[inaudible]*
16	**P3:**	*put it on ma lips*
17	**T:**	*right (2.0) petroleum jelly (1.0) all I've done is, (.) transferred the petroleum jelly (1.0) onto*
18		*the rod. then then I'll take one of these, (3.0) paper clips? you've seen these before? what do*
19		*you use them for, [inaudible] so (6.0) so I've got one? two? three? four, fi::ve? paper clips*
20		*right? (4.0) What do you think happens to the petroleum jelly? if I heat it up?*
21	***P3:***	*[inaudible]*
22	**T:**	*TURNS INTO SOLID?! Right, let's try it*

Before introducing the concepts of *heat (energy)* and *heat transfer* into the discourse, the teacher and pupils incrementally build up mental representations, or text-worlds, of key parts of the concrete, perceivable world of the apparatus foregrounded by the teacher. This is achieved by using several world-building elements (e.g., the deictic terms *I*, *this* and *these*), relational processes to identify and characterize parts of the apparatus, (e.g., *that's the copper rod*.)

Once the teacher has set the scene and has foregrounded the key parts of the apparatus, which then form part of the participants' shared knowledge, he starts to propel the discourse forward by commenting on the actions he takes to prepare the apparatus for the experiment. These function-advancing propositions are in this case material intention processes (Werth 1999: 238; Gavins 2007: 56): e.g., 'all I've done is transferred the petroleum jelly' (lines 17). Talking through the steps undertaken to set up the experiment may serve an additional function, namely, to add detail of the participants' mental representations of the apparatus and experiment. Thus, the initial dynamic text-world of the immediate situation, that starts to develop in the participants' minds, is firmly rooted in the concrete world of the objects and the event the participants can perceive.

4.1 Adding levels of complexity

The participants create new and more detailed text-worlds during the demonstration. In lines 02–03, by using an intensive identifying relational process, 'a rod is a straight bit of something', Mr. Dale demonstrates the certainty of his knowledge of the world over and above his perceptual knowledge of the immediate surroundings by establishing through the modal system an epistemic modal-world, a distinct type of text-world. Furthermore, this modal-world reasserts his identity as a figure of authority who has access to a larger science knowledge base than his pupils.

The extent to which the pupils accept the epistemic modal-world as credible, and therefore 'participant accessible' (Werth 1999: 214), depends on the participants' relationship to each other, and whether the statement is open to verification in the discourse-world. It is likely that the majority of pupils would find it credible for two reasons. First, the objects of the text-world, *a rod* and *a straight bit of something*, are participant-accessible in that although Mr. Dale refers to any unspecified *rod* and any *unspecified bit of something* by using the indefinite article a, the pupils are able to verify this statement against their perceptual knowledge of what a rod looks like in the discourse-world (Mr. Dale points to one on the bench). Secondly, the willful nature of communication, as claimed by Grice (1975), leads its participants to expect that the other is telling the truth (Gavins 2007: 76; Werth 1999: 49). This is especially true of what Mr. Dale, a person with authority, says in the classroom.

4.2 Introduction of heat energy into the discourse: Creating a hypothetical world

The word *heat* is introduced for the first time into the discourse as a material process when Mr. Dale requests the pupils to predict what will occur when he *heats* the Vaseline (line 20). Although *heat energy* and *heat transfer* cannot be seen by the participants, their effects can. To make sense of the situation, the pupils create an unrealized, remote hypothetical text-world of a scene in which the Vaseline is heated. Mr. Dale initiates this text-world by requesting that the pupils create a mental representation of the Vaseline, with the question, 'what do you think happens to the petroleum jelly if I heat it up?' (line 20), prompting the pupils to visualize a scene.

In this instance, it is unlikely that any of the pupils have seen Vaseline being heated before, as this is not the everyday association most pupils have with it (see line 16, 'put it on ma lips'). Although the response of one pupil is inaudible, Mr. Dale's response in line 22 strongly indicates that the pupil responded in the previous turn with 'turns into a solid,' which, as indicated by the teacher's surprised tone, is an unexpected answer.

Fauconnier and Turner's (1996, 2002, 2003) Conceptual Integration Theory offers a plausible account of how the pupil arrived at this answer. The discourse evokes a blended space (Figure 2), which is created by a merger of two input spaces. Input Space 2: (Figure 2) , the concrete, perceptual world of the Vaseline visible to the pupils, acts as an anchor to the blended mental space (Hutchins 2005). In this anchored blend, the pupils are able to verify their predictions with what happens during the experiment. Input Space 1: (Figure 2) is a conceptual model of a similar looking substance to the Vaseline being heated, that the pupil had seen previously. One obvious example that springs to mind is egg white, which turns into a solid when heated. Although it was not possible to verify what the pupil had in mind when responding to the teacher's question, the conceptual model would need to be one of possible-outcomes-of-substances-being-heated (e.g., turns into a solid, melts, disappears), in order for the response to make sense to the rest of the class.

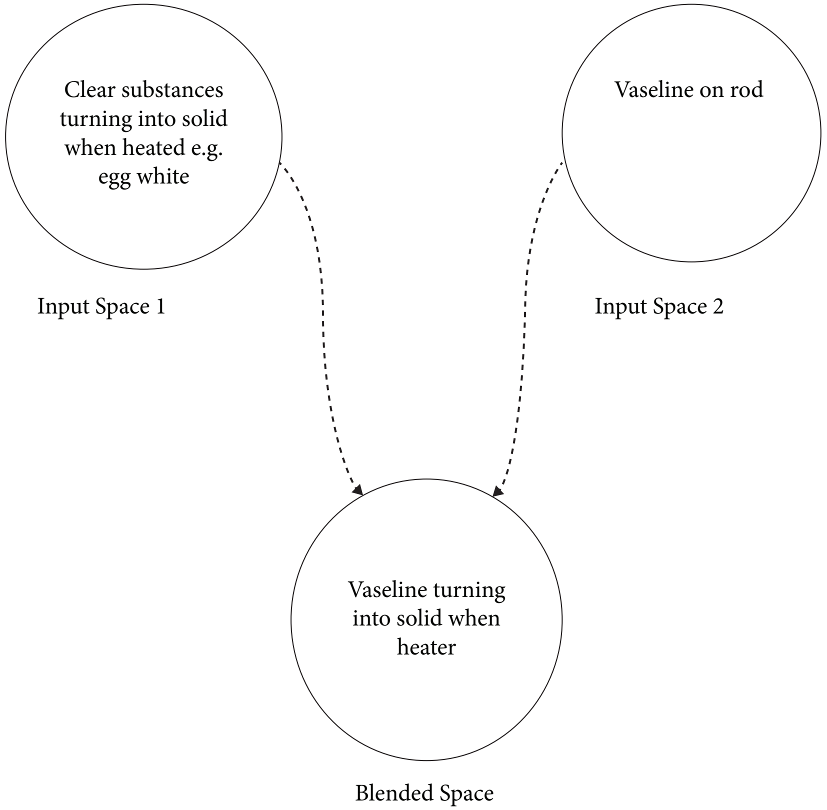

Figure 2. Blended space line 20: What do you think happens to the petroleum jelly if I heat it up?

The trustworthiness of the pupil's response depends on the pupil's status in the class. If the pupil is normally considered to be a reliable participant of the discourse-world, i.e., a pupil who often responds correctly, it is more likely that the other pupils would regard the text-world evoked by the pupil as trustworthy and reliable. Although the teacher's turn: *TURNS INTO A SOLID?* (line 22) indicates with its raised intonation, that the teacher was surprised at the pupil's response, he does not sanction the pupil's response completely but continues with the function advancing imperative, 'right let's try it'. This creates a certain amount of suspense in the teacher's narrative in that the pupils need to wait and watch the experiment to find out what happens to the Vaseline when heated.

4.3 'Capturing' pupils' mental SOURCE-PATH-GOAL schemas

Shortly after the teacher had applied the heat, he asked the pupils to consider why the Vaseline furthest from the source of the heat had not melted, 'why has that not melted yet?' (lines 33–31). A pupil responds appropriately with: 'is it because it's far away from the[' (line 32). The teacher then interrupts the pupil with, 'what is the heat supposed to be doing?' (line 33). Interestingly, the abstract concept of *heat energy* is being referred to, here, not as a process as in line 20, but as a noun.

Extract 2. Mr. Dale heats the metal rods

22 **T**: *TURNS INTO SOLID?! Right, let's try it (3.0) oh right? (3.0) smells, doesn't it (5.0) We're*
23 *doing an experiment now. (4.0) in this experiment boys and girls? I'm going to heat the RODS*
24 *UP that's the copper rod that's the steel rod. I'm going to bring the Bunsen Burner over to this*
25 *side? I'm going to hang the ↑ paper clips (1.0) with pieces of Vaseline (10.0) See what I'm*
26 *doing? ↑ Four paper clips onto the rod there? a:::::nd (2.0) clips and rods (12.0) clips the clip*
27 *there has gone [inaudible] the clip there has gone already hasn't it how many have fallen so*
28 *far?*
29 **P:** *[inaudible]*
30 **T:** *no they haven't. three. (5.0) what has happened to the Vaseline? (6.0) ↑ why has that not*
31 *melted yet?*
32 **P4:** *is it because it far away from the*[
33 **T:** *]what is the heat supposed to be doing?*

34 **P4:** *traveling*
35 **T:** *traveling? very good, ok heat is tra::veling, isn't it? acro:ss the rod, (3.0) heat's been*
36 *trans↑ferred that one there? or that one. (3.0) what do you notice? which one seems to be*
37 *getting hot quicker, the ↑copper, or the steel. the one at the ↑back? which one's that? the red*
38 *one*
39 **P4:** *copper*
40 **T:** *copper, very good, ↑what's the hottest part of the rod? this part, right, ↑ which one is the*
41 *coldest part of the rod at the moment.*
42 **P4:** *this part*
43 **P5:** *the end*
44 **T:** *is it going to stay cold forever?*
45 **P5:** *no*
46 **T:** *what's going to happen to it?*
47 **P4:** *heat's going to travel*
48 **T:** *heat's going to tra:::vel? exactly?*

One possible interpretation of this interruption is that the teacher wanted to 'capture' the image schema that motivated the pupil's response at that moment, and not because the pupil supplied an incorrect answer. An image schema is taken here to be 'a recurring dynamic pattern of our perceptual interactions and motor programs that gives coherence and structure to our experience' (Johnson 1987, xiv). The abstract concepts of *heat energy* and *heat transfer* are not directly perceivable through the senses, so to facilitate the flow of the dialogue between the participants, their linguistic realization is metaphorically structured here through image schemas. In this face-to-face interaction, the following analysis shows how these metaphoric meanings take on a dynamic quality and are understood to be 'shared experiential processes that arise, develop and fade out' during the dialogue (Jensen 2017: 260).

In lines 30–31, the teacher asks, 'why has it not melted yet?' Expressed as the negative counterpart to, 'why has it melted?', the question builds an image of the Vaseline melting in the immediate future, reinforced with the time adverbial *yet*. For P4, the Vaseline appears at the end point of the motion schema, or the GOAL, of the SOURCE-PATH-GOAL image schema, that motivates the response, 'is it because it's far away from the[' (line 32). Sensing that the SOURCE-PATH-GOAL schema is at this moment intersubjectively shared between the participants, the teacher harnesses this mental image to develop his description of the *heat transfer* process.

The teacher then focuses the pupils' attention towards the PATH element of the SOURCE-PATH-GOAL image by asking the pupils, 'what is the heat supposed to be doing?' (line 33). The teacher uses the semi-modal *is supposed to* to make a prediction and to create a modal-world (Carter and McCarthy 2006). With the textual trigger *is doing*, a material process verb in its continuous form, the pupils' attention is drawn to the PATH element of the schema. Utilizing the SOURCE-PATH-GOAL image schema, pupil 4 reinforces the PATH element of the image by responding to Mr. Dale's question with 'traveling' (line 34). The teacher acknowledges this immediately and, in his turn, repeats and develops the pupil's response with, 'traveling? very good, ok heat is *tra::veling*, isn't it? across the rod' (line 35). The PATH image is reinforced further by Mr. Dale elongating tra::veling when he uses his voice to place prominence on the word. This serves as an iconic device to signal to the listener that the heat is moving.

The PATH image is emphasized once again with the use of the preposition *across*, in *across the rod* (line 35). This analysis draws on Langacker's (1991) cognitive grammar system, a linguistic description that accounts for the profiling effects the language structures have on the mind. As depictions of Langacker's grammar system are very visual, it is possible to represent this language diagrammatically.

The sense that *across* takes in this instance can be represented as in Figure 3:

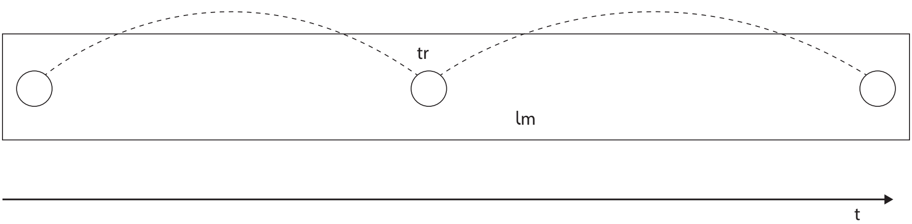

Figure 3. 'across the rod' based on Langacker's diagrammatic representation (1991: 22)

KEY: t = time, tr = trajector (heat) and lm = landmark (rod)

The trajector heat (energy) occupies all the points on the path leading from one side of the landmark (the rod) to the other, and does so successively through time as further indicated by the use of the morpheme –ing in the process *traveling*.

4.4 Profiling the GOAL part of the schema

In line 35–36, Mr. Dale rephrases what he has just been said by referring to the process using the scientific terminology, *heat's been transferred*. Here, the use of the passive voice profiles the process by which the *heat energy* reaches the Vaseline, in a similar way to *heat is traveling*. However, the use of the past participle *transferred* by the teacher in this context also profiles the end result, or GOAL, of the process.

The SOURCE-PATH-GOAL image schema underlies many of the clausal structures used to represent the target abstract concepts of *heat (energy)* and *heat transfer* of the lesson. In addition to the prevalence and the apparent importance of the image schema in representing and communicating to the other participants individual construals of the concepts in language, the cognitive discursive analysis also highlighted how these abstract concepts are not divorced from the here-and-now concrete physical and dynamic social world of the classroom, but evolve as part of them. This episode demonstrated how the teacher was successfully able to anticipate and harness his pupils' thought processes to develop his version of the event.

This section focused on how these concepts were first introduced into the discourse by Mr. Dale. In contrast, the following section presents an analysis of a group discussion that took place in the following lesson among three pupils as they prepare a written explanation of the *heat transfer* process. To do this, they are required to use their understanding of how the atoms of the rod transfer the *heat energy* along to the paper clips.

5. Group task: Explaining heat transfer

The pupils are given the task of writing an explanation of the *heat transfer* process that took place during the demonstration, using their understanding of the particle theory of matter that states that solids, liquids and gases are made up of atoms, or particles. They are told that they should use *heat, spread, vibrate*, *solid* and *particles* in their answer. This task is presented to the pupils as a group-writing task in that the pupils are told to spend their time planning and drafting in a group of three, one written response together. The text-world analysis provides a credible account of how the individual pupils construct and represent the abstract concept of *heat transfer* through their productive use of the language. The analysis of the pupils' active use of the language in the construction of the text-worlds is of particular interest here, as it demonstrates the close connection between the pupils' ability to have a shared understanding of what the linguistic structures refer to and the clarity of the text-worlds created. The discourse-world of the group task consists of the three pupils sitting at a small table at the back of the classroom, with P20 facing P1 and P6. P20 has a pen in his hand and is writing the group's response as the three pupils discuss their answer together.

Extract 3. Group discussing and writing explanation of heat transfer.

1 **P1:** *he said we're not writing yet oh heat spreads through the rod (whispering – he's come back)*
2 **P20:** *HEAT spreads thro::ugh the rod*
3 **P6:** *and the particles start to vibrate (1.0)*
4 **P1:** *and (writes this down) (1.0) the par(.)ticles [writes this down] vibrating (whispers) then (.) the*
5 *particles start vibrating*
6 **P20:** *it spreads further down the rod (2.0) like the particles are vibrating which makes (.) which*
7 *passes it on to other particles*
8 **P1:** *how are we meant to use ↑ solid?*

> Written response of the pupils:
> *The heat spreads through the solid rod and the particles start vibrating and it keeps going along the solid rod until all the paper clips have fallen off.*

What emerges from an initial analysis of the pupils' productive spoken and written language is that the pupils correlate *heat energy* with the movement of particles. In lines 1–2, pupils P1 and P20 co-create a text-world of the world that they have seen and touched during the demonstration, known here as the 'macro-world': 'heat spreads through the rod'. P6 continues from P1 and P20 by trying to establish a text-world of the non-perceivable' micro-world, 'and the particles start to vibrate' (line 3). However, the effect of P6's use of *and*, in addition to the lack of any indication that the deictic space has shifted from a macro-level to a micro-level, is that the addressee is not fully prepared for a world-switch to the micro-level. The overall effect of this is that the addressee toggles between the two worlds and as the text-world of the micro-world has not been clearly established, the two worlds remain 'merged', as shown in Figure 4.

The cause of the vibrating particles in the micro-world is not given in the pupils' response. As the purpose of the writing task is to provide an explanation for the heat transfer process, the addressee borrows from macro-world the foregrounded *heat* which could, if the addressee had no reason to believe otherwise, fulfill the function of the cause. The effect of this merger is that it is not clear whether the pupils view the movement of particles *as* heat energy (established scientific viewpoint) or as a separate phenomenon that causes the particles to vibrate. The ambiguous nature of the pupils' language prompts further exploration of the pupils thinking, in a stimulated recall interview one week after the group task took place.

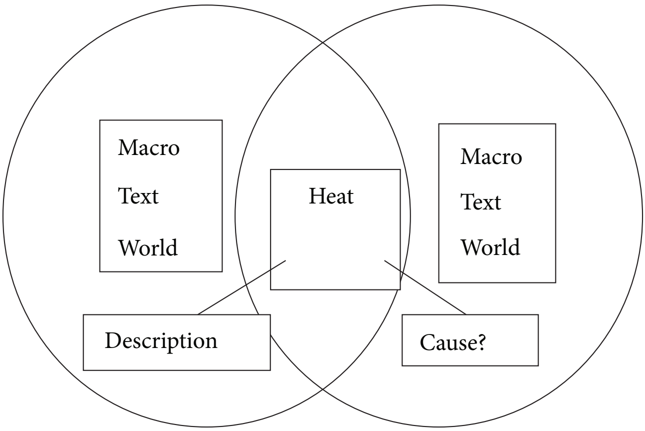

Figure 4. Merging micro- and macro-worlds

5.1 Stimulated recall with pupils

R plays Extract 4 (lines 1–14) and then interviews the pupils.

Extract 4. Pupils discuss mental images of heat transfer

1 **R:** *so when you say heat SPREADS through the ROD wh what do you imagine heat to be doing*
2 **P6:** *the heat would be (.) erm (.) it would MOVE*
3 **R:** *uh-hah*
4 **P6:** *through so I just like imagine it being a red COLOR then then it's going down the rod.*
5 **R:** *and do you visualize the ↑particles at the same time when you think of that what are they*
6 *doing*
7 **P6:** *so when the red color hits the particles they just start to shake*
8 **R:** *right ok uh-hah Ok and you think of it in kind of ↑steps maybe the heat spreads through the*
9 *rod AND the particles start to vibrate it's almost like he says it's like in steps so then the*
10 *↑heat and then the particles vibrate is that how you imagine it do you think it's different or*
11 **P6:** *[nods]*
12 **P20:** *I just imagine the particles like knocking*
13 **R:** *right so you don't think of heat as something (.) separate*
14 **P20:** *[shakes head]*

Although the language used by the pupils during this interview is ambiguous despite the researcher's probing, the opportunity to explain their own mental images to another person, facilitates the process of externalizing the pupils' implicit thinking. To do this, the pupils are asked to choose how to represent their thoughts to each other. A notable feature is the pupils' use of metaphor to represent their mental images. In line 4, P6 uses the metaphor 'the red color' (vehicle) for *heat energy* (topic), when asked what he imagines when heat is transferred along the rod. As the pupils had seen examples of actual reddening of metal while being heated in their textbooks and in a video, this could be motivated by the conceptual mechanism of metonymy, despite the fact that there was no reddening of the rod during the demonstration. A joint attentional frame is set up between the researcher and P6, 'which sets the context for the reading of the specific communicative intentions behind a word or utterance' (Tomasello 2003: 89). The researcher's use of the word 'imagine' appears to trigger P6 to shift his perspective to one that foregrounds the visual aspect of heat. This act reflects Warren's observation that 'the essence of metonymy is highlighting' (2002: 123). In other words, pupils use language to highlight properties of abstract concepts they wish to foreground to their audience.

Externalizing their thinking of the abstract concepts verbally does have some limitations. With this particular example, one limitation of articulating verbally private mental images of the heat transfer process is that the speaker tends to focus on one aspect of the image at a time. Key to understanding the *heat transfer* process is the ability to conceptualize the process holistically and appreciate the inter-relationship between the separate entities.

5.2 Drawing mental images

As established during the analysis of the group-writing task, pupils' linguistic (verbal) representations can be very expressive and, frequently the producer of the representation leaves the relationships between the entities unspecified or indeterminate (Cox 1999). In text-world terms, the group task analysis indicated that the speakers tend not to mark clearly deictic shifts that would help firmly establish a new text-world. Stunning and Overlanded (1995) propose that visual representations compel more specification. This 'specificity' of visual representations underpins my choice to probe the pupils' understanding in their interview by asking them to draw a visual representation of the mental images in their minds as they were engaged with the writing task set by the teacher. My aim was to challenge the two pupils into being as specific as they could about the relationship between heat and the particles in the rod, to provide more vivid and salient evidence of their understanding of *heat transfer*. This method of communicating their ideas in a drawing as a diagnostic tool allows its participants the opportunity to ‘critique the clarity and coherence’ of what they have drawn (Ainsworth et al. 2011: 1). Furthermore, using visuals in this way underpins much of what cognitive science, including Text-World Theory supports, namely, that the mind makes sense of what it experiences by constructing mental models that are often visual in nature (Barsalou 1999; Bergen 2012; Giovanelli 2017; Werth 1999). The text-world approach taken here acknowledges the effect the drawings have on the pupils’ conceptual thinking as they become part of the pupils’ discourse-world, making it a particularly suitable framework for this analysis.

After exploring their mental images verbally, I probed the pupils’ thinking further by asking them to draw an illustration. The pupils were told that they could draw what they imagined. They were given a blank sheet of paper and a box with an assortment of pencils, including coloring pencils. The two pupils were separated and were not able to see what the other pupil had drawn.

The pupils’ drawings (Figure 5 and Figure 6) became concrete entities that belonged to the discourse-world of the interview, together with the video recording on the laptop and the other participants. They became physical objects of that discourse-world that represented, sharpened and assisted with the creation of the pupils’ text-worlds. The illustrations drawn by P20 and P6 were similar in that both pupils drew the outline of a rod and that the rod’s particles were represented as small circles inside the rod, which mirrored how the pupils had seen particles visually represented previously in the lesson. One striking difference, however, between the two drawings was that P6 decided to show that the ‘hot’ particles were vibrating by drawing curved lines around the particles. Here, the curved lines metaphorically represent a salient aspect of the abstract concept of heat transfer causing the particles that the pupil could not perceive but only imagine, to vibrate.

This extra level of detail was picked up on after P6 had finished the drawing when the researcher asked P6 about what he had drawn. In this exchange P6 said, ‘they [pointing to the circles/particles] are knocking into each other making the rod hot’. The researcher responds by asking, ‘do you see heat as something that moves between the particles, then?’ To which P6 replies, ‘no’. Thus, the process of externalizing to others the mental images into the discourse-world on paper, and using these images as starting points for discussion, started to bring about necessary changes to the pupils’ conceptual understanding of abstract the phenomena. Furthermore, these observations support the claim made by Schwartz (1995) that the process of abstraction during group work activities appears to emerge from and is supported by the process of representing thoughts to each other.

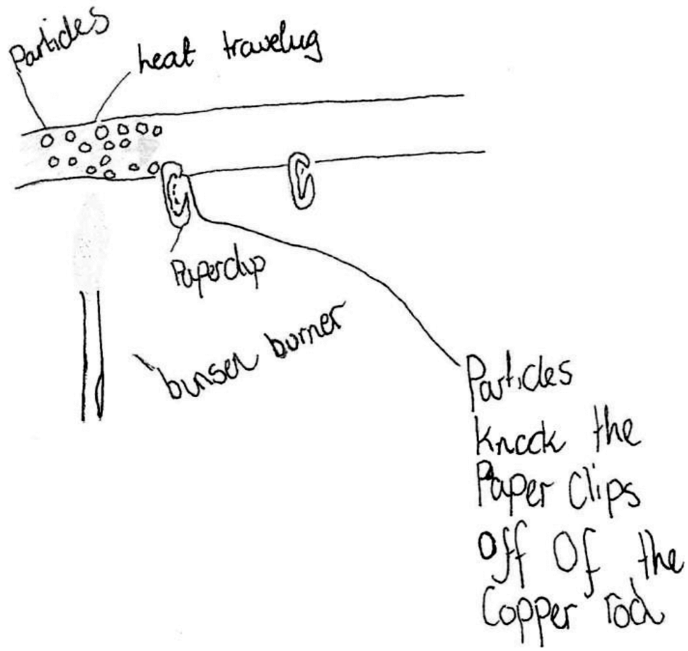

Figure 5. P20's drawing of heat transfer

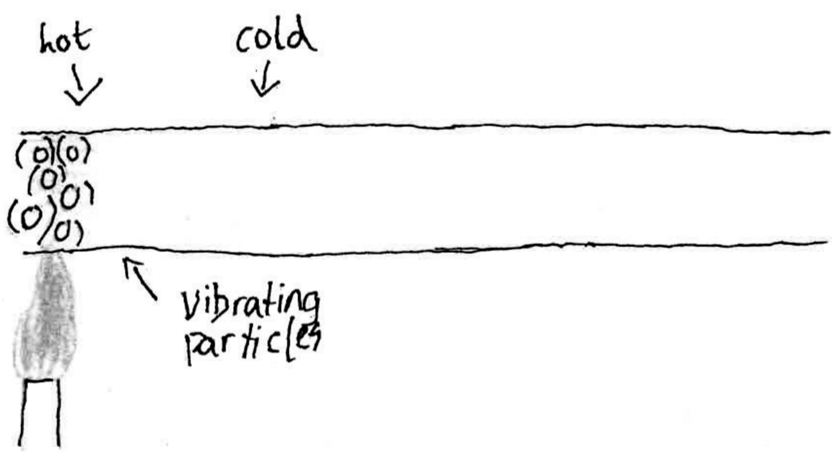

Figure 6. P6's drawing of heat transfer

6. Conclusion

This chapter has provided a cognitive linguistic account of how the scientific abstract concepts of *heat energy* and *heat transfer* are represented in discursive interaction. By employing a text-worlds approach, it has examined the conceptual development of the abstract concepts in a group of first year secondary pupils and their teacher in the physical and social setting of a classroom. The close interdependent relationship of the formation of the abstract concepts with the concrete conceptual world of here-and-now has been highlighted.

The chapter contributes to our understanding and knowledge about abstract concepts and their relation to concrete concepts in three ways. First, it highlights how the processing and representation of the concepts of *heat energy* and *heat transfer* is affected by the perceptual experience of the pupils. Section 4 shows how abstract concepts are introduced into the discourse by a teacher during a demonstration, only after the pupils first create mental representations, or text-worlds, of the discourse-world of the concrete, immediate environment that the pupils can see. The concrete objects in the discourse-world consist primarily of either specific objects that the pupils see in the classroom, i.e., the macro-world (steel rod, Vaseline, paper clips) or more generic entities that the pupils are unable to see because they were too small, i.e., the micro-world (particles and atoms). During the demonstration, the abstract concepts are introduced for the first time. The analysis shows, as part of this process, how the pupils construct and manage multiple mental representations, including epistemic modal-worlds. The function of the epistemic modal-worlds, here, is to introduce knowledge of the world that cannot be directly inferred from the physical perceivable environment, into the discourse. For the pupils to make sense of the situation, a hypothetical text-world was created that triggered a blend of two input spaces, one anchored to the apparatus in the discourse-world and the other from the pupil's memory.

The analysis indicates that the pupils are neither able to directly see, nor create mental images of, the abstract concepts, but they are only able to detect (e.g.,by observing how the paper clips fell from the rod) the physical effect *heat energy* had on the objects (e.g., paper clips) of their discourse-world. The effects of *heat transfer* are also represented in the pupils' drawings which provide further evidence of the pupils' understanding of the concept. The text-world analysis further demonstrates that the ambiguity of the pupils' spoken and written representations of *heat transfer* (see Section 5) results from the pupils' apparent merging of the macro-world (perceivable world of the apparatus) and micro-world (non-perceivable world of particles and atoms). The processing and representation of the abstract concepts appears therefore to be heavily dependent on the construction of well-defined text-worlds, by the pupils, through carefully selected world-builders. The text-world approach allows for a distinction to be made between these different conceptual levels (discourse-world, text-world, and epistemic modal-worlds) in the pupils' minds before, and as the abstract concepts are introduced, for highlighting the strong link between abstract concepts and the concrete concepts from which they sprang.

The second aspect examined in this chapter is the role of classroom discourse in developing and shaping the content of the concrete and abstract concepts. In Section 4, the analysis describes how the pupils first construct mental representations of the apparatus by using world-builders consisting of deictic terms (e.g., *I, this* and *these*), and relational phrases (e.g., *that's the copper rod*) that describe and characterize the concrete, perceivable world of the apparatus. Further levels of conceptual complexity are achieved by building epistemic modal-worlds with the language of modality (e.g., *a rod is a straight bit of something*), in addition to a blended space created in response to being asked to make a prediction (*What do you think happens to the petroleum jelly if I heat it up*). Once the pupils have built text-worlds of the concrete world, the abstract concept of *heat energy* is introduced into the discourse, either with the process heat; '*What do you think happens to the petroleum jelly? if I heat it up?' (line 20*) or with the noun heat (*heat is tra::veling, isn't it? (line 35*). Finally, with regards to examining how and in which contexts abstract concepts are understood through metaphor, it is shown that the dynamic aspect of the concept of *heat transfer* is metaphorically represented in the interactional discourse via the SOURCE-PATH-GOAL image schema that underlies many of the clausal structures used (e.g., *heat is traveling*). It is argued that this both facilitates the flow of the interaction between the teacher and pupils and profiles the position on the rod which the transfer process has reached. Metaphors are also shown to play a key role in Section 5.1 and 5.2, when the pupils are asked to externalize their thinking to the interviewer.

This study contributes to our understanding of abstract concepts in that it examines their conceptual structure as they evolve in discourse through a discursive cognitive linguistic lens. As far as I am aware, it is the first time a text-world approach has been applied to classroom discourse to investigate the emergence of abstract concepts in this way. This study opens exciting possibilities of further research into how other discipline-specific abstract concepts are acquired, processed and represented in discursive interaction in a classroom setting.

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Transcription conventions

↑↓	Arrows indicate marked shifts into higher or lower pitch after the arrow
WORD	Upper case indicates increase in volume
?	Question mark indicates a raising intonation
.	Full stop indicates stopping fall in tone
::	Colons indicate prolongation of sound
[]	Square brackets indicate overlap
(.)	Short pause
(3.0)	Pause of 3 seconds

CHAPTER 13

Time domain matrix modeling in cognitive linguistic research

Ievgeniia Bondarenko

This chapter's objective is to elaborate the criteria for estimating the proportion of abstractness :: concreteness of the TIME concept. As a device, the time domain matrix profiles time's ontological features such as its origin, type, qualities, antithesis, object of influence, measure unit, measuring device, and metaphoric correlates. The chapter finds that abstractness :: concreteness of the time domain matrix depends on the type of construal of the world in which it is schemed – scientific (philosophical) or poetic. An overall tendency towards increasing concreteness is identified. This research is based on a corpus of 15,000 collocations with the lexical unit *time* and its historical equivalents. These collocations are featured in British philosophical and poetic works from corresponding historical periods between the seventh and twentieth centuries.

Keywords: abstractness :: concreteness, construal of the world, ontological time features, time domain matrix

1. Introduction

The issue of abstractness versus concreteness in relation to the TIME concept rests on the fact that time is supposed to demonstrate phenomenological duality. On the one hand, it stands out as an abstract quantity in non-relative physics (Hawking 2002), but on the other, it is the concept of concrete, commonplace time that regulates people's everyday life via clocks, calendars and timetables (Evans 2004: 211). The concreteness of the commonplace TIME concept is evidently the result of cognitive processes nurtured by human perceptual experience (Lakoff and Johnson 1999). This experience splits the notion of time as the product of convention into one kind of time for natural scientists (e.g., physicists) and philosophers, who practice a detached / non-human-centered view of time (Hawking 2005), and a different kind of time for "the rest". In physics, perceptual experience

https://doi.org/10.1075/hcp.65.14bon

of time is excluded from discussions of time: time is viewed as a dimension of any physical system, from the Universe to the atom (Prigogine 1997). Non-scientists (e.g., poets) relate time to commonplace events and make it human-centered or existential (Heidegger 1996).

Entrenchment of commonplace time in the human mind entails its metaphtonymization (Goossens 2002) as time inherently lacks a physical referent (object). This makes clocks, calendars or timetables metonymic correlates of time, whereas metaphorically, time is said to fly, flow or run as if passing by the observer or looked at as a landscape that the observer is passing through. Scientific time is associated with less concrete entities and remains an abstract notion correlated with space (Hawking 2002). This allows the supposition we aim to verify that scientifically, time is mainly viewed as an abstract (non-human-centered) concept, and nonscientific time tends to be viewed in terms of concreteness, (human-centeredness) through metaphtonymization. The reason for this tendency is rooted in the nature of how time is built into the construal of the world (Taylor 1995).

Hypothetically, one may suppose that the modes of construing the world – in other words, naïve (common-place), mythological and/or poetic as human-centered conceptual structures of reality – are responsible for generating time metaphors and making the TIME concept more concrete. Scientific world construal, on the other hand, is intended to avoid figurative language and thus renders time as a more abstract notion (e.g., Ball 2011), although this remains a controversial issue. At the same time, it is possible that abstractness :: concreteness of the TIME concept may depend on the historical period during which particular scientific or poetic world construals were formed.

On a linguistic level, construals of the world are reflected in the corpora of corresponding texts. Scientific construal of the world occurs primarily in articles, monographs or lectures, whereas poetic construal is found in poetic texts. In both kinds of construals, TIME is viewed as an imminent component. It is presented as a lexical concept (Evans 2009, 2010) verbalized in a certain lexical unit (*time* or its historical equivalents). In scientific and poetic texts, this lexical unit is considered as a part of a syntagmatic combination. Such combinations vary from the unit's immediate distributive neighbors to the whole sentence or even a paragraph (verse). In this article, for the sake of convenience, I tag these combinations as collocations even though they diverge from the initial definition of collocation as "semi-preconstructed phrases that constitute single choices" (Sinclair 1991: 110).

This research is focused on the possible dependence between the proportion of abstractness :: concreteness in the meaning of the TIME concept and the type of construal of the world in which it is schemed. The chapter, therefore, aims to articulate the evidence for a hypothetical dependence between abstractness and concreteness of the TIME concept using a case study based on corpora of seventh- to twentieth-century British scientific and poetic texts, all of which feature the lexical unit *time* or its historical equivalents.

2. Corpora and methods

2.1 Corpus data

This research is based upon data culled from collections of British scientific (philosophical) texts focused on the issues of time perception and British poetic texts from corresponding periods of the seventh to twentieth centuries. The data encompass the sub-corpora of Old English (henceforth OE), Early Modern English (henceforth EME) and Late Modern English (henceforth LME) periods. The Middle English period is omitted here since a robust collection of poetic texts by John Gower, William Langland and Geoffrey Chaucer have no correlate from that era of comparable impact in British scientific works focused on time. This is also true of the following, Elizabethan poetic epoch, which is represented through massive amounts of data from works by Sir Philip Sidney, William Shakespeare and Christopher Marlowe. OE, EME, and LME sub-corpora are represented by 15,000 collocations with the *time* lexical unit and its historical equivalents.

The sub-corpora of the collocations are featured in the following collections of texts.

The OE period encompasses the following sources: a collection of pre-Christian Anglo-Saxon calendars considered by The Venerable Bede in his *De temporibus* (703 A.D.) and *De temporum ratione* (725 A.D.), both of which articulate a relatively scientific (heliocentric [Sun-oriented] and celenocentric [Moon-oriented]) view of time, and *Beowulf* (9th–10th centuries).

In the Early Modern English period, the cornerstone of the scientific nonrelative view of time, Sir Isaac Newton's works in natural philosophy (e.g., *Philosophae Naturalis Principia Mathematica,* as well as later works by the empiricists John Locke, George Berkeley and David Hume) coincide historically with the poetic works of the early Stuart period, which featured poems by John Donne, Edward Herbert, Ben Jonson and John Milton.

In this chapter, LME covers only the 20th century. The scientific works by the analytical philosophers Bertrand Russell and J.T. Fraser are recruited as the background for considering the TIME concept implemented in the texts of the British authors Thomas Hardy, T.S. Eliot, W.B. Yeats, W.H. Auden, and Ted Hughes.

My investigation takes a classic corpus linguistic approach, presupposing the analysis of corpus occurrences as the product of a single researcher's expertise and introspection.

2.2 The method of time domain matrix modeling

In this chapter, TIME is viewed as a lexical concept since its immediate lexical manifestation is the lexical unit *time* and its historical equivalents. The Theory of Lexical Concepts and Cognitive Models articulated by Evans (2006, 2009, 2010), following Langacker's Cognitive Grammar Theory, holds that lexical units or words provide access to large-scale encyclopaedic knowledge networks. They are modeled as domains or a hierarchical set that forms a domain matrix (Langacker 1987; Clausner and Croft 1999).

As an elaboration of Evans's theory, I argue that time may be considered in terms of its ontology – that is, it is modeled as an ontological domain matrix profiling all relevant aspects of time, such as its origin; beginning and end; elements (units); antithesis; qualities; locality; type; measuring instruments; metaphoric correlates; objects, tools and results of influence (Bondarenko 2014). Following Dirven and Verspoor's theory of event schemas and participant roles (1998: 77-86), these aspects may be divided into those indicating 'substantial' features of time and those presupposing the particular view of time as the subject of an action.

The former group includes the following aspects:

- time's origin is the factor that gives an impetus to its emergence;
- the beginning and end of time are the corresponding points where time measuring may start and end;
- units of time are presented in different time intervals, both traditional (a second, moment, hour etc.) and conventional (e.g., a three-pipe problem, i.e., a criminal case that Conan Doyle's Sherlock Holmes could only solve upon having smoked three pipes);
- the antithesis of time is either its absence or eternity;
- the qualities of time encompass the range of features that may be ascribed to it in the world model (e.g., it is predetermined, ungovernable, endless etc.);
- locality (e.g., the human brain) is the place where time is situated in the world model;
- type of time is presented as the whole range of its ontological aspects: its reality attribute [time relevant to space], astronomical [exact] time, relevant [long, short] period, epoch, time of event, periods of human life, and emotion [time perceived emotionally];
- measuring instruments are all possible tools, ranging from the ancient clepsydra to the atomic clock;
- metaphoric correlates are the (mainly) concrete entities that map time features.

The aspects presupposing a view of time as the subject of an action are the following:

- the object of time influence is any world phenomenon, material or abstract, subject to transformations within temporal intervals;
- the tool of time influence is an instrument, process or agent that entails these transformations (corruption, wind, etc.);
- the result of time influence is its outcome (e.g., death for humans or destruction for lifeless matter).

Following Langacker (2000: 7), the mentioned factors verbalized in particular contexts as collocations with *time* impose a particular profile (concept) on the conceptual base (domain). Therefore, the nomenclature of the domains in the matrix is variable depending on the features of time implemented in terms of the world model.

In random corpora, the elements of the matrix may be illustrated in the following way.

The domain ORIGIN as the base for the concept GOD:

(1) *Eueryman, **God gyue you tyme** and space!* (*Everyman*)

Here, the concept of time is considered as given by God, viewed as the origin of time.

The domain BEGINNING / END (OF TIME) as the base for the concept HUMAN LIFE:

(2) *When we come at **the end of time** / To Peter sitting in state …* (Yeats 1984: 60)

In (2), the concept time is a dimension of human life that has its beginning and end.

The domain (TIME) LOCATION as the base for the concept MIND:

(3) ***Time therefore being nothing, abstracted from the succession of ideas in our minds**, it follows that the duration of any finite spirit must be estimated by the number of ideas or actions succeeding each other in tha same spirit or mind* (Berkeley)

In (3), the concept time is related to the succession of ideas, and the human mind becomes time's location.

The domain TYPE (OF TIME) as the base for the concept REALITY ATTRIBUTE:

(4) *But **matter, space and time** / In those aereal mansions cease to act* (Shelley 2003)

In (4), time is an attribute of reality, since it represents one of the dimensions of the physical reality of the matter.

The domain (TIME) ANTITHESIS as the base for the concept ETERNITY:

(5) *For Time, though in Eternitie, appli'd …* (Milton, *Paradise Lost*)

An antithesis, that is absence of time in (5), is eternity that excludes time by definition: "state of existence outside time, especially the state which some people believe they will pass into after they have died" (Collins Dictionary).

The domain QUALITY (OF TIME) as the base for the concepts ONE-WAY (6) and UNCHANGEABLE (7):

(6) *Time, as experienced, is a* ***one-way flow*** (EB)

(7) *Time and a world /* ***Too old to alter*** *…* (Hughes 1995: 33)

In (6), time is considered as a metaphor of the moving object (flow) that has only one direction. Thus, its quality is rendered as one-way. In (7) time is metaphorically compared to a person that does not to change her habits.

The domain (TIME) INFLUENCE RESULT as the base for the concept HUMAN AGE:

(8) *The time (our guiding object from the first)* (Wordsworth 2004)

In (8), time is viewed as a guiding object in human life, i.e. the factor that exercises influence with predictable results.

The domain (TIME) OBJECT OF INFLUENCE as the base for the concept WORLD:

(9) *But reckoning* ***Time****, whose million'd accidents /* ***Creep in 'twixt vows, and change decrees of kings, / Tan sacred beauty, blunt the sharp'st intents****, /* ***Divert strong minds*** *to the course of altering things …* (Shakespeare 2010)

In (9), inhomogeneous phenomena are finally clustered under one concept of time that may behave in different ways (changing, creeping, tanning and blunting).

The domain (TIME) MEASURE / UNIT as the base for the concepts SECOND, MINUTE, HOUR, DAY, WEEK, MONTH, YEAR, and AGE:

(10) *How many* ***seconds*** *in a* ***minute****? / Sixty, and no more in it. / How many* ***minutes*** *in an* ***hour****? / Sixty for sun and shower./ How many* ***hours*** *in a* ***day****? / Twenty-four for work and play. / How many* ***days*** *in a* ***week****?/ Seven both to hear and speak. / How many* ***weeks*** *in a* ***month****?/ Four, as the swift moon runn'th./ How many* ***months*** *in a* ***year****?/ Twelve the almanack makes clear./ How many* ***years*** *in an* ***age****?/ One hundred says the sage./ How many* ***ages*** *in time? / No one knows the rhyme* (Rossetti 1990: 238).

As illustrated in (10) time units may encompass a variety of intervals.

The domain (TIME) MEASURING DEVICE as the base for the concept CLOCK:

(11) *The primary time standard is currently NIST-F1,* ***a laser-cooled Cs fountain****, the latest in a series of time and frequency standards, from the ammonia-based*

atomic clock (1949) to the caesium-based NBS-1 (1952) to NIST-7 (1993)
(Time in Physics 2017)

The domain (TIME) METAPHORIC CORRELATE as the base for the concept RESOURCE:

(12) *Well might Senec, and many a philosopher, /* ***Bewaile time more than gold in coffer*** (Chaucer 2000)

Time as a resource, verbalized in (12), constitutes a domain of metaphoric correlates that remains constant throughout the history of the English language. It is worth noting that the examples mentioned above are taken from random corpora because the offered classification encompasses *all possible* time aspects that may never occur together in a certain world construal. For the user of this classification, at least two possible difficulties may emerge. The first is that the identification of the aspect verbalized by a collocation may be (but is not necessarily) fairly intuitive. Secondly, these collocations may turn multivalent. As for the first difficulty, however, some experience enables one to tag corpora occurrences as easily as to identify metaphoric correlates in their verbal implementations. This classification procedure generally requires a minimum of experience and common sense to differentiate between, e.g., time location and time origin, etc. As for the issue of multivalency, it is almost impossible to name any linguistic classification that would exclude *fuzzy sets* (De Cock et al. 2000), that is cases than cannot be tagged by any of the parameters or may be tagged by both. Besides, I find that the number of such cases is negligible as a potential factor influencing the final conclusions of such an analysis. At the same time, I acknowledge that further research should develop approaches that increase the level of reliability.

Figure 1 provides an illustration of a *complete* ontological time domain matrix, i.e., one including *all aspects* of time. For certain construal of the world of a certain period, the matrix includes only domains that are verbally manifest in the model. It may include only a couple of domains for a certain historical period and world construal. For another period or world construal, it may demonstrate the diversity of time aspects and therefore, the number of domains will increase. It is also essential that all elements of the matrix are of equal value, in contrast to the original *hierarchical* prototype matrix in Langacker's system.

I also argue that this matrix is a relevant tool for verifying the balance of concreteness :: abstractness in conceptions of time in scientific and nonscientific construals of the world. In this supposition, I depart from the idea that embodiments of time based on perceptual experience entail immediate personal participation. Therefore, a concept may be considered concrete on condition that it has a physical referent (i.e., an object with measurable features [dimensions]), or if it is mapped by means of a cognitive metaphor.

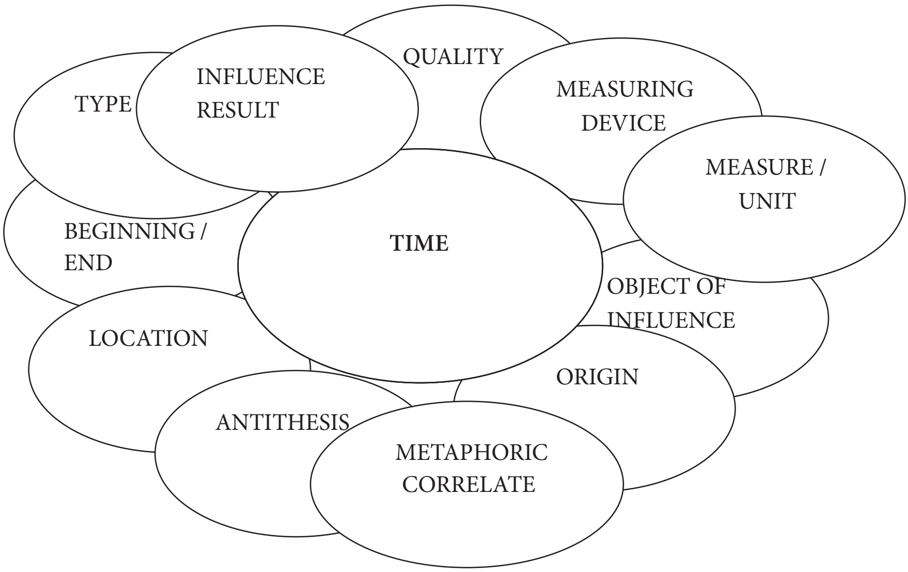

Figure 1. Complete ontological domain matrix of the TIME concept

As for the first thesis about a physical referent, some recent socio-psychological research (construal-level theory) supports the following assertion:

> "the influential construal-level theory of psychological distance (henceforth, CLT; Trope & Liberman, 2010, 2003) states that objects and events that are proximal (close to an egocentric self) are represented with rich, complex, **concrete**, contextual, and subordinate features. This is referred to as a low-level construal. A high-level construal is the tendency to represent distal objects and events **abstractly**, by their simple, invariant, superordinate characteristics"
>
> (Snefjella & Kuperman 2015: 1449; emphasis added)

This argument suggests that close physical distance or immediate personal participation lends concreteness to the concept (i.e., the object or event construal). At the same time, greater physical distance augments the feature of abstractness as it relates to an object or event. In cognitive linguistics, this idea is elaborated as *scalar adjustment*. The metaphor of granularity is used to identify the difference between a coarse-grained and fine-grained view of the same object depending on the observer's imagined or actual distance from it (Croft & Cruse 2004: 52).

Concerning the second argument about cognitive metaphors, their role in shifting the balance towards a concept's concreteness is crucial. This is true not only because of the previous argument, but also because metaphors immanently map relatively abstract concepts onto concepts that are more concrete. In other words, cognitive metaphors entrench the notion (concept) within human consciousness using our bodily experience (Lakoff and Johnson 1999: 4, 16).

For example, the domain ORIGIN in theology may be considered relatively human-centered since religion is a human institution. In this case, theology profiles a more concrete concept (GOD) than modern science (PRIMEVAL MATTER). Here, GOD is envisaged as a divine person, whereas MATTER does not possess a physical referent. On the other hand, some domains may be bases for inherently concrete concepts. This applies, for example, to the domain MEASURING DEVICE that is the base for the concrete concepts CLOCK or WATCH. This is also the case for the domain MEASURE/UNIT that is the base for such concepts as MINUTE or HOUR. Those concepts historically emerged as periods of concrete common-place experience or everyday routines (boiling a kettle, burning a candle, reading a prayer, etc. (Hobden 1983–1984). This allows the supposition that in a human-centered construal of the world, concrete time domains prevail over abstract ones.

Therefore, in our research, the concrete or abstract characteristics of time are construed in terms of an ontological domain matrix that takes into account all relevant aspects of time.

2.3 Epistemic underpinnings of scientific and nonscientific construals of the world

The offered model is also applicable to the present research since its components can be distributed between diffusively coupled scientific and nonscientific construals of the world.

The term "construal" in this chapter is an elaboration of Jackendoff's reading, which is augmented by Taylor (1995: 4) based on Langacker's work (Langacker 1987: 487–488). In contrast to Jackendoff's notion of a "projected world", Taylor, following Langacker, offers the notion of "a situation". Taylor is inclined to avoid the word *world* as it connotes "not some objectively existing set of circumstances, but a subjective reality, i.e., a set of experiences, impressions, or creations of the imagination" (Taylor 1995: 3). However, a situation may be portrayed as subjectively as the world itself since a concrete situation is part and parcel of the world. Moreover, human cognition is immanently based on experiences and impressions that entail subjectivity. In this chapter, therefore, the term "construal" is understood to denote a kind of image of the world portrayed and conceptualized by human cognition. It is the mental reconstruction of reality created by a particular person or group of persons (e.g., a professional community, a nation, or all of humanity) in terms of their worldview and stipulated by their existential perceptions, intellectual and emotional experiences. This mental reconstruction is highly conventionalized and "triggered" by particular "signals" in the verbal code associated with a particular construal.

As the construal of the world is created by human cognition, it is immanently subjective (i.e., human-centered). However, the level of subjectivity of the construal of the world depends on epistemic underpinnings that make it both an online (i.e., situational) and offline (i.e., stored in memory) mental structure. The former aspect is stipulated by its relationship between "a speaker (hearer) and the situation that he conceptualizes and portrays" (Langacker 1987: 487–488). Its offline features are manifest in the system of values, beliefs, prejudices, scientific and common knowledge, etc. underlying the process of portraying and conceptualizing reality.

Scientific :: nonscientific (which I also refer to as mythological, common-place and poetic) ways of construing the world are tagged by the following epistemic features that articulate the world: (i) *objective* (not influenced by humans, e.g., the time of sunset) :: *subjective* (influenced by humans – e.g., time "dragging" when someone is waiting); (ii) *mental* (derived from the mind) :: *sensual* (derived from the senses); (iii) *material* (referring to the world of things) :: *spiritual* (referring to the world of ideas); (iv) *rational* (processed by logical operations) :: *emotional* (processed by feelings); (v) *logical* (e.g., analyzed and synthesized) :: *aesthetic* (perceived as an artistic image one may like or dislike); (vi) *regular* (further elaborated as regularities) :: *occasional* (viewed as unique phenomena) (Bondarenko[1] 2014: 20–21).

The duality of scientific :: nonscientific construals of the world and time is fuzzy since any of the spelled-out features may be present in the construal of the world regardless of the type of text that features it. In other words, the poetic construal of the world implicit in a poem may manifest the inherently scientific quality of possessing *material* features, as in:

1. According to my system, following Yuriy Tsofnas (1999), ways of construing the world (scientific vs. poetic) differ in terms of dual epistemic features. Scientific world construal is tagged as: (i) *objective*; (ii) *mental*; (iii) *material*; (iv) *rational;* (v) *logical*; and (vi) *regular.* On the other hand, poetic construal is tagged as: (i) *subjective*; (ii) *sensual*; (iii) *spiritual*; (iv) *emotional;* (v) *aesthetic*; and (vi) *occasional*. This means that objects and phenomena construed in scientific or poetic terms are conceived as imminently possessing the corresponding qualities. This duality, however, should not be understood in Cartesian spirit as indispensable precondition for either of the world construals. In other words, scientific world construal can possess the features of poetic world construal, for example, implementing emotional or aesthetic elements. The abundance of such aesthetic elements as metaphors and other tropes in scientific texts sometimes acts as an object of scientific interest (see, e.g., Black 2016), and at other times becomes the basis for criticism (see, e.g., Ball 2011).

(13) *The upright is Chance, and* ***old Time is the base****; / But brave Caledonia's the hypothenuse* (Burns 1789)

At the same time, scientific work may demonstrate inherently poetic (e.g., *aesthetic*) features, such as *a metaphoric image* (14) or any other artistic trope:

(14) *Time, as experienced, is a* ***one-way flow*** *…Actually, only material fluids flow, but,* ***like physic experiences in general, that of time can be described only in the language of material phenomena*** . (Time in EB)

Example (14) also clearly demonstrates that time in scientific construal of the world may be manifest even in more concrete concepts than that of poetic. Therefore, the proportion of abstractness :: concreteness in the TIME concept will depend on the type of construal of the world in which it is schemed, as the next section will explicate.

3. Time domain matrix modeling in British scientific (philosophical) vs. nonscientific (poetic) construals of the world in the seventh to the twentieth century

Superficially, the time domain matrix allows for exposing the distinction between the domains that are imposed inherently upon human-centered concepts (e.g., LIFE, GOD, DYNASTY, EMOTION) and those that are the base for immanently non-human-centered concepts (CELESTIAL OBJECT [SUN, MOON], SPACE, CYCLE, UNIVERSE). However, their abstractness :: concreteness as well as the proportional relationship between the two in the case of concepts that cannot be easily identified as human- or non-human-centered have yet to be considered.

In this chapter, the step-by-step procedure for reconstructing the ontological time domain matrix as a tool for evaluating this proportional relationship is as follows. First, I analyze the sub-corpora by taking the collection of scientific (or philosophical) and poetic texts of a certain period and extracting the passages with collocations containing the lexical unit *time* or its historical equivalents. Second, in these passages, I single out the collocations imposing particular profiles (concepts) in corresponding domains as their bases in the time ontological domain matrix. As the third step, I figure out the level of abstractness :: concreteness of the domain-base depending on the abstractness :: concreteness of the concept-profile. And finally, I juxtapose two models of domain matrices of a certain period to identify the proportion of abstract :: concrete components in their compared structures.

3.1 Abstractness: Concreteness of the TIME concept in OE construals of the world

In the OE period, the procedure just elaborated allows for modeling time in scientific construal of the world in the following way.

Bede's time system is articulated in *The Reckoning of Time* (1999), which provides instruction on how to measure time and construct a Christian calendar. In his works he refers to GOD as the "maker of time" (*temporum conditor*) as well as "author and controller of time" (*auctor et ordinator temporum*; 1999: xxv). This concept is a profile in the domain TIME ORIGIN.

The Venerable Bede's views of the science of time and how to measure it are given in a nutshell in the following passage:

(15) PUPIL: *Tell me when this reckoning [ration (numerorum)] was first invented.* TEACHER: *At the time when the creatures were made, that is, in the beginning of the world. For that was when number first began, as we read in Genesis, "And the evening and the morning were the first day"' … It also speaks of number when it says "the first day, the second day, the third day …" Again God spoke of number when He said of the Sun and the Moon, "And let them be as signsforseasons and days and years" Who can understand days and seasons and years, save by number?* (1999: xxiv–xxv)

In (15) concepts in the following domains are identified:

As a TIME MEASURING DEVICE, Bede suggests the CALENDAR (1999: 19–157). The expressions *maker of time, author and controller of time* impose such profiles as the concept GOD as well as the celestial bodies SUN and MOON on the base, domain ORIGIN. Profiles such as the concepts SEASON, DAY, and YEAR are imposed on the domain (TIME) MEASURE / UNIT: *He said of the Sun and the Moon "And let them be as signs for seasons and days and years".*

Bede considered two basic time qualities: (i) its cyclical nature (the 19-year solar cycle [1999: 121–122]) and (ii), its linear nature in God's incarnations and world history (1999: 126–130; 239–250). Therefore, I infer the concepts CYCLICAL and LINEAR as profiles in the domain QUALITY OF TIME.

Bede also explains various times of the day and time periods throughout the year with reference to different positions of the shadows and locations in different parts of the world. This is one of the most significant features of time in scientific construal of the world that binds spatial coordinates and time, making TIME an ATTRIBUTE OF REALITY as a profile in the domain (TIME) TYPE.

As the next step, the concepts are tagged as abstract or concrete to evaluate abstractness :: concreteness of domains that comprise the matrix and, as a result, the level of abstractness :: concreteness of the TIME concept in the construal of the world.

Here, the concrete human-centered concept GOD is a profile in the domain ORIGIN. The concrete concepts (as in references to concrete geometrical shapes) CYCLICAL and LINEAR are the profiles in the domain QUALITY OF TIME. Since TIME as an ATTRIBUTE OF REALITY is in used in different parts of the world in reference to concrete positions of shadows and locations, it is tagged as non-human-centered but concrete. As for CALENDAR, its nature is rather paradoxical. On the one hand, it is considered Sun or the Moon-oriented and therefore conditions concreteness of domain as a MEASURING DEVICE. On the other hand, it is rather conventional to consider calendars (which might be Gregorian or Julian along with multiple other religious, national and fiscal varieties) human-centered and therefore concrete. Moreover, defined as (i) "a *system* for fixing the beginning, length, and divisions of the civil year and arranging days and longer divisions of time (such as weeks and months) in a definite order" and (ii) "a tabular *register* of days according to a system usually covering one year and referring the days of each month to the days of the week" (Merriam-Webster), CALENDAR incorporates the features of both abstract (i) and concrete (ii) concepts. I am therefore inclined to refer it to the class of intermittent abstract/concrete concepts whose nature varies depending on the context. As the units of measure SEASON, DAY and YEAR are fixed in the calendar, they refer to the domain MEASURE / UNIT as the base for non-human-centered but abstract/concrete concepts.

In the OE poetic construal of the world, the TIME concept is modeled in the following way.

The domain TYPE is the base for the abstract concepts EPOCH (16) and RELEVANT DURATION (17) as well as the concrete concepts TIME OF EVENT (18), ABSOLUTE DURATION (19), FREQUENCY (20) and TIME OF HUMAN LIFE (21):

(16) *Lo, so may he say who sooth and right / follows 'mid folk, of* ***far times mindful****, / a land-warden old, that this earl belongs / to the better breed!* (Beowulf 1998: 39);

(17) *How much awaits him / of lief and of loath, who* **long time** *here, / through days of warfare this world endures* (Beowulf 1998: 25);

(18) *and hailed them thus: – "****Tis time that I fare from you*** *…* (Beowulf 1998: 9)

(19) ***in ten days' time*** *their toil had raised it* (Beowulf 1998: 25)

(20) *Not* ***first time*** *this / it was destined to do a daring task* (Beowulf 1998: 34)

(21) *We twain had talked, in* ***time of youth****, / and made our boast, – we were merely boys*) (Beowulf 1998: 14)

In (16) the concept is abstract since there is no reference point in the time identification. In (17) time duration is identified conventionally. The concreteness of the concept in (18) is provided by the indication that the event referenced took place at a certain moment; in (19) concreteness results from naming the exact time interval in numerical values, and in (20) from referring to the life of a concrete person. Therefore, in these examples the domain may be considered more concrete than abstract.

The concrete concept MOVING OBJECT is a profile in the domain METAPHORIC CORRELATE:

(22) ***Time*** *had now* ***flown****; afloat was the ship, / boat under bluff* (Beowulf 1998: 7)

Graphically, the ontological domain matrices of the TIME concept in OE scientific and poetic construals of the world are modelled in the following way (see Figure 2), where abstract domains are highlighted in light grey and intermittent domains are highlighted in dark grey:

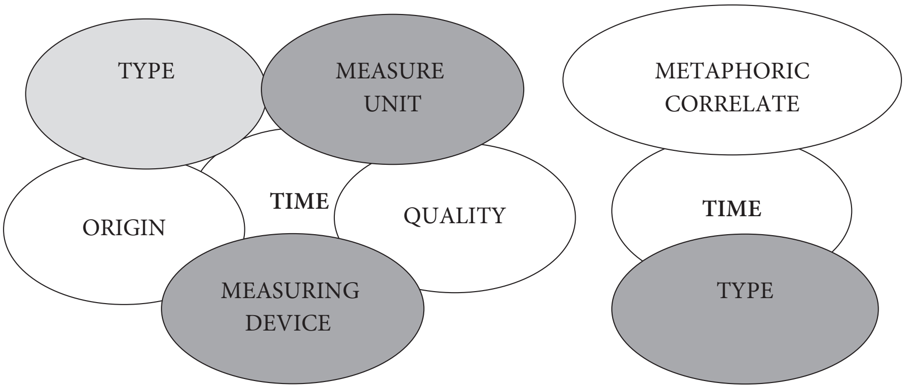

Figure 2. TIME concept matrices of abstract :: concrete domains in OE scientific (left) and poetic (right) construals of the world

Figure 2 demonstrates that the OE poetic construal of the world is manifest in fewer domains, but all of them are concrete (the domain TYPE is only partially concrete), whereas the scientific construal also incorporates abstract domains.

3.2 Abstractness: Concreteness of the TIME concept in EME construals of the world

In the EME period, Newton in his *Philosophae Naturalis Principia Mathematica* identifies time's dual nature (domain QUALITY) as ABSOLUTE and RELATIVE:

(23) ***Absolute, true, and mathematical time****, in and of itself and of its own nature,* ***without reference to anything external, flows uniformly and by another name is called duration****.* ***Relative, apparent, and common time*** *is any* ***sensible and external measure (precise or imprecise) of duration by means of motion; such a measure – for example, an hour, a day, a month, a year –*** *is commonly used instead of true time* (Newton 1846: 77)

Absolute time is referred to using the abstract concept of DURATION (a profile in the domain TYPE), and relative time is articulated in terms of the somewhat more concrete MEASURE OF DURATION, correlated with its MOTION. Therefore, Newtonian absolute time is evidently more abstract than relative time that is measured in concrete UNITS (*an hour, a day, a month, a year*). Therefore, in this theory, the domain MEASURE/UNIT is concrete, the domain QUALITY is intermittent, and the domain TYPE is abstract.

Whereas DURATION in Newton's theory is "of its own nature and without reference to anything external" (Newton 1846: 77), Locke's DURATION is generated by the human mind (domain: ORIGIN that is *verbalized in distance between any parts of that succession, or between the appearance of any two ideas in our minds*):

(24) *It is evident to any one who will but observe what passes in his own mind, that there is a train of ideas which constantly succeed one another in his understanding, as long as he is awake.* ***Reflection on these appearances of several ideas one after another in our minds, is that which furnishes us with the idea of succession: and the distance between any parts of that succession, or between the appearance of any two ideas in our minds, is that we call duration*** (Locke)

So, in Locke's system, the domain ORIGIN is the base for the concrete concept MIND. Moreover, for Berkeley, time cannot be identified as an abstract notion beyond the human mind:

(25) *For my own part, whenever I attempt to* ***frame a simple idea of time, abstracted from the succession of ideas in my mind, which flows uniformly and is participated by all beings, I am lost*** *and embrangled in inextricable difficulties.* (Berkeley 2003)

Conversely to Newtonian time, time for Berkeley is as concrete as it is individual for every person. This supports the hypothesis offered in this chapter that a human-centered concept is more concrete than non-human-centered ones. However, the TIME concept here is manifest in the scientific construal of the world, which serves as evidence of the concept's diffusive nature:

(26) *Time, place, and motion, taken in particular or concrete, are what everybody knows, but, having passed through the hands of a metaphysician, they become too abstract and fine to be apprehended by men of ordinary sense.* (…) *If time be taken exclusive of all those particular actions and ideas that diversify the day, merely for the continuation of existence or duration in abstract, then it will perhaps gravel even a philosopher to comprehend it.* (Berkeley 2003)

In (26) the concept CONCRETE OR NON-UNIVERSAL is a profile in the domain QUALITY. Hume, following Locke's idea of the human mind operating at a range of speeds that cannot be influenced externally, argues that "the idea of time, then, is not a simple idea derived from a simple impression; instead, it is a copy of impressions as they are perceived by the mind at its fixed speed" (Hume in IEP):

(27) *The idea of time is not deriv'd from a particular impression mix'd up with others, and plainly distinguishable from them; but arises altogether from the manner, in which impressions appear to the mind, without making one of the number. Five notes play'd on a flute give us the impression and idea of time; tho' time be not a sixth impression, which presents itself to the hearing or any other of the senses.* (Hume 1719: 1.2.3.10)

So, the domain TYPE is the base for the abstract concept SUCCESSION (OF IDEAS) verbalized in (27).

In the EME poetic construal of the world, time has definite limits. The domain QUALITY is the base for the abstract concept PREDETERMINED:

(28) *Some moneths shee hath bene dead (but* ***being dead,/ Measures of times are all determined****)* (Donne 1793: 73).

Since time is measured in intervals, the domain MEASURE/UNIT is the base for the concrete concepts HOUR, DAY and MONTH, as in (5):

(29) *Love, all alike, no season knows nor clime, / Nor* ***hours, days, months, which are the rags of time*** (Donne 1793: 25).

Time's ORIGIN in the poetic construal of the world is either GOD OR CELESTIAL BODIES, each of which implies a concrete concept:

(30) ***The Father*** *in his purpose hath decreed – /* ***He in whose hand all times and seasons rowl*** (Milton 2001: 19);

(31) *All kings, and all their favourites, / All glory of honours, beauties, wits, /* ***The sun it self, which makes time****, as they pass …* (Donne 1793: 28)

Time in this system is relevant only for human existence. Example (32) features the concrete concept HUMAN as a profile in the domain OBJECT OF INFLUENCE (c.f. [5], which features the domain ANTITHESIS as the base for the abstract concept ETERNITY):

(32) *Then think each minute that you* ***lose, a day; / The longest Youth is short, / The shortest Age is long time flies away, / And makes us but his sport; / And that which is not Youth's is Age's prey*** (Herbert 2017)

The intermittent domain TYPE is the base for the abstract concepts ATTRIBUTE OF REALITY (33) and RELEVANT DURATION (34) as well as the concrete concepts EXACT TIME (35), EPOCH (36) and HUMAN LIFE (37):

(33) ***And time and place*** *are lost* (Milton)

(34) ***long time*** *in eeven scale / The Battel hung* (Milton)

(35) *In* ***spring time, when the Sun with Taurus rides*** *…* (Milton)

(36) *And all the Prophets in thir Age* ***the times / Of great MESSIAH*** *shall sing* (Milton)

(37) *For* ***what is life, if measured by the space / Not by the act?*** */ (…) Here's one outlived his peers, /* ***And told forth fourscore years; He vexed time****, and busied the whole state; / Troubled both foes and friends* (Jonson 2011: 821)

Concreteness of time in the EME poetic construal of the world is featured in a robust collection of metaphors. There, TIME is mapped as MOVING OBJECT (38), RESOURCE (39), LIVING BEING (40) and TRANSFORMING FORCE (41):

(38) *And from these corporal nutriments perhaps /Your bodies may at last turn all to Spirit /* ***Improv'd by tract of time*** *…* (Milton)

(39) *Besides the Wishes, hopes and* ***time I lost*** *…* (Herbert 2017)

(40) *Death! ere thou hast slain another, / Learned, and fair, and good as she, /* ***Time shall throw a dart at thee*** (B. Jonson, Bartleby)

(41) *There was a place, / Now not, though Sin,* ***not Time, first wraught the change*** (Milton)

Graphically, ontological domain matrices of the TIME concept in EME scientific and poetic construals of the world are modeled as the matrices in Figure 3, where abstract domains are highlighted in light grey and intermittent domains are highlighted in dark grey:

From Figure 3 it is evident that TIME in both construals of the world is equally abstract and concrete. However, only the poetic construal is imbued with metaphoric mappings of TIME, which augment its concreteness.

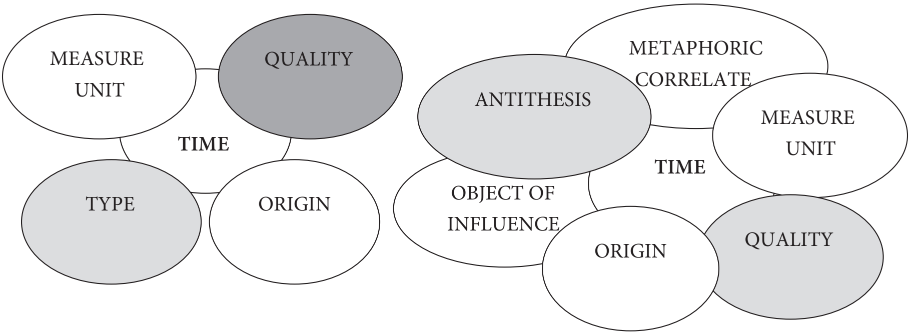

Figure 3. TIME concept matrices of abstract :: concrete domains in EME scientific (left) and poetic (right) construals of the world

3.3 Abstractness: Concreteness of the TIME concept in LME construals of the world

In the LME period, scientific construal of the world is featured in the philosophical works of Bertrand Russell. His view of time encompasses the following aspects. First, in his system time is real (and thus exhibits the ATTRIBUTE OF REALITY as a profile in the domain TYPE). This concept may be considered concrete since the basis for time perception (ORIGIN) is the real world of the senses (implying the concrete concept HUMAN):

(42) ***The contention that time is unreal*** *and that the world of sense is illusory must, I think, be regarded as* ***based upon fallacious reasoning*** (Russell: 71)

Time in Russell's theory is compared with a STREAM that diverges from the idea of time as a TYRANT (both concepts are profiles in the domain METAPHORIC CORRELATE):

(43) *A truer image of the world, I think, is obtained by* ***picturing things as entering into the stream of time from an eternal world outside****, than from a view which regards* ***time as the devouring tyrant of all that is****.* (Russell: 71)

J.T. Fraser, who authored multiple works focused on time, sees HUMAN as a form of time (i) MEASURING DEVICE, (ii) OBJECT OF INFLUENCE, and (iii) ORIGIN:

(44) *The formulator of philosophies of time and fabricator of time keepers are one and the same organism. […]* ***we have our first look at man who is*** **(i)** ***a clock,*** **(ii)** ***a clockwatcher and a clock maker in one person*** *… […]* ***The relation of the clockwatcher to the flow of time is often described as that of*** **(iii)** ***perception*** *[…]* (Fraser 1990: 72).

Fraser's theory of specific universes binds time with the type of world to which it is attributed (Fraser 1982: 29–31). There, time's TYPE is abstract when it deals with *atemporality* (which he attributes to chaos) and *eotemporality*, the time represented as a physicist's *t* in equations. In his system, time is mainly concrete when dealing with *prototemporality* (which he attributes to relations between pairs of events specified in terms of "before" and "after"); *biotemporality* (the time of irreversible processes); and *time of the human mind* (Michon 2008: 53).

In the LME poetic construal of the world, time is tagged in a scientific way but as a paradox of CYCLICAL human life, a concrete concept as a profile in the domain QUALITY:

(45) *Through winter-time we call on spring, / And through the spring on summer call, / And when abounding hedges ring / Declare that winter's best of all; / And after that there's nothing good / Because the spring-time has not come – / Nor know that what disturbs our blood / Is that longing for tomb* (Yeats 1984: 179).

As a UNIT time is measured in concrete existential values (e.g., "coffee spoons"):

(46) *For I have known them already, known them all – / Have known the evenings, mornings, afternoons, /* ***I have measured out my life with coffee spoons*** (Eliot)

As an abstract ATTRIBUTE OF REALITY as a profile in the domain TYPE, time metaphorically correlates with space:

(47) *Then* ***Time froze / To immobility and changed to Space*** (Sitwell 2016).

Other METAPHORICAL CORRELATES of TIME that make it concrete are LIVING BEING (48), SUBSTANCE (49), MOVING OBJECT (50), TRANSFORMING FORCE (51), RESOURCE (52) and LANDSCAPE (53):

(48) *When* ***Time began to rant and rage*** *…* (Yeats: 41);

(49) *Said the Skeleton lying upon* ***the sands of Time*** *…* (Sitwell 2017);

(50) *And* ***time*** *and the world are ever* ***in flight*** *…* (Yeats 1984: 47);

(51) *I feel remorse for all that* ***time has done / To you****, my love …* (Muir 2011: 214);

(52) *If he commutes he* ***loses his time*** */ And leaves his house daily to be plundered by gunmen* (Bunting 1993: 326);

(53) *…as one would turn to nod good-bye to Rochefoucauld, /* ***If the street were time and he at the end of the street*** *…* (Eliot).

Therefore, ontological domain matrices of the TIME concept in LME scientific and poetic construals of the world are modeled as the matrices in Figure 4, where the abstract domain is highlighted in light grey and the intermittent domain is highlighted in dark grey:

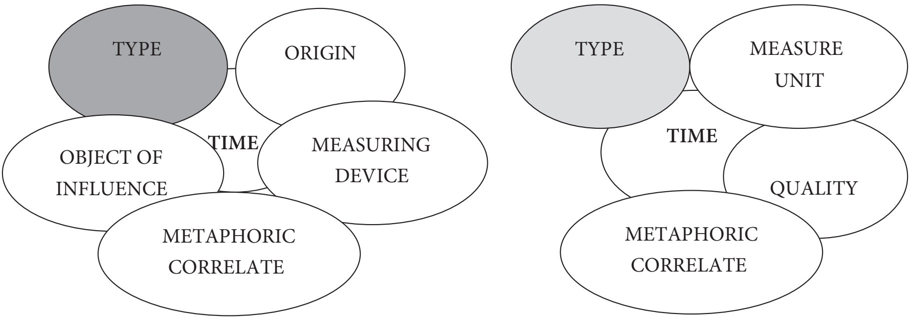

Figure 4. TIME concept matrices of abstract :: concrete domains in LME scientific (left) and poetic (right) construals of the world

Figure 4 illustrates the tendency in scientific construal of the world towards increased concreteness of the TIME concept; this tendency can be seen in references to concrete notions of time and in metaphorical mapping. This tendency may be explained by the diffusive nature of scientific and poetic construals of the world that use elements of the time domain matrix as interchangeable components.

4. Conclusions

In this chapter, I focused on a method of time ontological domain matrix modeling aimed at identifying the proportion of abstractness :: concreteness of the TIME concept. I tested the relevance of this method through a corpus-based diachronic analysis of the TIME concept in British scientific (philosophical) and nonscientific (poetic) construals of the world from the seventh to the twentieth century. Construal of the world is considered to be the mental reconstruction of reality in the mind of an individual person or a group of persons (e.g., a professional community, a nation or all of humanity) based on their worldview and conditioned by their existential perception, intellectual and emotional experience.

Scientific (as non-human-centered) and poetic (as human-centered) construals of the world have converse epistemic underpinnings (*objective* :: *subjective*; *mental* :: *sensual*; *material* :: *spiritual*; *rational* :: *emotional*; *logical* :: *aesthetic*; *regular* :: *occasional*), which, however, are diffusive. The latter means that, e.g., the subjective is present in non-human-centered construal of the world and the objective is present in human-centered construal. In the data analyzed here, those underpinnings inherent to scientific construal can also manifest themselves in poetic construal and vice versa.

Scientific and poetic construals of the world are featured in OE, EME and LME corpora including 15,000 collocations with the lexical unit *time* and its historical equivalents.

In selecting a "tool" for this study, I departed from the assumption that a given lexical unit implements a lexical concept that has an ontological domain matrix as its base. Here, the domain matrix covers such ontological aspects of time as its origin, qualities, type, object of influence, antithesis, measure/ unit, measuring device, metaphoric correlate, etc. The abstractness :: concreteness of each domain in the matrix as a base has an immediate relevance to the abstractness :: concreteness of the concept as a profile. Abstractness :: concreteness of the TIME concept is nurtured by the embodiment of perceptual experience (i.e., concrete notions of time that are referred to or metaphorical mapping).

A diachronic analysis of the TIME concept in the scientific construal of the world led to the conclusion that the model historically tends to become more concrete over time. On the other hand, the TIME concept in the poetic construal of the world mainly remains an existential entity, a concrete result of the perception of the world.

Within one epoch, the relationship between scientific and poetic time models is nonlinear, with rare exceptions. The models implemented in modern philosophical and poetic world construals converge and use some elements interchangeably: the scientific model is tagged by poetic features, such as metaphorized time, and the poetic model sometimes features TIME as an abstract concept detached from immediate perceptual experience.

The domains TIME ORIGIN (as the base for the concepts GOD and CELESTIAL BODIES), TYPE (as the base for the concepts ATTRIBUTE OF REALITY), EXACT TIME, EPOCH and HUMAN LIFE indicate concreteness of time models and stand out as constants that serve as markers of time perception specific to particular historical periods. This is also the case with historically constant metaphoric correlates relating to TIME, such as LIVING BEING, MOVING OBJECT, RESOURCE, TRANSFORMING FORCE, SUBSTANCE and LANDSCAPE, all of which condition concreteness of the TIME concept in the modern period.

To conclude, TIME superficially viewed as an immanently abstract concept, demonstrates features of concreteness. This supports the editors' hypothesis that concreteness like abstractness is a gradual rather than binary property. In my case, this is illustrated in domain matrices that may include a variable number of domains as bases for concrete / abstract profiles. Finally, metaphorization of time greatly contributes to its grounding, which makes it more concrete even in scientific construal of the world.

In further research, I intend to deploy the offered method to identify tendencies relating to abstractness :: concreteness as it relates to time perception in different construals of the world across English-speaking cultures and historical periods.

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Analytical index

Human language is the most powerful communication system that evolution has produced. Within this system, we can talk about things we can physically see, such as *cats* and *tables*, but also about more abstract entities, such as *theories* and *feelings*. But how are these abstract concepts grounded in human cognition and represented in the mind? How are they constructed in language? And how are they used in natural communication settings?

This book addresses these questions through a collection of studies that relate to various theoretical frameworks, ranging from Conceptual Metaphor Theory to Words as Social Tools. Contributors investigate how abstract concepts are grounded in the mind, represented in language, and used in verbal discourse. This richness is matched by a range of methods used throughout the volume, from neuroimaging to computational modeling, and from behavioral experiments to corpus analyses.

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