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Models of lexical meaning

Paolo Acquaviva, Alessandro Lenci, Carita Paradis, Ida Raffaelli

1. Introduction.

While we might say that the first stages of lexical semantics originated already in the first decades of the 19th century, its orientation during the first 100 years was historical and its main concern was diachronic lexical change (Geeraerts 2010). Lexical semantics as we see it today is concerned with modelling the meaning of lexical items. Its leading questions are how forms and meanings combine, what they mean, how they are used, and of course also how they change. These aspects are challenging, since language is dynamic and word meanings are not easily placed in neat little boxes. Meaning definition, description and explanation are hard nuts for all semanticists, irrespective of theoretical affiliation and scientific priorities. If the priority is to describe the empirical domain of meanings in real language in a sufficiently fine-grained way, to be able to explain the mappings of concepts to forms, to account for how meanings of lexical items are learnt and how meanings change, then a methodology must be selected that meets those requirements. If, on the other hand, concerns of economy and explicit formalization take priority over the need to consider language use in all its guises, then another type of methodology is called for. In other words, our research questions, our scope and priorities govern our methods.

Paradis (2012) establishes five questions that are of key importance to any theory of lexical semantics which makes claims to be a coherent framework within which lexical meanings can be described and explained:

- What is the nature of meaning in language?
- What is the relation between words and their meanings?
- How are meanings of words learnt and stored?
- How are meanings of words communicated and understood by language users?
- How and why do meanings of words change?

The answers to these five questions make up the fundamental theoretical assumptions and commitments which underlie different theories of lexical semantics, and they form the basis for their various methodological choices. Related to the research questions and the basic assumptions of meaning in language is the question of how meaning representations can and should be modelled, how meanings relate to world knowledge and at what level of granularity. Four main approaches emerge as important, each with its own merits and limitations: relational, symbolic, conceptual and distributional.

The relational approach is mainly associated with paradigms that view lexical meaning as a network of mutually influencing intralinguistic relations. The structuralist paradigm (one of the most prominent relational approaches), conceived foremost by Saussure, argues for a twofold

understanding of the nature of lexical meaning. The first one is that meaning is realized as an interrelation between the sound-image and the concept (the signifier and the signified) and that it is bidirectional, each evoking the other. This conception was later elaborated by Ullmann (1969) in his semantic triangle as one of the main principles of the communication process, as a model of how lexical meaning is realized between the speaker and the listener. The second one includes the notion of the *value* that is in the core of language as a system. Language is a system of interdependent terms in which the value of each term results solely from the simultaneous presence of the others (Saussure 1986: 114). The value influences the meaning of the lexical item, but it is external to it. Its content is fixed by the association of everything that exists outside it. Being part of a system, the lexical item is endowed not only with a meaning but also with a value that determines the position of the lexical item with respect to other units in the language system (Saussure 1986: 116). The structuralist paradigm has a clear stance about how lexical meaning changes. Coseriu (1973) makes a clear distinction between innovations that are driven by individuals in language use, on the one hand, and meaning change that amounts to an innovation that has become an element of the language system, thus influencing other (lexical) meanings within the system. The structuralist approach was well aware of language use as a source of the meaning change. However, its research focus was oriented towards the interdependency of one lexical meaning to another. This is the main reason why lexical-semantic relations such as synonymy and antonymy are considered as the most prominent types of relations that the structuralist paradigm deals with. On the other hand, polysemy, which clearly shows that the distinction between usage and the system is not clear-cut, was neglected by many structuralist scholars.

Next, the symbolic approach to meaning-making in languages is employed by the generativist school of thought as well as by formalists more generally. Meanings are represented by symbols and processed through symbol manipulation following explicit rules. The content of a sentence equals the beliefs or thoughts, which are connected to each other via inferential relations. In other words, language is modelled as a string of symbols that are parsed in the computation according to a set of grammatical rules. The computational system operates on the syntactic structures in the derivation. The nodes of the structure are filled with semantic features which eventually interact with general cognitive and motor abilities. The language faculty is distinct from the latter systems but interfaces with them, which makes inferencing and verbal use of natural language possible. While the interpretation of an expression is relative to a context, the way symbols are manipulated is independent of the environment, that is, of factors like the communicative situation, the speakers, or the type of discourse. The advantages of such an approach are that some very general aspects of language structure can be captured and described. Its limitations emerge when it comes to modelling rich meaning representations, and it has not much to say when it comes to explanations for concept acquisition, variation, language shifts and change, metaphorization and language use in different discourses (Eckardt 2006).

The third approach to the modelling of representations, the conceptual approach, embraces all kinds of meanings, not only formalizable meanings, and takes an interest in the psychological side of language understanding and the richness of lexical knowledge. This approach provides the tools for the investigation of concept formation based on spatial structures, shifts in meaning and motivations for polysemies such as metonymization, metaphorization and constructionalization (Croft & Cruse 2004, Paradis 2011, Traugott & Trousdale 2013), which represent significant challenges for the structuralist and the symbolic approach. The approach to the analysis of meaning in language is usage-based and as a

consequence it takes an interest in the description and explanation of language use in all its structural and cultural complexity. This approach is represented by the Cognitive Linguistics school of thought, which relies on dynamic and spatial structures, variously referred to as image schemas (Langacker 1987, Lakoff 1987, Talmy 2000), configurations and construals (Paradis 2005, 2015) and conceptual spaces or the geometry of meaning (Croft, 2012, Gärdenfors 2014). These are all theoretical entities that are used to describe, predict and explain the phenomena in language use that the research focusses on.

The fourth model of semantic representation, the distributional approach, is grounded on the assumption that lexical meaning depends on the contexts in which lexemes are used. At least parts of a word content can be characterized by its contextual representation, to be defined as an abstraction over the linguistic contexts in which a word is encountered (Miller & Charles 1991). In distributional approaches, semantic similarity of lexical items is treated as a dependent variable of the contexts in which they are used, that is a function of their contextual representations. Distributional semantics is not only an assumption about the meaning representations, but it is also a computational framework to learn semantic representations from linguistic distributions automatically extracted from corpora. Lexemes are in fact represented with real-valued vectors encoding their co-occurrence statistics with linguistic contexts. Semantic similarity among lexemes is then modeled by measuring their vector similarity. Methods for computational analysis of word distributional properties have been developed both in computational linguistics and in psychology (Lenci 2008). In the cognitive sciences, many researchers have strongly argued for the psychological validity of distributional representations as models of semantic memory (Landauer & Dumais 1997, Jones et al. 2015). For instance, corpus-derived measures of semantic similarity have been assessed in a variety of psychological tasks ranging from similarity judgments to modeling of semantic and associative priming, categorization, and predicate-argument thematic fit. Innovative applications of distributional are also being explored in linguistics, for instance in the study of semantic change (Sagi et al. 2009) and lexical variation (Peirsman & Speelman 2009), to provide the notion of synonymy with a more robust empirical foundation (Geeraerts 2010), and for the diachronic investigation of construction productivity (Perek 2016).

2. Perspectives on lexical meaning.

This section overviews various perspectives on lexical meaning emerging from different theoretical approaches: grouping large families of analyses under broad labels, we review first structuralist approaches, then approaches that share a formal and symbolic orientation, then the Cognitive Linguistics approach, and finally the recent development of structuralist approaches known as distributional semantics. As will be seen, fundamentally different theoretical choices lead to analyses that highlight different aspects of the phenomena, and in many respects complement each other.

2.1. The Structuralist Perspective.

One of the main properties of the structuralist paradigm is its diversity of approaches and models. Although it is a relationally-oriented paradigm, focused on investigating lexical

meaning from an intralinguistic perspective, the structuralist paradigm embraces a diversity of models and approaches that showcase a close relation to some contemporary models. This is especially relevant for what is known as the field theory elaborated by Trier (1931). In Trier's terms lexical fields differ from conceptual fields. Lexical field covers a conceptual field. All lexemes are of equal importance in structuring a field. A lexical field is composed of paradigmatically related lexemes, frequently parasynonyms, with a shared unique conceptual base. The main idea of field theory is that lexical items do not exist in isolation. Being members of a field, lexemes are an integrative part of the language system, sharing with other members of the field the same conceptual, that is to say, semantic area. Trier's model is often regarded as the most prominent field model within the structuralist paradigm. The idea of clear-cut boundaries between lexemes within a field and between fields has been strongly criticised, especially by cognitive linguists. However, it should be pointed out that there are some field models within the structuralist paradigm that are clearly distinguished from Trier's model, although sharing some main features with this model. Most notably, these are Guiraud's model of morphosemantic fields (1967) and Baldinger's model of onomasiological fields (1984). They both share with Trier's model the idea of lexemes interrelated in sense. They differ with respect to the way they see the organisation of lexemes within the field. The structure of morphosemantic fields, as well as onomasiological fields, broadly corresponds to the principles of prototype organization of categories and lexical structures. In other words, lexemes do not have an identical role in structuring the field (as they do according to Trier): one of them is the centre or the core of the field, and others, depending on their characteristics, are positioned closer to it or further away from it. Therefore, morphosemantic and onomasiological fields are heterogeneous, as opposed Trier's fields which are homogeneous. The heterogeneity of morphosemantic and onomasiological fields is evident in their asymmetric structure – the existence of a central lexeme and other lexemes which are associated with it on the basis of various derivational and semantic processes (for morphosemantic fields) or on the basis of the semantic structure of particular lexemes (for onomasiological fields). The difference between the morphosemantic and the onomasiological fields is in the centrality principle. The centre of the morphosemantic field is a lexeme that is a morphological and semantic basis for all of the derivationally motivated lexemes. Thus, the Croatian adjective *jasan* 'clear' is the core lexeme of the field composed of lexemes formed from this adjective like *pojasniti* 'to explain', *objasniti* 'to explain', *izjasniti se* 'to declare oneself', and so on. The core of the onomasiological field is a lexeme that is most frequently used in the variety of senses largely corresponding to the conceptual background of the field. For example the Croatian verb *željeti* 'to wish' is the core of its onomasiological field since it is the verb most frequently used when talking about wishing something. It has the most general meaning and can appear in a variety of contexts, whereas *žudjeti* 'to long for' has a more specific meaning, and is used less frequently, and thus cannot be the centre of the field. The usage of particular lexemes and their semantic structures are crucial for the internal organisation of onomasiological fields, a fact which shows that lexical relations within the field are due to properties of individual lexemes. The model of onomasiological fields is an excellent example of the correlation between language use and language system that was not embraced by all models within the structuralist paradigm. It should be pointed out that Trier's field theory is regarded as a dominant structuralist model in the context of lexical field analysis. Cognitive linguists often criticise Trier's model. Cognitive linguistics considers lexical fields as heterogeneous, with a prototypical lexeme as a centre of the field. All other lexemes are more or less close to the prototype. A brief overview of the model of morphosemantic fields and onomasiological fields pointed to some of the main features of these two models that make them similar and

comparable to prototypical principles of lexical organization. It also shows that the structuralist paradigm was more divergent in developing models for lexical descriptions than it is often acknowledged. Thus, the structuralist paradigm should not be regarded in opposition to some of the cognitive linguistic tenets, but moreover as its predecessor in some aspects.

Linguistic traditions, which incorporate distinct semantic theories and approaches, differ in how they understand the impact and the function of language use on the semantic structure of a lexeme. Broadly speaking, one of the most prominent models of lexical semantic analysis within the structuralist framework, namely the componential analysis, has in all its versions ignored the impact of the context and, in general, of language use. Moreover, the components encoded by a lexical item have been defined as mirroring the main properties of referents. These properties are considered as necessary and sufficient conditions, and thus as objective elements that form lexical meaning. According to componential analysis, lexical meaning is described as completely detached from language use. It is regarded as a stable and fixed structure that enters different types of intralinguistic relations. Therefore, as stated by Lakoff (1987: 157-184), componential analysis is considered as being part of the objectivist paradigm that describes meaning structure as a (logical) combination of components that are the primitive building blocks out of which complex categories (semantic structures) are constructed. Within the objectivist paradigm, the semantic structure is a product of a set of atomic concepts (Lyons 1993: 321) and thus, described exhaustively, without any residues.

Although it could be argued that the critique of componential analysis mainly comes from post-structuralist approaches, foremost Cognitive Linguistics, it has to be pointed out that even some of the most prominent structuralist scholars, like André Martinet or Georges Kleiber, were strict opponents to this model of meaning description. Kleiber (1978) claims that components, as corresponding to the properties of entities in the real world, do not mirror any kind of contextual or syntagmatic constraints imposed on the lexical items. In other words, nothing in the componential analysis approach indicates the nature of contextual or syntagmatic constructions which allow for the usage of a lexical item. It means that according to the componential analysis approach an utterance such as *The seat is ringing* would be unproblematic since there is no constituent that describes the semantic structure of the noun *seat* that would indicate that such a usage is not in accordance to our knowledge of the world, which tells us that seats cannot ring, whereas telephones can. André Martinet (1989) was also strictly against componential analysis, considering it as a model that has not captured the main features of how lexical meaning is constructed (or construed). Martinet (1989) claims that for an in-depth analysis of the lexical meaning it is necessary to know all the contexts in which a lexical item can appear. Thus, the only path to describe the meaning of a lexeme is through the analysis of contexts; i.e. the different usages of a lexical item. For Martinet, lexical meaning is a concrete realization of the lexical item in language use. To corroborate his claim he gives examples of lexical items referring to abstract domains, such as *democracy*, *love*, or *government*. The meaning of these lexemes cannot be learned by ostension, as meanings of nouns referring to concrete domains like *chair*, *dog*, or *head*. Meanings of lexemes referring to abstract concepts can be learned only through their usage, that is, through the repetition of lexical items in certain contexts. Within the structuralist paradigm such an understanding about how lexical meaning is constructed, especially in Martinet's view, posits lexical meaning as an extralinguistic phenomenon that does not necessarily have an impact on the intralinguistic relations which constitute the language system. Coseriu (2000) for example considers that lexical meaning has to be described only with respect to intralinguistic relations. Contextual realizations of lexical items are rather ad hoc categorizations that have no impact on the

language system. These stances are not completely in accordance with Baldinger's approach to onomasiological fields, as was previously indicated.

It was already pointed out by Saussure (1986) that language cannot be separated from language use or, in Saussurian terms, speaking. Language is a product that is passively assimilated by the individual. Speaking, on the other hand, is an individual act. It is deliberate and intellectual, and allows the speaker to use the language code to express his own thoughts. The liaison between language and speaking is clearly defined by Saussure and has become one of the backbones of modern linguistics. Language and speaking are interdependent. Language is necessary if speaking is to be intelligible and produce all its effects; but speaking is necessary for the establishment of language, and historically its actuality always comes first. Speaking is what causes language to evolve: impressions gathered from listening to others modify our linguistic habits (Saussure 1986: 18-19). However, Saussure is very clear about the object of modern linguistics. It is the language and language only and it cannot be confused with speaking. The boundaries between language and speaking should not be erased.

Although the claim about the clear boundaries between language and speaking was one of the principal tenets of structuralism, some linguists like Roman Jakobson thought that with respect to lexical meaning it would be important to define at which point to a certain aspect of a lexical meaning realized in a linguistic context becomes decontextualized. A very clear definition of decontextualization as a process related to linguistic acquisition is given by Langacker. According to Langacker (1987: 63) decontextualization is an important process in acquiring a linguistic unit or a sense. If a property is constant across contexts the property may survive the decontextualization process and remain a semantic specification of the resulting unit. Decontextualization lies at the origin of every new sense that becomes an element of the semantic structure of a lexical item. Although, Cognitive Linguistics in many of its approaches focuses on decontextualization as one of the major processes in acquisition of lexical meanings, it should be pointed out that this phenomenon was already analysed by structuralists and can be traced back to the pre-structuralist linguistics as well.

Within the structuralist framework this phenomenon was observed in details by Stephen Ullmann (1983) as shifts of applications. For example the Croatian verb *skinuti* 'to take off (clothes or books from the shelf)' occurs often in contexts such as *skinuti nečije pokrete* 'to take off someone's gestures', *skinuti nečiji izraz lica* 'to take off someone's facial expression'. In these contexts the verb *skinuti* realizes the sense 'to imitate'. Since such usage has recently become frequent, we could argue that the verb has developed a new sense that first appeared as a shift in application of the lexical item in a specific context, but it has become decontextualized over time. Both Jakobson and Ullmann see this phenomenon as one of the main sources of polysemy what is quite similar to Cognitive Linguistic point of view on polysemy. Within the Cognitive Linguistics framework (Lakoff, 1987; Langacker, 1987; Paradis, 2000, 2001; Taylor 2003, among others) polysemy is one of the major topics since it reflects all the complexity between the impact the language use has on the language system, that is, language knowledge. Differently from the structuralist paradigm, Cognitive Linguistics does not argue for clear boundaries between the two. What makes it partly similar to the structuralist paradigm is the understanding of language knowledge (system) and language use (speaking) as interrelated and at a high degree of correlation.

The frequency of usage has a huge impact on the change of the lexical item, on the formal as well as on the semantic level. The co-occurrence of two or more words that regularly and frequently appear together in different contexts was already identified by Antoine Meillet

(1958) as one of the major sources of lexical and semantic changes. Although he was Saussure's disciple, Meillet's thoughts and discussions about lexical semantics and semantic change are entirely related to some of the major pre-structuralist tenets. This is the reason he is regarded as a pre-structuralist in the context of lexical semantics. One of the most remarkable examples used already by Meillet is the origin of the French analytic negation system. In French there is a number of words which originally refer to concrete entities such as *personne* 'person', *pas* 'step', *point* 'dot', *rien* (lat. *res/rem* 'thing'). All these words acquired a new, negative sense because of their frequent usage with the adverb *ne*. In French, *ne...pas/point/person/rien* is an obligatory negative construction in which the words are used in their new senses that were driven by the frequent and regular co-occurrence with the conjunction *ne*. Moreover, the noun *personne* means 'nobody' in the utterance such as *Qui as-tu vu? Personne*. 'Whom did you see? Nobody.' The origin of the French negation system is also an excellent example of syntactically or construction driven semantic change. The lexical items *pas* or *personne* have preserved both senses in modern French, which are realized in very different syntactic constructions. However, lexical meanings (very often the etymological ones) can disappear over time (see Geeraerts, 1997). As shown in Raffaelli (2009) frequent usage of a lexical item in certain contexts could lead to the loss of the original sense of a certain lexical item. This is the case of the Croatian adjective *trudan* 'pregnant' whose original sense was 'hard', 'tired'. The utterance of the adjective in contexts related to pregnancy led to the semantic change of the adjective *trudan* which is nowadays used exclusively in the sense 'pregnant'. However, it is also an excellent example of the fact that language diversity (the existence of different dialects) has to be taken into account when some statements about the changes in language are given. The adjective *trudan* has preserved its original sense in one of the Croatian dialects – the Čakavian dialect.

Language use is at the origin of language evolution, language acquisition and language organisation. It is inseparable from the language system, thus representing the main path towards the description of what language is. Although it is generally thought that the structuralist paradigm was primarily a relation-oriented approach mostly focused on intralinguistic relations, this brief discussion has aimed to illustrate some of the main ideas shared by structuralist and post-structuralist paradigms (especially Cognitive Linguistics) having their origins back in pre-structuralist approaches to lexical semantics (as shown with Meillet's examples). Thus, the structuralist paradigm should be regarded in correlation and not in opposition to what was before and what followed after it.

2.2 Formal and symbolic approaches

Recent controversies like that involving Adger (2015a,b), Behme and Evans (2015), and Evans (2014) give the impression that much recent research stands opposed to an older paradigm, deductive, based on introspection, inattentive to the wealth of empirical phenomena uncovered by typological and quantitative approaches, entirely based on syntax, and revolving around the work of Noam Chomsky. In fact, this is by and large a strawman, as critics of so-called 'formalist' (or, less aptly, 'generative') models typically focus narrowly on certain methodological aspects of Minimalist syntax and of frameworks directly related to it (like

Distributed Morphology), disregarding the enormous diversity of theoretical positions within and without Chomskyan approaches, and the wealth of empirical evidence and falsifiable predictions contained in them. In fact, there is no coherent family of theories which could be meaningfully grouped under the label of ‘formal’, especially from the perspective of their approach to semantics and, what is relevant here, lexical semantics. Instead of trying to outline a non-existent ‘formalist’ view on the mental lexicon, it is instructive to consider how a specific set of assumptions about language and the mind can shape our research questions on the mental lexicon, and what distinctive contributions they have made and can make.

2.2.1 Meaning and lexical meaning

The claim of linguistic nativism is logically distinct from the claim that language can be modelled by means of symbolic representations involving specific formal tools (generative grammars). In principle, an innate language capacity could be characterized in different, non-formalized terms; for example, it might be framed as a description of the typological variation space based on non-categorical primitives (as ‘relative pronoun’ or ‘purposive clause’ or ‘agentivity’ could be) and specifying a range of potentially language-specific combinatorial patterns. Conversely, a formal symbolic representation can aim at modelling just any information system, not just innate knowledge. The claim that linguistic behaviour is best explained by reference to an innate linguistic capacity, and the claim that this capacity is best modelled by means of a formal generative grammar, are both substantive theoretical choices; but it is the second that more directly concerns the definition of lexical items and their content.

A very large family of approaches embraces a representational theory of the mind, and views language as tacit knowledge of a system. A theory of language in this perspective aims to model the content of this knowledge through rules and principles. Language is thus viewed as a mind-internal reality, with a precise psychological and neurological basis; however, most approaches aim to model the structure of the *content* of this knowledge, not directly of the mind states of speakers. Grammar thus models a knowledge that is bio-physically instantiated in the brain, but analyzes it at a level of abstraction. In the words of Adger (2015b: 164):

Generative grammar takes the right level of abstraction to be one at which a particular computable function can be specified, as this is the level at which an explanation can be given of a basic property of human beings: our capacity to systematically pair sound and meaning over an unbounded domain by using discrete symbolic resources. The explanation given by generative grammar is that the human mind implements a particular computable function that creates an unbounded set of hierarchically structured objects that interface in particular ways with the systems of sound and meaning.

From this perspective, lexical meaning, and linguistic meaning in general, is fundamentally a mind-internal construct, insofar as the theory models a mind-internal competence. This internalist stance, however, can be more or less prominent. The work of Noam Chomsky has consistently asserted the mind-internal nature of linguistic meaning, and denied the usefulness of world-determined reference. However these considerations have little direct impact on his technical contributions, which mostly concern themselves with the combinatorial apparatus (a fully developed and original argument that addresses the notion of truth from a Minimalist perspective can instead be found in the work of Hinzen 2007). In contrast to this radically internalist stance, which minimizes the role of the relation between linguistic meaning and mind-external reality, classic model-theoretic semantics based on truth conditions is predicated

of an externalist approach. The point has some significance, because semantic frameworks deriving from Montague semantics have historically evolved alongside Chomskyan models of syntax (Government-Binding and then Minimalism), often presupposing each other despite the sharply different philosophical assumptions. What is significant, and instructive, is that this contiguity has allowed formal syntax and semantics to develop as closely related sub-disciplines sharing a large body of results.

Beside semantic internalism, ‘generative’ models typically also subscribe to the view that language is a specific cognitive ability irreducible to non-linguistic ones. Linguistic knowledge, in this view, certainly interfaces **with** non-linguistic knowledge; but it is not subsumed by it, and in particular it is not based on mind-external properties of the body (as opposed to a strict interpretation of the thesis of embodied cognition). An influence of the human body in linguistically relevant categories can be compatible with this position, but not the idea that the mental lexicon, as a part of the theory of language, is shaped by mind-external factors.

Concerning specifically *lexical* meaning, what deserves to be highlighted is the theoretical sharpening of the notion of lexical item, and the vast body of generalizations and predictions that has resulted from approaches as different as syntax-based lexical decomposition (in several different varieties: von Stechow 1995, Hale and Keyser 2002, Ramchand 2008, Harley 2012, 2014, Borer 2013), Pustejovsky’s Generative Lexicon framework (Pustejovsky 1995), Rothstein’s (2004, 2010) semantic analyses of verbal and nominal predicates, and the decompositions into semantic primitives proposed by Lieber (2004), Jackendoff (1990, 2010, 2011), and above all Levin and Rappaport Hovav (Rappaport Hovav and Levin 1998, Levin and Rappaport Hovav 2011).

In all these approaches, and in others less directly related to lexical decomposition, the central role accorded to the combinatory principles underlying symbolic structures makes it imperative to specify what are the basic elements of these structures; what are their formal properties and how these properties relate to those of complex structural objects; and to what extent they can be equated with ‘words’. As we will see in more detail in the next section, it is often less than straightforward to precisely determine what linguistic element counts as a ‘lexical item’ for semantic purposes, in part because a lexical item is often fully specified only in a given context. The content of lexical words, then, must be characterized in the larger semantic context above word level — lexical semantics is part of semantics. Besides, a satisfactory characterization should be framed in terms that can be applied to the typologically most diverse systems (including for instance polysynthetic languages, where the traditional notion of ‘word’ is quite problematic), while guaranteeing predictivity and falsifiability: there are boundaries to the contents that can be lexicalized, as well as significant generalizations concerning the relation between the morphological make-up of a word and what it can mean. The ‘formal’ theories that address these challenges attempt to elucidate lexical knowledge by means of representations that aspire to explicitness, and which aim to capture significant generalizations about what can and above all cannot be encapsulated in a word’s meaning.

While the content of a concept can show gradience and prototype effects suggestive of a radial category, the theoretical terms used to model them in this type of approach are categorical, as items of a meta-language well distinct from any object natural language. Features, lexical categories, semantic categories, and similar formal tools do not have the function to model what speakers ‘have in mind’ when they use language, but to provide the terms for what aims to be part of a theory of grammar as *tacit* knowledge. Thus, characterizations such as ‘negative’, ‘nominal’, ‘mass’, or ‘imperfective’, are typically reconstructed in formal terms using logical

notions such as ‘monotone-decreasing’ or ‘cumulative’, or non-logical terms that define, for example, categories like nouns or verbs as clusters of features, or structural configurations (as in Distributed Morphology, or in Borer’s Exoskeletal framework). Evidently it is an open question, susceptible of empirical verification, to what extent such formal tools can provide a satisfactory account for both lexical and supra-lexical semantic phenomena.

A crucial aspect of the use of formal categories in symbolic representations is that it allows the value of complex expressions to be rigorously computed as a function of the value of their parts and of their structural relation with each other. Compositionality is best seen as an empirical hypothesis: assuming that structures are interpreted compositionally, we can account for the ease to learn, formulate, and understand semantically contentful complex structures. The hypothesis is certainly a powerful and very plausible one — as long as it corresponds to the interpretive properties of structured expressions. For phrases and sentences, a strictly compositional account must contend with the context-dependence of important aspects of the interpretation, where certain senses are activated as a consequence of the linguistic and extra-linguistic context. For lexical items, the question whether lexical content should be modelled as a structured representation (rather than an atom) intersects the question whether such representations can effectively be analyzed compositionally (see Gerner 2014 for a recent study of non-compositionally interpreted complex words). The peculiarities that distinguish lexically encapsulated meaning (like *kill* or *unpopular*) from the meaning of complex phrases (like *cause to die* or *not popular*) are well known since the debate surrounding generative semantics in the early 1970s, and have been central to much linguistic theorizing since then. Even restricting our attention to formal semantic or to syntactic approaches, many proposals have been advanced, which differ along multiple dimensions: the distinction between ‘lexical’ and ‘grammatical’ information, the distinction (if any) between linguistic and non-linguistic content, the identification of semantic primitives, and of course the details of structural representations (beyond the overview by Engelberg 2011, see Dowty 1979, Wunderlich 1997, von Stechow 1995, Levin and Rappaport Hovav 1998, 2011, Rothstein 2004, Hale and Keyser 2002, Borer 2005, 2013, among many). The issues at stake, in fact, are very broad because they concern at the same time semantics (not just lexical), syntax, morphology, and the representation of conceptual content. In this broad context, the semantic compositionality of the posited representations is a more or less explicit assumption, most prominent in formal truth-conditional semantics; in addition, it surfaces explicitly where a lexical semantic core is associated with a local structural domain for idiosyncratic, non-compositional interpretation distinct from its ‘regularly’ interpreted grammatical context (Marantz 1997, Arad 2003, Harley 2014), rather than with an atomic semantic ‘root’ (Levin and Rappaport Hovav 1998, 2011) or with a conceptual content that does not directly feature in the grammatical representation (Schwarze and Schepping 1995, Borer 2013).

All work in the various approaches discussed in this section privileges a view of linguistic knowledge as internalized representation, and consequently is not directly concerned with mind-external and social aspects. However, this does not mean that such aspects are irrelevant, or problematic. Larson and Segal (1994) briefly consider the challenges posed by interpersonal and historical factors on a notion of internalized knowledge of meaning, and argue that an internalist perspective is compatible with a notion of S(ocial)-meaning (socially determined) as opposed to the I(nternal)-meaning that the theory attempts to model directly. The two notions can be posited side to side, and both have a role to play in a global account of a community’s lexical conventions, even though the knowledge of (lexical) semantic facts is by assumption internalized knowledge of an individual. While the specific properties of this inter-individual

aspect of lexical knowledge have not been very significant in the study of the mental lexicon (as opposed to diachronic analyses; see Ouhalla 2012 for an example), the issue is anything but irrelevant in itself. In fact a better understanding of the manifestations of shared lexical knowledge is arguably a desideratum, made all the more urgent by the development of quantitative and distributional approaches (see section 2.4), which foreground statistical patterns of usage.

2.2.2 Words and word pieces in the mental lexicon

A mind-internal perspective sits comfortably with the analysis of the lexicon as *mental* lexicon. It would seem straightforward, then, to equate the basic symbols of formal representations (at least those that do not clearly have a grammatical or syncategorematic function) with lexical items, understood as items of the mental lexicon. In fact, this amounts to a serious oversimplification. On the psychological side, what is stored in memory and retrieved as a unit can correspond to a lexical stem shorn of grammatical specifications, or to a grammatical word, or to a semantically identified ‘lemma’. But the ubiquity of polysemy, the difficulty in identifying distinct ‘senses’ on objective grounds, and the fact that each ‘sense’ has a different network of associations and is differently related to non-linguistic world knowledge, mean that the precise content of such a semantic lemma is not usually self-evident; see already the discussion of ‘lexical units’, ‘lexemes’, and ‘sense spectra’ in Cruse (1986), and Murphy’s (2002) important observation that ‘a word does not simplistically relate to a concept (no matter how represented), but to a network of interrelated and overlapping distinct ‘senses’, related to background world-knowledge’ (2002: 441). On the linguistic side, the relation between lexical stems and ‘items in the mental lexicon’ is first of all blurred by compounds (including seemingly transparent ones like *bedroom*; see Libben and Weber 2004), to which we should add blends (*infotainment*), clippings (*exam*, *vet*); more significant are cases like particle verbs or other separable verbs, where the two elements do not form a syntactic unit. In a broader typological perspective, the boundary between inflectional realization and the derivation of a distinct lexical item is not always clear in languages that form nouns by joining a stem to a classifier or to a noun class prefix, nor is it always self-evident whether what counts as a single lexical item is the complex or the stem alone. Similar considerations apply to so-called ideophones, free morphemes that in languages like Korean or Japanese modulate a verb’s lexical meaning (see Tsujimura 2014). Finally, even superficially unremarkable complexes like adjective + noun can in fact be sharply distinct for semantic purposes, between ‘regular’ modification structures (like *strong tea*) and cases where the modifier has syntactically the same status but in fact identifies a distinct entity (like *green tea*, which does not denote the same substance as *tea* but rather a sub-kind). In all these cases, the ‘lexical items’ whose content is available in the mental lexicon are not revealed by simple inspection, but must be identified on the basis of empirically motivated theoretical choices; see Svenonius (2008) for an example that distinguishes various types of classifiers and modifiers on a structural basis.

As can be seen, many of these questions become visible through the examination of how morphology relates to semantics. This should not surprise, as morphology is centrally concerned with discriminating on principled grounds between operations on lexical items and operations that create new ones. A morphosemantic perspective is therefore central to the study of the mental lexicon.

The need to make explicit what exactly counts as a ‘lexical item’ for semantics, and to do so in relation to morphology and syntax, leads therefore to a number of questions, which require

precise theoretical choices. In fact, this brings out the problematic nature of the notion of lexical item itself — clearly a major issue for the study of the mental lexicon. Positions vary greatly on this fundamental point, and this is not the place to attempt a review of them. Still, it is important to note that the opposition between ‘lexicalist’ and ‘non-lexicalist’ theories is about the lexicon as part of linguistic competence, not about the existence of (something like) the mental lexicon. If only lexicalist approaches envisage a lexicon as a distinct linguistic component, this does not mean that non-lexicalist approaches (like Borer 2010, 2013, or Harley 2012) give up on a semantic notion of lexical item. On the contrary, they explicitly assert the existence of such semantic listemes, but not as part of the linguistic knowledge that determines what words are and can be. This is different from claiming, for instance, that the semantic side of a lexical item is an emergent notion, resulting from a stable network of associations, and ultimately reducible to a set of uses. Words, however defined or ‘distributed’, have a semantic content which is not just an epiphenomenon. This content either determines (for lexicalists) or is correlated to (for non-lexicalists) a cluster of linguistic properties. From the former camp, Levin (2011) makes this point explicit, as she distinguishes the mass of information (stated or implied) associated with the use of a verb in context from the semantic properties that are necessarily present across all uses of a verb, regardless of context; these alone constitute the verb’s lexicalized meaning. A non-lexicalist perspective likewise recognizes this cluster of linguistic properties, but analyzes them in the same way as it analyzes non-listed linguistic objects like phrases and sentences, viewing ‘lexicity’ as a matter of association with knowledge of a different kind: about listed forms, about morphological properties, and, crucially for present purposes, about a conceptual content (this is obviously a simplified generalization; Fábregas and Scalise 2012 offer a more detailed overview, especially on pp. 4-6; and Borer 2013 is the most developed exposition of a non-lexicalist approach, with a detailed account of the relation between grammar and encyclopaedic content).

2.2.3 Variation in the empirical domain

For all approaches, the goal is to systematize as precisely as possible the context-invariant information associated with lexical items (revolving around argument structure and event structure for verbs, and countability and individuation for nouns), and to do so in a way that can predict significant generalizations across typologically different languages. The empirical domain of lexical semantic phenomena to explain is vast, including, for instance, the following:

- the role of verb *Aktionsart* on deverbal nominalizations (see Alexiadou and Rathert 2010);
- restrictions on causative readings and on denominal verbalizations (like the impossibility of a reading ‘to make laugh’ in **the clown laughed the children*, and the fact that ‘they put salt in the box’ can be expressed as *they boxed the salt* but not as **they salted the box*; Hale and Keyser 2002);
- crosslinguistically stable differences between the morphological complexity of adjectives expressing basic states like *loose* and event-derived states like *broken* (Koontz-Garboden 2005);
- the fact that simple verbs can express the manner of an event, like *swim*, or its result, like *clean*, but not both (Rappaport Hovav and Levin. 2010).

A central place in this domain of explananda is occupied by so-called ‘lexicalization patterns’ (the term from Talmy 1985), typologically representative alternations in the way languages encapsulate information lexically.

Typology and the crosslinguistic dimension are a key aspect of this type of investigation, and in this connection the contributions by Gennaro Chierchia (Chierchia 1998, 2010) stand out. They propose a broad-ranging semantic parametrization of the interpretation of nouns across natural languages, as fundamentally denoting kind-level entities or predicates. The analysis is couched in rigorous formal semantic terms, but at the same time it has direct consequences — and predictions — for morphology and syntax, correlating with important typological properties such as the obligatoriness of classifiers or the presence of an inflectional plural. The debate inspired by these contributions has promoted a significant advance in comparative lexical semantics (Chung 2000, Longobardi 2001, Wilhelm 2008, to name only a few); in turn this has fruitfully interacted with syntactic and morphological approaches (especially Borer 2005, and much work inspired by it) to provide a similar impulse on comparative research on countability and individuation (see Massam 2012 and literature cited there). This is clearly a strand of research that has a particular relevance for the study of the mental lexicon, as it addresses on empirical bases the perennial question of the tension between a presumably universal cognitive apparatus and the very diverse linguistic encapsulations of meaning.

2.2.4 Lexical knowledge and concepts

The study of the mental lexicon is where the theme of universality and crosslinguistic variation in lexical semantics intersects the question of semantics and conceptual content. Most proposals about the decomposition of lexical items have generally identified semantic content with conceptual content; the exchange between Fodor and Lepore (1999) and Hale and Keyser (1999) illustrates some of the arguments, limited to one particular syntactic approach. However, it is far from obvious that the structures posited by lexical decomposition accounts (which are hypothesized as *linguistic* objects) should directly reflect *conceptual* structure. Some theorists have explicitly equated the two: Jackendoff (1990, 2002) analyzed the building blocks of lexical semantics as elements of a *conceptual* representation, so that primitives like GO or TO are conceptual in nature and not strictly language-internal (even though they are invoked to account for the linguistic properties of words). On the other hand, the ‘Two-Level Model’ of Bierwisch and Schreuder (1992) (see also Kaufmann 1995 and Wunderlich 1997) distinguish two distinct levels, a conceptual one and a semantic one from which grammatically relevant aspects of meaning are calculated. As shown in the useful critical discussion of Dölling and Heyde-Zybatow (2007), a distinction between grammatically represented information which is structurally represented, and ‘pure’ conceptual content without grammatical relevance, is quite common, both in lexicalist accounts (Rappaport Hovav and Levin 1998) and in non-lexicalist ones (Goldberg 1995, Borer 2005a,b, 2013, Ramchand 2008). It is certainly understandable that linguistic semantics should focus predominantly on the former dimension; however, this has arguably limited the contribution of lexical semantics to the study of the mental lexicon. Consider the simple observation that languages differ in the way they cut up a range of perceptual experiences: Borer (2005a: 12) notes that in English bees ‘sting’ but mosquitoes ‘bite’, like dogs and snakes; by contrast, in Hebrew the attacks of bees and mosquitoes are described by the same verb (*‘aqac*), while those of dogs and snakes are described by two more distinct verbs (*našax* and *hikiš* respectively). Surely, the different ranges of applicability point to different boundaries in the ‘conceptual content’ of these terms. But in Borer’s words ‘it would be unfortunate to conclude from this that Hebrew speakers live in a different conceptual (or, for that matter, physical) world from that occupied by English speakers.’ (*ibid.*). If, say, BITE₁ and BITE₂ are distinct but commensurable (Borer suggests ‘bundles of features, plausibly hierarchically arranged’), then their conceptual content must be

elucidated in a way that accounts for this (presumed) overlap, and makes clear what empirical evidence can be brought to bear on the matter. Crucially, this would go beyond a lexical semantic analysis. Just as crucially, though, it would *relate* semantics to the psychological investigation of concepts; and this is needed to avoid the unenlightening situation where a ‘lexical concept’ is defined as the conceptual content of a lexical item, and a lexical item, circularly, as the linguistic encapsulation of a concept (see Acquaviva and Panagiotidis 2012 for critical discussion). The question of how lexical semantic explanation can be related to psychologically plausible models of mental representation has indeed acquired a certain degree of urgency, as shown in the important contributions of Riemer (2013, 2016); especially so since many psychological accounts of the representation of verbal meaning no longer support the classic notion of modality-independent, discrete, stable ‘concepts’. In order to contribute to theory of the mental lexicon, therefore, lexical semantics can no longer rely on some assumed psychological notion of ‘conceptual content’, but should itself strive to validate its results in ways that are psychologically plausible.

An interesting development in this connection is represented by those investigations that seek to shed light on the psychological representation of polysemy. Several studies (see Brown 2008 for a critical review, as well as Murphy 2007, both cited by Rainer 2014) have attempted to establish on experimental grounds whether the distinct senses that can be activated by a single form like *paper* (substance or daily publication) are stored, accessed, and represented as subentries of a larger item, or rather as independent entries, as distinct from each other as homonyms. Apart from their intrinsic importance as contributions to the understanding of the mental lexicon, such studies can be particularly useful in bridging the gap between the use of ‘linguistic’ analysis (using language-internal evidence) and the use of psychological and neurological evidence; see in particular Pylkkänen, Llinás, and Murphy (2006) in this connection.

2.3 The Cognitive Perspective

In this section we give a presentation of the foundational ideas of Cognitive Linguistics and relate them to the views in Generativist and Structuralist approaches. The section starts with the basic assumptions and proceeds to take a closer look at some core lexical semantic concepts in the literature, and how they are treated within this framework. As we have seen in the above sub-sections, the assumptions differ across theoretical accounts. Cognitive Linguistics takes a pragmatically enriched view of meaning modelling where natural language use is of key importance (Cruse & Croft 2004, Paradis 2005, Fillmore 2006, Goldberg 2006, Geeraerts 2010, Gärdenfors 2014). Lexical items do not have stable meanings, rather they evoke meanings when they are used in discourse. Discursive meanings of lexical items are viewed as construals of specific meanings in specific contexts (Paradis 2015). Meaning creation in context is both dynamic and constrained by encyclopaedic factors and conventionalization pattern. The way people use and understand language is related to the world around us. Language is dependent on our sensory and cognitive system, on the one hand, and on our role as members of different cultures on the other. The way we experience the world is decisive for how we understand it and how we portray it in human communication. The focus of interest is different from the symbolic approach in that researchers in this field take an interest in how language is used in all its richness and in different contexts (for a comparison between the generative and the cognitive commitments, see also Paradis 2003). Language and concept formation has socio-

psychological grounding. Category membership is primarily a matter of more or less, rather than either, which is an idea launched by Wittgenstein (1968). His notion of family resemblance and gradience for membership of the category of game influenced prototype theorists' work (Rosch 1973, 1975), sociolinguists such as Labov and the subsequently the Cognitivist movement (Taylor 2003, for a discussion of gradience and categoriality, see Aarts 2004).

According to the Cognitivist approach, meaning in language is encyclopaedic in the sense that there is no specific point along a linguistic-encyclopaedic continuum where we can say that linguistic knowledge ends and encyclopaedic knowledge starts. This does not mean that all aspects of meaning are considered to be of exactly the same type (Langacker 1987: 158-161, Paradis 2003, Croft & Cruse 2004). The major dividing line between the two is rather whether is at all possible to distinguish between linguistic knowledge and encyclopaedic knowledge. The reason for this difference between the approaches hinges on the stand for or against language as a separate module in the brain. To illustrate the problems with the exclusion of encyclopedic lexical knowledge for the description and motivations of meaning variability of lexical items, Paradis (2003) gives examples of words in the English language arguing that knowing the meaning of *open*, *fast* and *newspaper* in different contexts always involves knowing about the kinds of activities, properties and things involved. In order to understand the meaning of *open* we need to know what kind of activities we perform when we open things such as boxes, debates, pubs, computers or books. Similarly we need to know what entities can be fast and in what way or whether newspaper refers to an artefact, a company or people working there.

Language is considered to be shaped by the two main functions it serves: the *semiological function* and the *interactive function* (Langacker 1998: 1). The semiological function is the mapping of meanings (conceptualizations) to linguistic forms in speech and writing. These structures are often referred to as form–meaning pairings or Constructions (Fillmore & Kay 1995; Goldberg 1995). The interactive function, on the other hand, concerns the communicative side of language use as a social phenomenon including aspects such as the function of providing information as well as expressing the speaker's subjective stance and intersubjective awareness (Verhagen 2005, Gärdenfors 2014; Paradis 2015). Both the semiological and the interactive functions are important for the guiding idea that language use must be explained with reference to the underlying mental processes as well as with reference to the social and situational context. At the core of the Cognitive approach is the meaningful functioning of language in all its guises and all its uses in text and discourse. It is a usage-based framework with two different applications, one ontological and one methodological, both of which are central to the framework. In the first application of the term usage-based, meanings of words are acquired, develop and change through their use in social communication (Traugott & Dasher 2001, Tomasello 2003, 2008 Paradis 2008, 2011). The other application of the term usage-based refers to the fact that naturally occurring text-based data are important as are behavioral data sources to gain insight into the nature of meaning in 'real' language use (Gonzalez-Marquez et al. 2007).

The Cognitive approach to meaning does not only contrast to formal approaches, but also to the Structuralist approach which sees language as an autonomous intralinguistic system of relations between lexical items, organized on the basis of lexical fields (Lehrer 1974, Cruse 1986). According to that view, meanings of lexical items are not substantial, but relational and defined in terms of what they are not. For instance, *weak* gets its meaning from its relation to *strong*. *Strong* means what it does because it does not mean 'weak'. Paradigmatic relations like

these hold between lexical items which can felicitously fill the same slot in an expression or a sentence (Lyons 1977). The same applies to synonyms such as *mother* and *mum* in *my mother is tall*; *my mum is tall*, or hyponyms such as *horse* and *animal* in *the horse is in the stables*; *the animal is in the stables*. This paradigmatic approach to meaning does not make much sense in the Cognitive framework, as we will see below. There was however also another line of research within Structuralism within which the scholars instead stressed the importance of the syntagma for lexical meaning, i.e. linear relations formed between lexical items in a sentences Cruse (1986: 16). Through these syntagmatic structuralist ideas and through the development of machine-readable corpora, collocations and co-occurrence patterns became important theoretical notions (Firth 1957, Sinclair 1987). The approach to lexical meaning endorsed by the syntagmatic structuralists assumes that a lexical item gets its meaning from the totality of its uses or, put differently, a lexical item gets its meaning from the company it keeps in language use. In this respect, the syntagmatic approach paved the way for new trends in linguistics, namely for usage-based approaches to lexical semantics where contextual factors and real language in use are prime research objectives for the description of meanings. This includes Cognitive Linguistics approaches and computational approaches to lexical meaning (Pustejovsky 1996, Jackendoff 2002, Lenci & Sahlgren, to appear).

Following up on the notion of the syntagm within the Cognitive perspective, we point to the the contribution of lexical items to the syntagmatic context at the level of sentence or utterance as well as the contribution of the syntagmatic contexts to the interpretation of the lexical item. As concrete examples of topics and their treatments within Cognitive Linguistics, the notions *polysemy*, *homonymy*, *synonymy*, *hyponymy* and *antonymy* and the relations they may form due to contextual factors at the syntagmatic level are selected for a brief discussion. Like meanings in general, relational variants are viewed as construals of meanings and may be grouped into three main types.

- Polysemes are lexical items that have the same form. They evoke different but related meanings in their syntagmatic strings. Homonyms also share the same form, but their meanings are not at all related.
- Synonyms have different forms. They evoke meanings that are similar to some degree but are instantiated in different domain matrices or frames. Similarly, hyperonyms and hyponyms do not share forms but evoke related meanings at different levels of generality, i.e. more general or less general.
- Antonyms have different forms. They evoke opposite properties of the same meaning. Following Jones et al. (2012), the term is used as a cover term for all different types of opposites in language.

Let us consider a pair of lexical items from the first category, where the items share form but both differ and share aspects of meaning. Consider (1) from an interview with Woody Allen.¹

- (1) As I've said many times, rather than *live on* in the hearts and minds of my fellow man, I would rather *live on* in my apartment [emphasis added].

¹ Paris Review. The art of humour no1 <http://www.theparisreview.org/interviews/1550/the-art-of-humor-no-1-woody-allen>. (7 October 2015)

(2) The *pen* is mightier than the *sword*.

The two uses of *live on* in (1) are polysemes. The explanation for our interpretation of the two expressions is that they share aspects of meaning but occur in two different syntagmatic contexts and totally different meaning domains support those contexts. The first use of *live on* is instantiated in a mental domain by *in the hearts and minds of my fellow man*, while the second use of *live on* is couched in a concrete place, namely *in my apartment*. Polysemous lexical items such as *live on* are related by way of comparison, more precisely through metaphorization. A state in the domain of apartment is compared to a state in the mental domain. The two states share properties, but are instantiated in different domains (e.g. Lakoff & Johnson 1980, Gibbs 1994, Giora 2003, Hanks & Giora 2011, Paradis 2015).

Pen and *sword* in (2) do not refer to the objects as such but to what these objects are used for and to their users. The meanings are metonymically construed through the affordances of the conceptual structure of PEN and SWORD respectively, that is, what they are used for and by whom. That part of the conceptual structure is made salient through the zooming in on the most relevant aspect. The lexical items can be seen as shortcuts to the relevant areas in conceptual space (Paradis 2004, Panther & Thornburg 2003, Benczes, Barcelona & Ruiz de Mendoza Ibáñez 2011). Regarded as construals of usage, we are able to explain classical philosophical problems such as whether a fake gun is a gun or as in (2) where pen and sword are both hyponyms of weapon. In this context, *mightier* links *pen* and *sword*. The interpretation of *pen* is metonymically related to how the pen is used and so is the interpretation of *sword* (Paradis 2004). In this particular syntagm, neither is used to refer to the artefacts *per se* but to their use that communication is a more effective tool than violence or military force and thereby a hyponymic relation is construed.

Both types of polysemes are motivated variants in the sense that they evoke meanings which are related through a construal of comparison and resemblance (metaphorization), or through a contingent relation and a part-whole construal of salience (metonymization) (Croft & Cruse 2004, Paradis 2004, 2005, 2015). In contrast, homonyms such as *sole* (the bottom part of a shoe) and *soul* (the spirit) are arbitrary variants with the same form but with unrelated meanings. Homonyms just happen to sound and/or look the same in contemporary speech or writing.

Secondly, synonyms are lexical items that share core aspects of meaning, but differ with respect to the patterning and ranking of the meaning domains on the basis of which they are profiled.

- (3) They are rich/prosperous/loaded.
- (4) The twins are ambidextrous/both-handed.

In (3) *rich/prosperous/loaded* all refer to wealth, but in slightly different ways and contexts, where *rich* is the more neutral with respect to usage while *prosperous* is formal and *loaded* is not. It is well-known that there are no absolute synonyms in language use. There is a gradient of conceptual and communicative similarity (Cruse 2010: 142–145, Divjak 2010, Storjohann, 2010). From a conceptual point of view synonymy can be described as the opposite of polysemy. Synonyms share core conceptual structures which are expressed through different word forms. Metaphorical polysemes and homonyms, on the other hand, are instantiated in different conceptual domains, under the constraint of invariant configurations (Lakoff 1990, Paradis 2012, 2015), while expressed by the same lexical item, and metonymical variants are instantiated in the same domain. The conventional meaning of the lexical item and the

discursive meaning are in a part-whole relationship created through a construal of salience a zooming in or zooming out (Paradis 2004).

Furthermore, hypernyms and hyponyms are also synonyms in the sense that they share core meanings but differ with respect to specificity or generality as in (5) and (6). Synonyms are construable as a bi-directional coupling, as in if you are rich you are also prosperous or loaded, and if somebody is ambidextrous he or she is also both-handed and *vice versa*. In the case of hypernyms and hyponyms the bi-directionality does not hold. The meaning construal is unidirectional as seen in (5) and (6).

- (5) Mumbling is talking but talking is not necessarily mumbling.
- (6) A dagger is a knife but a knife is not necessarily a dagger.

Finally, antonymy is a binary construal of opposition that holds between two different lexical items in discourse. It is a relation of difference in similarity. Antonyms always evoke opposite properties of one and the same conceptual dimension (Paradis & Willners 2011, Jones et al. 2012). For instance, *good* and *bad* may be used as antonyms along the dimension of MERIT and *good* and *evil* along the dimension of BENEVOLENCE. Interestingly, antonymic lexical items are in fact used in the same semantic contexts also when they are not used to express opposition (Paradis et al. 2015). Contrary to what one may think in the first place, this means that antonymy differs from synonymy in that it thrives on similarity and the members form pairs along one dimension. Given *long*, *short* comes to mind immediately. For this reason, the question ‘What is the opposite of X?’ is easy to answer, while it is hard to find an answer to ‘What is the synonym of X?’. In contrast to the other relations, antonymy is a truly fundamental relation in the sense that it appears to be the most readily apprehended by speakers of a language.

Contrast in perception and bipolar organization in cognition are the underpinnings of antonymy in language. Most speakers have strong intuitions about how antonyms are used and that some antonyms are perceived to be better exemplars than others. Research using different observational techniques has established that there are a number of opposable word pairs that have special status as canonical antonyms (Murphy et al. 2009; Paradis et al. 2009, Paradis & Willners 2011, van de Weijer et al. 2012, van de Weijer et al. 2014). The strength of antonym couplings is determined by factors such as the degree of conventionalization as form–meaning pairs in discourse, the degree of entrenchment as antonymous words in memory, and the salience of the dimensional domain they express, e.g. LUMINOSITY *dark–light*, STRENGTH *weak–strong*, SIZE *small–large*, WIDTH *narrow–wide*. It has been argued that it is the meaning dimension that is the cause of the strength of the lexical relation rather than the effect of the high frequency of these words in language (Murphy & Andrew 1993; van de Weijer et al. 2012). The contentful meaning structures, e.g. LUMINOSITY, STRENGTH, of the dimensions that form the base of canonical antonyms, coincide with the core of semantic types that are central to all human activities, and as noted by Dixon (2009).

2.4 The Distributional Perspective

Distributional semantics is a rich family of computational models assuming that the statistical distribution of words in linguistic context plays a key role in characterizing their semantic behavior. The theoretical foundation of distributional semantics is what has become known as the Distributional Hypothesis: *Lexemes with similar distributional properties have similar*

meanings. Distributional semantics has been attracting a growing interest especially in the last twenty years, but its roots are much older. They lie in linguistic and philosophical traditions that, despite being substantially different, share the common assumption that *the meaning of words must be described by looking at how they are used in language*.

Zellig Harris is usually referred to as the theoretical and methodological source of research in distributional semantics: “If we consider words or morphemes A and B to be more different in meaning than A and C, then we will often find that the distributions of A and B are more different than the distributions of A and C. In other words, difference of meaning correlates with difference of distribution.” (Harris, 1954: 156). In his later works, Harris characterizes linguistic distributions in terms of syntactic dependencies involving relations between a word acting as *operator* and a word acting as its *argument*. The “selection” (that is, the distribution) of a word is the set of operators and arguments with which it co-occurs with a statistically significant frequency, and is strongly correlated to its meaning. According to Harris, meaning “is a concept of no clear definition” (Harris 1991: 321), but distributional analysis can turn it into a measurable, objective and therefore, scientific notion: “Selection is objectively investigable and explicitly statable and subdividable in a way that is not possible for meanings - whether as extension and referents or as sense and definition.” (Harris 1991: 329). The goal of Harris’ distributional programme is therefore not to exclude meaning from the study of language, but rather to provide a scientific foundation for its investigation.

Distributional semantics is a direct product of American structuralism, but it is also strongly indebted to European structural linguistics. The (semantic) relation between two words or morphemes is defined differentially, based on their distributional behavior. Like for De Saussure, words have meaning only within a linguistic system, in which they are used and entertain various relations with other expressions. Jakobson (1959) calls the knowledge of such relations “linguistic acquaintance”, whose importance supersedes the role of the “direct acquaintance” with the entities words refer to. The latter may even be lacking (for instance, we can use *ambrosia* correctly even without direct experience of its referent), while linguistic acquaintance is an essential condition to understand the meaning of any lexeme. Structural semantics proceeded independently from distributionalism, but the latter was often adopted as a method to define paradigms in terms of syntagmatic relations. The Distributional Hypothesis can indeed be reformulated in stricter structuralist terms (Sahlgren 2006): *Lexemes that share syntagmatic contexts have similar paradigmatic properties*. For instance, Apresjan (1966) referred to Harris’ distributional methodology as a way to provide more objectivity to the investigation of semantic fields by grounding it on linguistic evidence. Apresjan carried out a distributional analysis of adjectives in terms of their frequency of co-occurrence with various syntactic contexts. The interplay between syntagmatic and paradigmatic dimensions is also central for Cruse (1986): The greater the paradigmatic “affinity” of lexical items, the more congruent their patterns of syntagmatic relations.

The idea that distributional analysis is the key to understand word meaning has also flourished within the linguistic tradition stemming from John Firth. In fact, corpus linguistics represents another important root of distributional semantics. Firth’s contextual theory of meaning was based on the assumption that meaning is a very complex, and multifaceted reality, inherently related to language use in contexts (e.g., social setting, discourse, etc.). One of the key “modes” of meaning of a word is what he calls “meaning by collocation” (Firth 1951), determined by the context of surrounding words. The study of collocations has kept on growing as an independent line of research, but its theoretical assumptions and methods are deeply intertwined with distributional semantics. Finally, another crucial philosophical reference for distributional semantics is represented by the usage-based view of meaning developed by

Ludwig Wittgenstein in his later writings. In the *Philosophical Investigations*, Wittgenstein urges us not to assume a general and fixed meaning of words. Instead, we should look at *how* the words are being used, because “the meaning of a word is its use in the language.” (Wittgenstein 1953).

2.4.1. Distributional Semantic Models

The Distributional Hypothesis is a general assumption on the relationship between meaning and linguistic distributions, and states that the semantic similarity of lexical items is a function of their distribution in linguistic contexts. Distributional Semantic Models (DSMs) are computational methods that turn this hypothesis into a scientific framework for semantic analysis. DSMs are also commonly referred to as *word space models*, *semantic space models*, (*semantic/distributional*) *vector space models*, *geometrical (semantic) models*, *context-theoretic semantic models*, *statistical semantic models* or *corpus-based semantic models*. These names emphasize different aspects of the way DSMs learn and represent the semantic content of lexical items. DSMs form a vast multifarious family of computational models often developed within very different research traditions and for diverse purposes (e.g. information retrieval, natural language processing, cognitive modelling, and so on), but they all share the following principles: words are represented as vectors built from their distribution in the contexts extracted from corpora, and similarity between words is approximated in terms of geometric distance between their vectors.

The standard organization of DSMs is usually described as a four-step method (Turney & Pantel 2010):

1. for each target word, contexts are first collected from a (usually large) corpus and counted to build a *co-occurrence matrix*. The matrix rows correspond to the target lexemes and its columns to the contexts;
2. raw frequencies are then transformed into significance scores (e.g., positive pointwise mutual information) that are more suitable to reflect the importance of the contexts to characterize the target lexemes;
3. the resulting matrix tends to be very large and sparse, requiring techniques to limit the number of dimensions, such as Singular Value Decomposition or Principal Component Analysis.
4. finally, a similarity score is computed between the vector rows, using various vector similarity measures, the most common one being the cosine.

DSMs have many design options, due to the variety of parameters that can be set up at each step of the process and may affect the results and performances of the system. The definition of contexts is surely a crucial parameter in the implementation of the models. Three types of linguistic environments have been considered: in *document-based models*, as in *Latent Semantic Analysis* (LSA) (Landauer & Dumais, 1997), words are similar if they appear in the same documents or in the same paragraphs; *word-based models* consider a linear window of collocates around the target words (Lund & Burgess, 1996; Sahlgren, 2006); *syntax-based models* are closer to Harris’ approach as they compare words on the basis of their dependency relations (Curran, 2003; Padó & Lapata, 2007; Baroni and Lenci, 2010). Word-based models have an additional parameter represented by the window size (from a few words to an entire paragraph), while syntax-based models need to specify the type of dependency relations that are selected as contexts. Some experiments suggest that syntax-based models tend to identify

distributional neighbors that are taxonomically related, mainly co-hyponyms, whereas word-based models are more oriented towards identifying associative relations (Van de Cruys, 2008; Peirsman *et al.*, 2007; Levy & Goldberg, 2014). However, the question whether syntactic contexts provide a real advantage over linear models is still open. On the other hand, a more dramatic difference exists with respect to document-based models, which are strongly oriented towards neighbors belonging to loosely defined semantic topics or domains (Sahlgren, 2006).

Because of its history and different roots, distributional semantics is a manifold program for semantic analysis, which is pursued in disciplines as different as computational linguistics and psychology. The goals of DSMs are equally various: thesaurus construction, word-sense disambiguation, cognitively plausible models for language acquisition and processing, etc. Within this broad range of applications, we can distinguish between a weak and a strong version of the Distributional Hypothesis (Lenci 2008).

The *Weak Distributional Hypothesis* is essentially a method for semantic analysis. The starting assumption is that lexical meaning (whatever this might be) determines the distribution of words in contexts, and the semantic properties of lexical items act as constraints governing their syntagmatic behavior. Consequently, by inspecting a relevant number of distributional contexts, we can identify those aspects of meaning that are shared by lexemes with similar linguistic distributions. The Weak Distributional Hypothesis assumes the existence of a *correlation* between semantic content and linguistic distributions, and exploits such correlation to investigate the semantic behavior of lexical items. It does not entail that word distributions are themselves constitutive of the semantic properties of lexical items at a cognitive level, but rather that meaning is a kind of “hidden variable” responsible for the distributions we observe, which we try to uncover by analyzing such distributions.

The Strong Distributional Hypothesis is instead a cognitive assumption about the form and origin of semantic representations. Repeated encounters with lexemes in language use eventually lead to the formation of a distributional representation as an abstract characterization of the most significant contexts with which the word co-occurs. Crucially, the Strong Distributional Hypothesis entails that word distributions in context have a specific *causal role* in the formation of the semantic representation for that word. Under this version, the distributional behavior of a lexeme is not just regarded as a way to describe its semantic properties, but rather as a way to explain them at the cognitive level.

The Strong and Weak versions of the Distributional Hypothesis set very different constraints and goals for computational models. Most of the DSMs in computational linguistics usually content themselves with the Weak version, and conceive distributional semantics as a method to endow natural language processing systems with semantic information automatically acquired from corpora. On the other hand, DSMs in cognitive research confront themselves with the potentialities as well the problems raised by the Strong Distributional Hypothesis, which must therefore face the tribunal of the cognitive evidence about semantic representations. In any case, the success of the Distributional Hypothesis, either as a descriptive method for semantic analysis or as an explanatory model of meaning, must be evaluated on the grounds of the semantic facts that it is actually able to explain.

2.4.2. Distributional representations as semantic representations

The main characters of distributional semantics can be summarized as follows:

- the theoretical foundation of distributional semantics is the Distributional Hypothesis. This is primarily a conjecture about semantic similarity, which is modeled as a

function of distributional similarity: *semantic similarity* is therefore the core notion of distributional semantics;

- the Distributional Hypothesis is primarily a conjecture about *lexical meaning*, so that the main focus of distributional semantics is on the lexicon, specifically on content words (i.e., nouns, verbs, adjectives, and adverbs);
- distributional semantics is based on a *holistic* and *relational* view of meaning. The content of lexical items is defined in terms of their (dis)similarity with other lexemes;
- distributional semantics is based on a *contextual* and *usage-based view of meaning*. The content of lexical items is determined by their use in contexts.
- the Distributional Hypothesis is implemented by Distributional Semantic Models. These are computational methods that learn distributional representations of lexical item from corpus data. The distributional representation of a lexeme is a *distributional vector* recording its statistical distribution in linguistic contexts;
- semantic similarity is measured with distributional vector similarity.

What are then the main features of distributional vectors as semantic representations? How do they differ from other types of representations of lexical meaning? As noted above, distributional semantics is strictly and naturally related to the structuralist view of meaning. This follows not only from the history itself of distributional semantics, but also from its relational view of meaning. Like structuralist approaches, distributional semantics considers the meaning of a lexical item as dependent on its relations with the other lexemes in the semantic space. A close “family resemblance” also exists with cognitive models, with which distributional semantics share a usage-based view of meaning.

Stronger differences instead divide distributional semantics from approaches to meaning adopting semantic representations in terms of symbolic structures. In symbolic models, lexical items are mapped onto formal structures of symbols that represent and make explicit their semantic properties. What varies is the formal metalanguage used to build semantic representations (for example, networks, frames, semantic features, recursive feature structures, and so on). Symbolic semantic representations are *qualitative*, *discrete*, and *categorical*. Semantic explanations only refer to the structure of semantic symbols with which lexical meanings are represented. For instance, in a semantic network like WordNet (Fellbaum 1998), the hypernym hierarchy of *car* explains that *John bought a car* entails that *John bought a vehicle*. Semantic similarity is also defined over the lexical symbolic structures, for instance by measuring the overlap between feature lists (Tversky 1977) or the distance in semantic networks (Budnitsky & Hirst 2006).

The characters of distributional semantics also make it quite different from theories of meaning that are not grounded on the Distributional Hypothesis, most notably formal (model-theoretic) semantics. Formal semantics is itself a rich and variegated family of semantic models that share a referential (denotational) view of meaning, based on the assumption that meaning is essentially a relation between the symbols of languages and entities external to language, and that the goal of semantics is to characterize the truth conditions of sentences as a function of the reference (denotation) of their parts. In fact, the core notions of Frege’s programme for formal semantics - truth, reference, and logical form - are as different as possible from those of Harris’ program for distributional semantics — linguistic contexts, use, and distributional vectors. The distance between these two semantic paradigms can be best appreciated by considering the contrast between their main philosophical references: the early Wittgenstein of the *Tractatus Logico-Philosophicus* (Wittgenstein 1922) for formal semantics, and the later Wittgenstein of the *Philosophical Investigations* for distributional semantics. Therefore, it is

no surprise that formal and distributional semantics, as the heirs of these two radically different views on meaning, have proceeded virtually ignoring each other, focussing on totally different semantic phenomena. As a matter of fact, a whole range of issues in the agenda of formal semantics, such as semantic compositionality, quantification, inference, anaphora, modality, or tense, have remained beyond the main horizon of distributional semantics.

Distributional vectors are very different from semantic representations adopted in symbolic and formal models of meaning. Distributional representations are *quantitative*, *continuous*, *gradable* and *distributed*. These properties directly stem from the fact that distributional representations are not symbolic structures, but real-valued vectors. Quantitative and gradable semantic representations are commonly adopted in cognitive science to account for key properties of concepts such as graded category membership, typicality and vagueness (Hampton 2007). Concepts are thus represented with vectors of features, weighted according to their importance for a concept (Smith & Medin 1981, McRae et al. 1997). Vector dimensions are typically derived from semantic feature norms (McRae et al. 2005a, Vinson & Vigliocco 2008), which are collected by asking native speakers to generate properties they consider important to describe the meaning of a word. The number of subjects that listed a certain feature for a concept is then used as feature weight.

The quantitative and gradable character of distributional representations makes them very similar to the way information is represented in artificial neural networks. Connectionist models use non-symbolic distributed representations formed by real-valued vectors such that “each entity is represented by a pattern of activity distributed over many computing elements, and each computing element is involved in representing many different entities” (Hinton et al. 1986: 77). Distributional representations are also distributed because the semantic properties of lexical items emerge from comparisons between their n -dimensional vectors, for example by measuring their similarity in distributional vector space. The semantic content of a word therefore lies in its global distributional history encoded in the vector, rather than in some specific set of semantic features or relations. Neural networks are general algorithms that encode information with vectors of neural unit activations and learn high-order representations from co-occurrence statistics across stimulus events in the environment. Connectionism is fully consistent with the distributional hypothesis, since linguistic co-occurrences are just a particular type of stimuli that can be learnt by neural networks. A natural convergence thus exists between research on neural networks and distributional semantics. In distributional approaches to meaning, lexical representations emerge from co-occurrences with linguistic contexts. Moreover, distributional semantic spaces are built with computational models - including neural networks - that use domain-independent learning algorithms recording the distributional statistics in the linguistic input. Nowadays, neural networks in fact represent one particular family of computational models in distributional semantics.

The notions of distributed and distributional representations are closely related but need to be kept well distinguished. In fact, the former concerns the *way* semantic information is represented with vectors, while the latter concerns the *source* of the information used to build the vectors. The term ‘distributional’ specifically refers to the property of vectors to encode the statistical distribution of lexemes in linguistic contexts. *All distributional representations are distributed, but not all distributed representations are distributional*. It is indeed possible to represent words with distributed semantic representations that are not distributional. Vector space representations of meaning are in fact common in cognitive science (Markman 1999). Osgood (1952) and Osgood et al. (1957) are among the first models of concepts in terms of n -dimensional semantic spaces. However, the dimensions of Osgood’s semantic spaces are not distributional, but are built according to the method of “semantic differential”: subjects are

asked to locate the meaning of a word along different scales between two polar adjectives (e.g., *happy - sad*, *slow - fast*, *hard - soft*, etc.), and their ratings are used to determine its position in the semantic space, which mainly capture connotative aspects of meaning. Rogers & McClelland (2004) use a neural network to learn distributed representations with vector dimensions encoding specific semantic properties (e.g., *has_wings*, *flies*, *is_a_plant*, etc.), and computational simulations with distributed representations derived from feature norms are proposed by Cree et al. (1999) and Vigliocco (2004). Gärdenfors (2000, 2014) represents concepts and lexical meanings with regions in “conceptual spaces”. These are defined as vector spaces whose dimensions are “qualities” of objects, corresponding to the different ways stimuli are judged to be similar or different, such as weight, temperature, height, etc. In Gärdenfors’ classical example, colours are characterized by a three-dimensional vector space defined by hue, brightness, and saturation. The meaning of a colour term like *red* is then identified with a region in this colour space, and colour similarities are defined via the distance of the corresponding regions in space. The geometrical representation of concepts proposed by Gärdenfors indeed closely resembles vector-based representations adopted in distributional semantics, but the dimensions of conceptual spaces correspond to attributes of objects, rather than to linguistic contexts.

3. Empirical challenges: two illustrations.

In the introduction we identified five questions that are crucial for all treatments of meaning in language. In relation to lexical semantics, they concern the nature of lexical meaning, what the relation between words and their meanings are, how meanings are learnt, stored, communicated and understood, and how they change. Section 2 has broadly followed these as guiding questions in reviewing and comparing the main approaches to lexical semantics. In this concluding section we will invert the perspective and consider two specific empirical domains and the challenges that they pose, namely colour terms and semantic flexibility in context. The two are viewed from different perspectives, which foreground respectively the need for extensive and carefully constructed data sets, and the need for a clear delineation (theoretical as well as empirical) of what counts as “lexical item” and how it is modelled, for any data-driven conclusion about the mental lexicon and generally about the role of language in cognition.

3.1 Colour terms.

What all approaches have in common is the need for empirically-based observation in one form or another, be they textual or experimental. In much of today’s research on lexical meaning we often see a combination of methods facilitated by the rapid development of technical knowledge when it comes to theoretical computational advances as well as when it comes to technical equipment for data storage and analysis. For all approaches, we also see the need for proper integration with mental processes related to the cognitive system (categorization and reasoning), to the perceptive and affective systems, and to the role of communication, that is,

how human beings make use of language to make themselves understood and to obtain responses to what they are saying.

The colour domain has been one of the most investigated, as well as one of the most “popular” areas within the realm of lexical semantics. The study that changed the investigation of colour terms is the famous Berlin and Kay’s study of colour terms in various languages (1969). It has become a backbone for other types of research of colour terms and it has been further developed since its publication. As pointed out by Majid, Jordan and Dunn (2015), the methodology given by Berlin and Kay was refined in the World Colour Survey (Kay et al., 2009) – the largest ever empirical study of semantics, featuring 110 languages spoken primarily by small-scale, preliterate, non-industrialised communities. The World Colour Survey enabled researchers to show cross-linguistic differences in colour naming that reflect cognitive principles and to point to differences in boundaries that languages impose onto the colour spectrum. As emphasized by Majid, Jordan and Dunn (2015), Berlin and Kay’s work has been an inspiration for many types of research, but it has been also criticised for over-sampling or under-sampling Indo-European (IE) colour terms. Research on colour terms was conducted with regard to some IE sub-families, like Slavic (Comrie and Corbett 1993), but no large-scale investigation has been undertaken. Therefore, there was room for a more integrative study that would take into account data from a large number of IE languages. Such an endeavour was a project called Evolution of Semantic Systems (EOSS). The project was conducted at Max Planck Institute for Psycholinguistics (Nijmegen) from 2011 to 2014 and included research on 50 IE languages. The project was grounded on linguistic, psychological and anthropological theoretical frameworks. One of the basic goals of the project was to investigate colour terms speaker use in the partition of the colour spectrum. Research on colour terms within the EOSS project consisted of several different trials with adult participants. The empirically-based results from the project enabled further investigation of lexicalization patterns speakers use in colour naming and thus conveying different meanings. First, it enabled a cross-linguistic analysis of genetically related languages. For example, a cross-linguistic analysis of lexicalization patterns used in colour naming in Croatian, Polish and Czech (Raffaelli, Kopecka, Chromý, 2016) showed a high degree of correlation between word-formation processes and the meanings that are conveyed by particular colour terms. Thus, for example all the three languages use suffixes like -kast (Cro), -aw (Pol) or -av (Cz) to convey the meaning ‘ish’ like *zelenkast* ‘greenish’, or -ast (Cro), -ow (Pol) or -ov (Cz) with the meaning ‘N-like’ like *narančast* ‘orange-like’. However, Polish and Czech have some additional suffixes with meanings that do not appear in Croatian like -sk- / -ck- ‘typical for’ (Cz) or -n- ‘made of’ (Pol). Second, results from the research based on the psycholinguistic methods (the frequency data of the terms used in the partition of the colour spectrum) enabled comparison to the data collected via other empirically-based methods. For example, the EOSS data for Croatian were compared to the frequency data from the Croatian n-gram system (based on the Web as Corpus approach) consisting of 1.72 billion tokens (Dembitz et al., 2014). The 165 different Croatian colour terms (types) from the EOSS project were checked in the Croatian n-gram system in order to provide evidence about their attestation in a large language resource. Moreover, the combination of two different methods shed light on correlation between strategies speakers use in colour-naming, and, according to the corpus data, about their conventionalization. The frequency data from the Croatian n-gram system show that basic colour terms are significantly the most frequent terms, thus highly conventionalized. The data also show that compounding is a more pervasive process in the formation of colour terms in Croatian than derivation (that is usually more productive in the formation of new lexemes). It means that compounding allows for a more

fine-grained naming of the colour spectrum and allows for greater creativity in colour naming than derivation does. There is also a high degree of frequency correlation between the most frequent compound terms in the two data sets. The compound *zeleno-plava* ‘green-blue’ and *plavo-zelena* ‘blue-green’ are the most frequent compound terms. These terms cover the central and the largest part of the colour spectrum (typical for all the IE languages) and according to the corpus data refer to phenomena in nature like, sea, water, different types of plants, etc. The combination of the two methods also showed the continuum of more and less conventionalized terms and, thus, their cognitive entrenchment. Terms less frequently used by speakers in the process of colour naming are also the less frequent terms in the corpus.

The combination of the two empirically based methods could have impact on future research of the correlation between perception and cognition as universal human capacities and the constraints imposed by cultural differences and typological differences of languages on the formation of lexical items.

Interesting evidence on the interplay between language and perception comes from the study of congenital blind subjects, who show a close similarity with sighted subjects in the use and understanding of colour terms. In a multidimensional scaling analysis performed by Marmor (1978) with similarity judgments about colour terms, the similarity space of the congenitally blind subjects closely approximates the Newton’s colour wheel and judgments by sighted control participants. Therefore, she concludes that knowledge of colour relations can be acquired without first-hand sensory experience. The congenital blind child studied by Landau and Gleitman (1985), Kelli, was indeed able to acquire impressive knowledge about colour terms, including the constraints governing their correct application to concrete nouns, without overextending them to abstract or event nouns. The common interpretation of these data is that congenitally blind people possess substantial knowledge about the visual world derived through linguistic input. Language-derived information either comes in the form of “supervised” verbal instructions (e.g., teaching that cherries are red) or in the form of “unsupervised” distributional analysis of linguistic contexts. Language, in fact, contains expressions such as *yellow banana* or *red cherry* that can be used to learn information about colour-noun associations, as well as the general constraints concerning the applicability of colour adjectives or visual verbs only to particular noun classes.

On the other hand, the similarities between colour spaces in congenitally blind subjects are not fully uncontroversial. For instance, Shepard & Cooper (1992) find important differences between the colour spaces of sighted and congenitally blind subjects, differently from Marmor (1978). Connolly et al. (2007) also show that the lack of visual experience of colours indeed has significant effects for the conceptual organization in blind subjects. They collect implicit similarity judgments in an odd-man-out task about two categories of concepts, “fruits and vegetables” and “household items”. Cluster analysis of the similarity judgments reveals a major overlap between the blind and sighted similarity spaces, but significant differences for clusters of the “fruit and vegetables” category for which colour is a “diagnostic” property (i.e., critical to identify the exemplars of that category, such as being yellow for a banana). Even for blind subjects with good knowledge of the stimulus colour, this is not relevant to organize the similarity space. The hypothesis by Connolly et al. is that such contrast stems from the different origin of colour knowledge in the two groups. In the congenital blind, colour knowledge is “merely stipulated”, because it comes from observing the way colour terms are used in everyday speech, while in the sighted it is an immediate form of knowledge derived from direct sensory experience, and used to categorize new exemplars. Similar differences have been found in the feature norming study by Lenci et al. (2013a): Congenitally blind subjects in fact

produced significantly less colour terms when describing concrete objects than sighted control subjects (Lenci et al. 2013b). These contrasting evidences show that, on the one hand, distributional information is rich enough to allow the organization of the colour space to be derived from the linguistic input, while on the other hand the lack of direct perceptual experience may result in critical differences in the role of and use of colour information.

The role of linguistic and perceptual information as sources of semantic representation is still a puzzle with many missing pieces. New technologies that enable new experiments, precisely calculated results and data collected via different methods should be considered as the methodological backbone of contemporary research in lexical semantics, and as the only way to fill these gaps. Experientially-based approaches to lexical semantics can provide evidence about how word meanings are construed, to what extent they are conventionalized and how much they are influenced by perception and cognition or by cultural diversity and different typological properties. The examples given above are just an illustration of an attempt to integrate traditional and theoretically well elaborated topics with empirically-based methods.

3.2 Coercion and semantic flexibility in context.

It is a simple fact that words assume different meanings in different contexts. If this plasticity had no bounds, any word could mean anything, given an appropriate context. Since that is not the case, a notion of lexical content distinct from that determined by context of use is justified; but it is a content that is at least partly shaped by its context. For this reason, investigating the boundaries of context-determined flexibility is and has been a central task of research in lexical semantics (see already Cruse 1986). This traditional topic, extensively addressed in structural and cognitive approaches, acquires a particular prominence also in ‘formal’ models with the advent of analyses that decompose lexical items into complex formal structures (syntactic or otherwise). In rough general terms, if lexical content is modelled as a linguistically represented structure, embedded in a larger structure, the question of what constrains lexical semantic flexibility in context is resolved into the question of how lexical meaning can and cannot be structurally decomposed. Among the large number of phenomena and competing approaches, we can concentrate here specifically on the phenomenon of coercion, whereby a context enforces an interpretation on a lexical item that lacks it in any other contexts. The typical illustrations involve entity-denoting nominals coerced into a different interpretation by predicates that take eventualities as arguments:

- (7) a Syd grabbed the book / cigar / bottle of wine.
b Syd enjoyed the book / cigar / bottle of wine.

Asher (2011: 16) observes that what drives this adaptation cannot be the semantics of the nominal object, because the same effect is replicated when this is a non-existent word like *zibzab*:

- (8) Syd enjoyed the zibzab.

Not every predicate can freely impose its requirements, however. Still following Asher (2011: 215), we can observe that the modifier *slow* qualifies a processual notion licensed by the head noun in *a slow person* (‘slow in understanding’) or *a slow animal* (‘slow in moving’), but not in the semantically anomalous *a slow tree*, although world knowledge could in principle license the reading ‘a slow-growing tree’. Likewise, we can *enjoy an apple* or *finish an apple*, but not

really *end an apple*; and the previous mention of a relevant discourse entity allows us to interpret *start with the kitchen* as ‘start *painting* the kitchen’ in (9b), but not in (3c) (adapted from Asher 2011: 19-20):

- (9) a ? Yesterday, Sabrina started with the kitchen.
b Yesterday, Sabrina painted her house. She started with the kitchen.
c ? Last month, Sabrina painted her cousin’s house. Then today, she started with the kitchen.

Positing articulated structures for the content of lexical items with different properties (like *end* and *finish*), and providing explicit constraints on how these meanings combine in context, is one way to approach these phenomena. By this move, “coercion is not really a problem about meaning change in the lexicon; it’s a problem about compositionality - about how lexically given meanings combine together in the right sort of way” (Asher 2011: 18). This aspect assumes particular prominence in syntactic decomposition approaches, which analyze lexical content in terms of the same types of formal objects (structures, primitives, combinatorial principles) as those that define linguistic contexts. Crucially, when decompositional analyses are sufficiently precise, their empirical value can be compared across different models and frameworks. Asher (2011: 252-255) presents some empirical arguments against the generalized use of abstract verbs for ‘locative’ or ‘possessive’ functions (Harley 2004, 2009, Cable 2011, among others), but he also notes that structures like *want a beer* effectively seem to motivate one extra verbal predicate represented in the syntactic structure, not just as a lexical inference; this is what licenses *rapidly* in (10a) but not (10b), as a modifier of an abstract ‘have’ predicate in a subordinate clause:

- (10) a John wanted his stitches out rapidly.
b ? The dog enjoyed his food rapidly.

More recently, Larson (2011) provided additional independent evidence for a hidden clausal structure as a uniform complement of *want* (and other intensionality-inducing verbs). Importantly, the clausal analysis that Larson argues for descends from a hypothesis on the *semantics* of verbs like *want*; it therefore predicts (successfully) the existence of similar phenomena also in other languages, insofar as volitional predicates can be identified. It should be noted that Larson’s syntactic analysis (like Cable’s) does not incorporate all the assumptions of Harley’s original Distributed-Morphological account.

At least for certain verbal predicates, then, a decompositional analysis is empirically well established and, more importantly, not limited to any one technical framework. If a notion of ‘lexical item’ is revealed as oversimplistic for at least those cases, on language-internal grounds, it is at least a reasonable hope to see these results subjected to critical assessment on experimental grounds, by psycho- and neurolinguistic approaches to the mental lexicon. A failure to take them into account leads to attributing properties (content, priming potential, ease of retrieval) to assumed ‘lexical items’ whose existence is in fact not motivated if not as morphological or phonological entities.

Beside this generic consideration, which is enough to cast doubts on naive approaches to lexical semantics that simplistically assume ‘words’, interdisciplinary perspectives arise more specifically in connection with coercion. This label groups together various phenomena of polysemy in context, which evidently have a major importance for a proper understanding of lexical knowledge as a psychological phenomenon and its neurological grounding. If linguistic

data can shed light on the way lexical knowledge is structured and distributed over formal representations (say, with the morphosyntactic representation *want [a cigar]* mapped to an abstract clausal structure WANT [HAVE CIGAR]), psycholinguistic investigations are indispensable for understanding the dynamic aspect of this phenomenon: what distinct sense components are activated in processing, for instance, and how they relate to non-linguistic background knowledge (if a clear divide can be drawn). The very fact that, for instance, *end* and *finish* have different coercion properties shows that contextual flexibility varies lexically and does not entirely reduce to encyclopaedic inferences; at the same time, however, we need to know how much of the information that goes into activating different senses is a function of linguistic knowledge, and how much of it derives from non-linguistic knowledge - if the two can be discriminated, something which grammatical theory alone cannot verify. Similarly, it is well known that languages with a clear mass-count opposition in nominals differ in how easily they allow nouns to be coerced into a non-favoured interpretation (as in *there is still a lot of car to paint*), a fact which highlights the language- and grammar-dependent nature of this type of coercion. A traditional approach would take for granted that terms that are more or less intertranslatable like the English *car* and the French *voiture* (with due allowance to the lack of perfect synonymy, within and across languages) are also directly comparable in terms of the conceptual content they express. If that is indeed the case, any differences in flexibility between the two must depend on grammar, not on the conceptual content, which is invariant by hypothesis. In other words, if *car* can be used in mass contexts like ‘a lot of car’ much more easily than *voiture*, the explanation would have to lie in the different grammars of the two languages, not in the concepts encapsulated by the lexical items. But there is no clearcut divide between ‘grammar’ and ‘lexical item’ in most decompositional accounts. In this approach, any asymmetry in linguistic flexibility derives from properties of the grammatical representation which are directly reflected in the conceptual content of these nouns. It would be extremely instructive to complement this theoretical stance with observable evidence suggestive of asymmetries in conceptual representation, or in the possibility to activate certain senses in a given context of use.

The flexibility of word interpretations in contexts has been extensively investigated in distributional semantics. Erk & Padó (2008) use a DSM to address a crucial aspect of compositionality, namely the fact that when words are composed, they tend to affect each other’s meanings. This phenomenon is related to what Pustejovsky (1995) refers to as “co-compositionality”. For instance, the meaning of *run* in *The horse runs* is different from its meaning in *The water runs* (Kintsch 2001). Erk & Padó (2008) claim that words are associated with various types of expectations (typical events for nouns, and typical arguments for verbs (McRae et al. 2005b) that influence each other when words compose, thereby altering their meaning. They model this context-sensitive compositionality by distinguishing the lemma vector of a word w_1 (i.e. its out-of-context representation), from its vector in the context of another word w_2 . The vector-in-context for w_1 is obtained by combining the lemma vector of w_1 with the lemma vectors of the expectations activated by w_2 . For instance, the vector-in-context assigned to *run* in *The horse runs* is obtained by combining the lemma vector of *run* with the lemma vectors of the most typical verbs in which *horse* appears as a subject (e.g. *gallop*, *trot*, etc.). Like in Mitchell & Lapata (2010), various functions to build vectors in contexts are tested. Erk and Padó (2008) evaluate their model for context-sensitive vector representation to predict verb similarity in context (for instance *slump* in the context of *shoulder* is more similar to *slouch* than to *decline*) and to rank paraphrases.

Distributional analyses have also been proposed for cases of coercion like (1) and (3) (Lapata & Lascarides 2003; Zarcone et al. 2013). Such models assume that the retrieved event (like reading in *the man began the book*) is the event most compatible with corpus-derived knowledge about typical events and their participants. This is in contrast to traditional accounts of coercion (Pustejovsky 1995) which ascribe covert event retrieval to complex lexical entries associating entities with events corresponding to their typical function or creation mode (e.g., qualia roles). Distributional semantics can thus provide a more economical and general explanation of phenomena like coercion that challenge formal models of compositionality. Moreover, the advantage of distributional approaches to coercion is that they can account for psycholinguistic evidence showing the influence of context on the interpretation of coercion sentences (Zarcone et al. 2014). For example, given *baker* and *child* as subjects of *finish the icing*, *baker* will cue *spread* as a covert event, while *child* will cue *eat* (even though it is perfectly possible that bakers eat icing or that children spread it).

Generally speaking, hypotheses framed in the terms of grammatical theories tend to lack independent evidence when it comes to deciding not *how* to model linguistic information, but *whether* some information is part of linguistic knowledge or not. The very notion of “sense” could be brought into sharper focus by crossing the results of formal linguistic and experimental investigations, so that what counts as a meaning “component” for grammatical analysis is at the same time independently validated on psycholinguistic grounds, and viceversa. In turn, an independently validated delineation of senses would prove useful in solving the central question whether speakers represent them as a continuum, or whether they are grouped together under a general category corresponding to a semantic item of the mental lexicon - and in that case, whether this is stored and assessed as a listeme, and to what extent its content coincides with what is posited on purely language-internal grounds.

These are, as is clear, just a few suggestions on how a closer synergy between linguistic, psycholinguistic, and neurolinguistic approaches to lexical semantic coercion could contribute to a better understanding of the mental lexicon.

Conclusion

The positions outlined in this chapter illustrate different, quite often incompatible perspectives on lexical semantics. In this they reflect the considerable diversity that characterizes linguistics as a whole. The chapter has reviewed the four key approaches that have emerged in the study of lexical semantics, with the goal of clarifying their historical background, their specific differences, the methodological and theoretical assumptions that lie behind those differences, and the main strengths and the main challenges of each perspective.

A certain degree of complementarity is inevitable in such a diverse theoretical landscape. It should be noted that behind each of the main perspectives lies a vast number of studies and often quite divergent priorities. When we move away from fundamental assumptions and programmatic goals, it becomes clear that the various perspectives prove anything but equivalent in their ability to successfully deal with the various aspects of lexical knowledge such as synonymy and antonymy, attested ranges of lexicalization patterns, compositionality of meaning in complex words, paradigmatic patterns across related lexical items, family-resemblance effects, context-induced malleability, flexibility of meaning in use, context-invariant patterns. The questions that arise in the study of the mental lexicon and of lexical

structures bring this complementarity into sharp focus. Over and above the requirements of a linguistic theory of lexical knowledge, the various approaches must provide an analytical framework that can be naturally compared, and preferably reconciled, with the results of psycholinguistic and neurolinguistic investigation.

It would be wrong, however, to see linguistic theories of lexical meaning as inevitably incomplete rival models, in need of validation from mind and brain sciences. Psychological and neurological methods of analysis cannot lead to useful results about the relation between cognition and language, and specifically of lexical knowledge, without assuming a model of what lexical knowledge consists of: how it is organized, what its semantic building blocks are, what a 'lexical item' is precisely, what the role of context and of non-linguistic knowledge is, and how these aspects relate to background assumptions about linguistic meaning. The models of lexical meaning we have reviewed articulate different answers to this type of questions, and in their ongoing development they have amassed a wealth of results and partial conclusions that deserve to be integrated (and challenged) by any investigation of the nature of lexical meaning.

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