Sense Relations

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March 25, 2014

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This article explores the definition and interpretation of the traditional paradigmatic sense relations such as hyponymy, synonymy, meronymy, antonymy, and syntagmatic relations such as selectional restrictions. A descriptive and critical overview of the relations is provided in section 1 and in section 2 the relation between sense relations and different theories of word meaning is briefly reviewed. The discussion covers early to mid twentieth century structuralist approaches to lexical meaning, with its concomitant view of the lexicon as being structured into semantic fields, leading to more recent work on decompositional approaches to word meaning. The latter are contrasted with atomic views of lexical meaning and the capturing of semantic relations through the use of meaning postulates.

1. Introduction

Naive discussions of meaning in natural languages almost invariably centre around the meanings of content words, rather than the meanings of grammatical words or phrases and sentences, as is normal in academic approaches to the semantics of natural languages. Indeed, at first sight, it might seem to be impossible to construct a theory of meaning of sentences without first uncovering the complexity of meaning relations that hold between the words of a language that make them up. So, it might be argued, to know the meaning of the sentence *Matthew rears horses* we need also to at least know the meaning of *Matthew rears animals* or *Matthew breeds horses*, since horses are a kind of animal and rearing tends to imply breeding. It is in this context that the notion of *sense relations*, the meaning relations between words (and expressions) of a language, could be seen as fundamental to the success of the semantic enterprise. Indeed, the study of sense relations has a long tradition in the western grammatical and philosophical traditions, going back at least to Aristotle with discussions of relevant phenomena appearing throughout the medieval and later literature. However, the systematisation and taxonomic classification of the system of sense relations was only taken up in the structuralist movements of the twentieth century, particularly in Europe following the swift developments in structuralist linguistics after de Saussure. This movement towards systematic analyses of word sense was then taken

up in the latter part of that century and the early part of the twenty-first century in formal modelling of the sense relations and, in particular, the development of computational models of these for the purposes of natural language processing.

The notion of 'sense' in this context may be variously interpreted, but is usually interpreted in contrast to the notion of *reference* (or, equivalently, *denotation* or *extension*). The latter expresses the idea that one aspect of word meaning is the relation between words and the things that they can be used properly to talk about. Thus, the reference/denotation of *cat* is the set of all cats (that are, have been and will be); that of *run* (on one theoretical approach), the set of all past, present and future events of running (or, on another view, the set of all things that ever have, are or will engage in the activity we conventionally refer to in English as *running*). Sense, on the other hand, abstracts away from the things themselves to the property that allows us to pick them out. The sense of *cat* is thus the property that allows us to identify on any occasion an object of which it can truthfully be said *that is a cat* - 'catness' (however that might be construed, cognitively in terms of some notion of concept, see for instance Jackendoff 2002 or model-theoretically in terms of denotations at different indices, see Montague 1974). Sense relations are thus relations between the properties that words express, rather than between the things they can be used to talk about (although, as becomes clear very quickly, it is often very difficult to separate the two notions).

Whether or not the study of sense relations can provide a solid basis for the development of semantic theories (and there are good reasons for assuming they cannot), nevertheless the elaboration and discussion of such meaning relations can shed light on the nature of the problems we confront in providing such theories, not least in helping to illuminate features of meaning that are truly amenable to semantic analysis and those that remain mysterious.

2. The basic sense relations

There are two basic types of sense relation. The most commonly presented in introductory texts are the *paradigmatic* relations that hold between words of the same general category or type and that are characterised in terms of contrast and hierarchy. Typically, a paradigmatic relation holds between words (or word-forms) when there is choice between them. So given the string *John bought a*, it is possible to substitute any noun that denotes something that can be bought: *suit, T-shirt, cauliflower, vegetable, house, ...*. Between some of these words there is more to the choice between them than just the fact they are nouns denoting commodities. So, for example, if *John bought a suit* is true then it follows that *John bought a pair of trousers* is also true by virtue of the fact that pairs of trousers are parts of suits and if *John bought a cauliflower* is true then *John bought a vegetable* is also true, this time by virtue of the fact that cauliflowers are vegetables.

The second type of sense relations are *syntagmatic* which hold between words according to their ability to co-occur meaningfully with each other in sentences. Typically syntagmatic sense relations hold between words of different syntactic categories or (possibly) semantic types such as verbs and nouns or adverbs and prepositional phrases. In general, the closer the syntactic relation between two words such as between a head word and its se-

mantic arguments or between a modifier and a head, the more likely it is that one word will impose conditions on the semantic properties the other is required to show. For example, in the discussion in the previous paragraph, the things that one can (non-metaphorically) buy are limited to concrete objects that are typically acceptable commodities in the relevant culture: in a culture without slavery adding *boy* to the string would be highly marked. As we shall see below, there is a sense in which these two dimensions, of paradigm and syntagm, cannot be kept entirely apart, but it is useful to begin the discussion as if they do not share interdependencies.

Of the paradigmatic sense relations there are three basic ones that can be defined between lexemes, involving sense inclusion, sense exclusion and identity of sense. Within these three groups, a number of different types of relation can be identified and, in addition, to these other sorts of sense relations, such as part-whole, have been identified and discussed in the literature. As with most taxonomic endeavours, researchers may be 'lumpers', preferring as few primary distinctions as possible, and 'splitters' who consider possibly small differences in classificatory properties as sufficient to identify a different class. With respect to sense relations, the problem of when In this article, I shall deal with only those relations that are sufficiently robust as to have become standard within lexical semantics: antonymy, hyponymy, synonymy and meronymy to define an additional distinction within the taxonomy gives rise to questions about the relationship between knowledge of the world and knowledge of a word: where does one end and the other begin (cf. 33. World knowledge vs. word knowledge). In general, finer points of detail will be ignored in this article and the discussion will be confined to the primary, and generally accepted, sense relations, beginning with hyponymy.

2.1 Hyponymy

Hyponymy involves specific instantiations of a more general concept such as holds between *horse* and *animal* or *vermilion* and *red* or *buy* and *get*. In each case, one word provides a more specific type of concept than is displayed by the other. The more specific word is called a *hyponym* and the more general word is the *superordinate* which are also referred to as *hyperonyms* or *hypernyms*, although the latter is dispreferred as in non-rhotic dialects of English it is homophonic with hyponym. Where the words being classified according to this relation are nouns, one can test for hyponymy by replacing X and Y in the frame 'X is a kind of Y' and seeing if the result makes sense. So we have '(A) horse is a kind of animal' but not '(An) animal is a kind of horse' and so on. A very precise definition of the relation is not entirely straightforward. One obvious approach is to have recourse to class inclusion, so that the set of things denoted by a hyponym is a subset of the set of things denoted by the superordinate. So the class of buying events is a subset of the class of getting events. This works fine for words that describe concrete entities, but becomes metaphysically more challenging when abstract words like *thought emotion*, *belief* etc. are considered. More importantly there are words that may be said to have sense but no denotation such as *phoenix*, *hobbit*, *light sabre* and so on. As such expressions do not pick out anything in the real word they can be said to denote only the empty set and yet, obviously, there are properties that such entities would possess if they existed that would

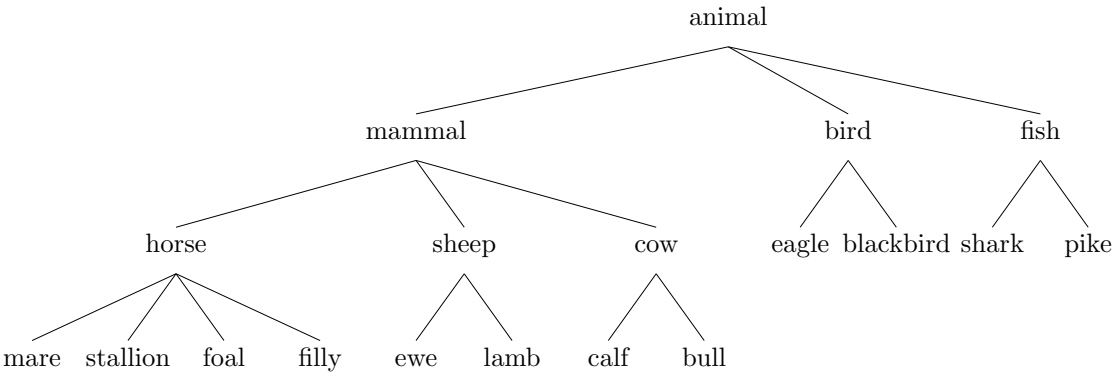

Figure 1: Hyponyms of *animal*

enable us to tell them apart. A better definition of hyponymy therefore is to forego the obvious and intuitive reliance on class membership and define the relation in terms of sense inclusion rather than class inclusion: the sense of the superordinate being included in the sense of the hyponym. So a daffodil has the sense of flower included in it and more besides. If we replace 'sense', as something we are trying to define, with the (perhaps) more neutral term 'property', then we have:

(1) *Hyponymy*: X is a hyponym of Y if it is the case that if anything is such that it has the property expressed by X then it also has the property expressed by Y

Notice that this characterisation in terms of a universally quantified implication statement, does not require there to be actually be anything that has a particular property, merely that if such a thing existed it would have that property.

Furthermore, in general if X and Y are hyponyms of Z (*co-hyponyms*, where two words can be defined as co-hyponyms just in case they share the same superordinate term and one is not a hyponym of the other, then they are generally incompatible (unless they are synonymous). For example, *horse, cat, bird, sheep*, etc. are all co-hyponyms of *mammal* and all mutually incompatible with each other: **That sheep is a horse.* Hyponymy is a transitive relation so that if X is a hyponym of Y and Y is a hyponym of Z then X is a hyponym of Z: *foal* is a hyponym of *horse*, *horse* is a hyponym of *animal*, so *foal* is a hyponym of *animal*. This sort of property indicates how hyponymy imposes partial hierarchical structure on a vocabulary. Such hierarchies may define a taxonomy of (say) natural kinds as in Figure 1. Complete hierarchies are not common, however. Often in trying to define *semantic fields* of this sort, the researcher discovers that there may be gaps in the system where some expected superordinate term is missing. For example, in the lexical field defined by *move* we have hyponyms like *swim*, *fly*, *roll* and then a whole group of verbs involving movement using legs such as *run, walk, hop, jump, skip, crawl*, etc. There is, however, no word in English to express the concept that classifies the latter group together. Such gaps abound in any attempt to construct a fully hierarchical

lexicon based on hyponymy. Some of these gaps may be explicable through socio-cultural norms (for example, gaps in kinship terms in all languages), but many are simply random: languages do not require all hierarchical terms to be lexicalised. That is not to say, however, that languages cannot express such apparently superordinate concepts. As above, we can provide the concept required as superordinate by modifying its apparent superordinate to give *move using legs*. Indeed, Lyons (1977) argues that hyponymy can in general be defined in terms of predicate modification of a superordinate. Thus, *swim* is *move through fluid*, *mare* is *female horse*, *lamb* is *immature sheep* and so on. This move pushes a paradigmatic relation onto some prior syntagmatic basis:

> Hyponymy is a paradigmatic relation of sense which rests upon the encapsulation in the hyponym of some syntagmatic modification of the sense of the superordinate relation. Lyons (1977:294)

Such a definition does not work completely. For example, it makes no sense at the level of natural kinds (is *horse* to be defined as *equine animal*?) and there are other apparent syntagmatic definitions that are problematic in that precise definitions are not obvious (*saunter* is exactly what kind of *walk*?). Such considerations, of course, reflect the vagueness of the concepts that words express out of context and so we might expect any such absolute definition of hyponymy to fail.

Hyponymy strictly speaking is definable only between words of the same (syntactic) category, but some groups of apparent co-hyponyms seem to be related to a word of some other category. This seems particularly true of predicate-denoting expressions like adjectives which often seem to relate to (abstract) nouns as superordinates rather than some other adjective. For example, *round, square, tetrahedral*, etc. all seem to be 'quasi-hyponyms' of the noun *shape* and *hot, warm, cool, cold* relate to *temperature*.

Finally, the hierarchies induced by hyponymy may be cross-cutting. So the *animal* field also relates to fields involving maturity (*adult*, *young*) or sex (*male, female*) and perhaps other domains. This entails that certain words may be hyponyms of more than one superordinate, depending on different dimensions of relatedness. As we shall see below, such multiple dependencies have given rise to a number of theoretical approaches to word meaning that try to account directly for sense relations in terms of primitive sense components or inheritance of properties in some hierarchical arrangement of conceptual or other properties.

2.2 Synonymy

Synonymy between two words involves sameness of sense and two words may be defined as synonyms if they are mutually hyponymous. For example, *sofa* and *settee* are both hyponyms of *furniture* and both mutually entailing since if *Bill is sitting on a settee* is true, then it is true that *Bill is sitting on a sofa*, and vice versa. This way of viewing synonymy defines it as occurring between two words just in case they are mutually intersubstitutable in any sentence without changing the meaning (or truth conditions) of those sentences. So *violin* and *fiddle* both denote the same sort of musical instrument so that *Joan plays the violin* and *Joan plays the fiddle* both have the same truth conditions (are both true or

false in all the same circumstances). Synonyms are beloved of lexicographers and thesauri contain lists of putative synonyms. However, true or absolute synonyms are very rarely attested and there is a significant influence of context on the acceptability of apparent synonyms. Take an example from Roget's thesaurus taken at random, 726, for *combatant* in which some of the synonyms presented are:

(2) disputant, controversialist, litigant, belligerent; competitor, rival; fighter, assailant, agressor, champion; swashbuckler, duellist, bully, fighting-man, boxer, gladiator, ...

Even putting to one side the dated expressions, it would be difficult to construct a single context in which all these words could be substituted for each other without altering the meaning or giving rise to pragmatic awkwardness. Context is the key for acceptability of synonym construal. Even the clear synonymy of *fiddle = violin* mentioned above shows differences in acceptability in different contexts: if Joan typically plays violin in a symphony orchestra or as soloist in classical concerti, then someone might object that she does not play the fiddle, where that term may be taken to imply the playing of more popular styles of music. Even the *sofa = settee* example might be argued to show some differences, for example in terms of the register of the word or possibly in terms of possible differences in the objects the words pick out. It would appear, in fact, that humans typically don't entertain full synonymy and when presented with particular synonyms in context will try and provide explanations of (possibly imaginary) differences. Such an effect would be explicable in terms of some pragmatic theory such as Relevance Theory (Sperber & Wilson 1986/1995) in which the use of different expressions in the same contexts is expected to give rise to different inferential effects.

A more general approach to synonymy allows there to be degrees of synonymy where this may be considered to involve degrees of semantic overlap and it is this sort of synonymy that is typically assumed by lexicographers in the construction of dictionaries. *Kill* and *murder* are strongly but not absolutely synonymous, differing perhaps in terms of intentionality of the killer/murderer and also the sorts of objects such expressions may take (one may kill a cockroach but does not thereby murder it). Of course, there are conditions on the degree of semantic similarity that we consider to be definitional of synonymy. In the first place, it should in general be the case that the denial of one synonym implicitly denies the other. *Mary is not truthful* seems correctly to implicitly deny the truth of *Mary is honest* and *Joan didn't hit the dog* implies that she didn't beat it. Such implications may only go one way and that is often the case with near synonyms. The second condition on the amount of semantic overlap that induces near synonymy is that the terms should not be contrastive. Thus, *labrador* and *corgi* have a large amount of semantic overlap in that they express breeds of dog, but there is an inherent contrast between these terms and so they cannot in general be intersubstitutable in any context and maintain the truth of the sentence. Near-synonyms are often used to explain a word already used: *John was dismissed, sacked in fact*. But if the terms contrast in meaning in some way then the resulting expression is usually nonsensical: *#John bought a corgi, a labrador, in fact*, where # indicates pragmatic markedness.

The felicity of the use of particular words is strongly dependent on context. The reasons for this have to do with the ways in which synonyms may differ. At the very least two

synonymous terms may differ in style or register. So, for example, *baby* and *neonate* both refer to newborn humans, but while *the neonate was born three weeks premature* means the same as *the baby was born three weeks premature*, *What a beautiful neonate!* is distinctly peculiar. Some synonyms differ in terms of stylistic markedness. *Conceal* and *hide*, for example, are not always felicitously intersubstitutable. *John hid the silver in the garden* and *John concealed the silver in the garden* seem strongly synonymous, but *John concealed Mary's gloves in the cupboard* does not have the same air of normality about it as *John hid Mary's gloves in the cupboard*. Other aspects of stylistic variation involve expressiveness or slang. So while *gob* and *mouth* mean the same, the former is appropriately used in very informal contexts only or for its shock value. Swear words in general often have acceptable counterparts and euphemism and dysphemism thus provides a fertile ground for synonyms: *lavatory = bathroom = toilet = bog = crapper*, etc.; *fuck = screw = sleep with*, and so on. Less obvious differences in expressiveness come about through the use of synonyms that indicate familiarity with the object being referred to such as the variants of kinship terms: *mother = mum = mummy = ma*. Regional and dialectal variations of a language may also give rise to synonyms that may or may not co-occur in the language at large: *valley = dale = glen* or *autumn = fall*. Sociolinguistic variation thus plays a very large part in the existence of near synonymy in a language.

2.3 Antonymy

The third primary paradigmatic sense relation involves oppositeness in meaning, often called *antonymy* (although Lyons 1977 restricts the use of this term to gradable opposites) and is defined informally in terms of contrast, such that if 'A is X' then 'A is not Y'. So, standardly, if *John is tall* is true then *John is not small* is also true. Unlike hyponymy, there are a number of ways in which the senses of words contrast. The basic distinction is typically made between gradable and ungradable opposites. Typically expressed by adjectives in English and other Western European languages, gradable antonyms form instances of contraries and implicitly or explicitly invoke a field over which the grading takes place, i.e. a standard of comparison. Assuming, for example, that John is human, then human size provides the scale against which *John is tall* is measured. In this way, John's being tall for a human does not mean that he is tall when compared to buildings. Note that the implicit scale has to be the same scale invoked for any antonym: *John is tall* contrasts with *John is not small for a human*, not *John is not small for a building*. Other examples of gradable antonyms are easy to identify: *cold/hot*, *good/bad, old/young* and so on.

(3) *Gradable antonymy*: Gradable antonyms form instances of contraries and implicitly or explicitly invoke a field over which the grading takes place, i.e. a standard of comparison.

Non-gradable antonyms are, as the name suggests, absolutes and divide up the domain of discourse into discrete classes. Hence, not only does the positive of one antonym imply the negation of the other, but the negation of one implies the positive of the other.

Such non-gradable antonyms are also called complementaries and include pairs such as *male/female, man/woman, dead/alive*.

(4) *Complementaries* (or binary antonyms) are all non-gradable and the sense of one entails the negation of the other and the negation of one sense entails the positive sense of the other.

Notice that there is, in fact, a syntagmatic restriction that is crucial to this definition. It has to be the case that the property expressed by some word is meaningfully predicable of the object to which it is applied. So, while *that person is male* implies that *that person is not female* and *that person is not female* implies that *that person is male*, *that rock is not female* does not imply that *that rock is male*. Rocks are things that do not have sexual distinctions. Notice further that binary antonyms are quite easily coerced into being gradable, in which case the complementarity of the concepts disappears. So we can say of someone that they are not very alive without committing ourselves to the belief that they are very dead.

Amongst complementaries, some pairs of antonyms may be classed as *privative* in that one member expresses a positive property that the other negates. These include pairs such as *animate/inanimate*. Others are termed *equipollent* when both properties express a positive concept such as *male/female*. Such a distinction is not always easy to make: is the relation *dead/alive* equipollent or privative?

Some relational antonyms differ in the perspective from which a relation is viewed: in other words, according to the order of their arguments. Pairs such as *husband/wife, parent/child* are of this sort and are called converses.

(5) *Converses*: involve relational terms where the argument positions involved with one lexeme are reversed with another and vice versa.

So if *Mary is John's wife* then *John is Mary's husband*. In general, the normal antonymic relation stands, provided that the relation expressed is strictly asymmetric: *Mary is Hilary's child* implies *Mary is not Hilary's parent*. Converses may involve triadic predicates as well, such as *buy/sell*, although it is only the agent and the goal that are reversed in such cases. If *Mary buys a horse from Bill* then it must be the case that *Bill sells a horse to Mary*. Note that the relations between the two converses here are not parallel: the agent subject of *buy* is related to the goal object of *sell* whereas the agent subject of *sell* is related to the source object of *buy*. This may indicate that the converse relation, in this case at least, resides in the actual situations described by sentences containing these verbs rather than necessarily inherently being part of the meanings of the verbs themselves.

So far, we have seen antonyms that are involved in binary contrasts such as *die/live*, *good/bad* and so on, and the relation of antonymy is typically said only to refer to such binary contrasts. But contrast of sense is not *per se* restricted to binary contrasts. For example, co-hyponyms all have the basic oppositeness property of exclusion. So, if something is a cow, it is not a sheep, dog, lion or any other type of animal and equally for all other co-hyponyms that are not synonyms. It is this exclusion of sense that makes *corgi* and *labrador* non-synonymous despite the large semantic overlap in their semantic properties (as breeds of dogs). Lyons (1977) calls such a non-binary relation 'incompatibility'.

Some contrastive gradable antonyms form *scales* where there is an increase (decrease) of some characteristic property from one extreme of the scale to another. With respect to the property heat or temperature we have the scale {*freezing, cold, cool, lukewarm, warm, hot, boiling*}. These adjectives may be considered to be quasi-hyponyms of the noun *heat* and all partake of the oppositeness relation. Interestingly (at least for this scale), related points on the scale act like (gradable) antonyms: *freezing/boiling, cold/hot, cool/warm.* There are other types of incompatible relations such as *ranks* (e.g. {*private (soldier), coporal, sergeant, staff sergeant, warrant officer, lieutenant, major, . . .*}*)* *and cycles (e.g.* {monday, tuesday, wednesday, thursday, friday, saturday, sunday}).

Finally on this topic, it is necessary again to point out the context-sensitivity of antonymy. Although within the colour domain *red* has no obvious antonym, in particular contexts it does. So with respect to wine, the antonym of *red* is *white* and in the context of traffic signals, its opposite is green. Without a context, the obvious antonym to *dry* is *wet*, but again within the context of wine, its antonym is *sweet*, in the context of skin it is *soft* and for food *moist* (examples taken from Murphy 2003). This contextual dependence is problematic for the definition of antonymy just over words (rather than concepts), unless it is assumed that the lexicon is massively *homonymous* (see below). (See also 22. Dual oppositions in lexical meaning.)

2.4 Part-whole relations

The final widely recognised paradigmatic sense relation is that involving 'part-of' relations or *meronymies.*

(6) *Meronymy*: If 'X is part-of Y or 'Y has X then X is a *meronym* of Y and Y is a *holonym* of X.

Thus, *toe* is a meronym of *foot* and *foot* is a meronym of *leg*, which in turn is a meronym of *body.* Notice that there is some similarities between meronymy and hyponymy in that a (normal) hand includes fingers and *finger* somehow includes the idea of *hand*, but, of course, they are not the same things and so do not always take part in the same entailment relations as hyponyms and superordinates. So while *Mary hurt her finger* (sort of) entails *Mary hurt her hand*, just as *Mary hurt her lamb* entails *Mary hurt an animal*, *Mary saw her finger* does not entail *Mary saw her hand*, unlike *Mary saw her lamb* does entail *Mary saw an animal.* Hence, although meronymy is like hyponymy in that the part-whole relations define hierarchical distinctions in the vocabulary, it is crucially different in that meronyms and holonyms define different types of object that may not share any semantic properties at all: a finger is not a kind of hand, but it does share properties with hands such as being covered in skin and being made of flesh and bone; but a wheel shares very little with one of its holonyms *car*, beyond being a manufactured object. Indeed, appropriate entailment relations between sentences containing meronyms and their corresponding holonyms are not easily stated and, while the definition given above is a reasonable approximation, it is not unproblematic. Cruse (1986) attempts to restrict the meronymy relation just to those connections between words that allow both the 'X is part of Y' and 'Y has X' paraphrases. He points out that the 'has a' relation does not always involve a 'part of' one, at least

between the two words: *a wife has a husband* but not *#a husband is part of a wife*. On the other hand, the reverse may also not hold: *stress is part of the job* does not mean that *the job has stress*, at least not in the sense of possession.

However, even if one accepts that both paraphrases must hold of a meronymic pair, there remain certain problems. As an example, the pair of sentences *a husband is part of a marriage* and *a marriage has a husband* seems to be reasonably acceptable, it is not obvious that *marriage* is strictly a holonym of *husband*. It may be, therefore, that it is necessary to restrict the relation to words that denote things of the same general type: concrete or abstract which will induce different 'part of' relations depending on the way some word is construed. So, *a chapter is part of a book = Books have chapters* if book is taken to be the abstract construal of structure, but not if it is taken to be the concrete object. Furthermore, it might be necessary to invoke notions like 'discreteness' in order to constrain the relation. For example, *flesh* is part of a *hand* and *hands* have *flesh*, but are these words thereby in a meronymic relationship? Flesh is a substance and so not individuated and if meronymy requires parts and wholes to be discretely identifiable, then the relationship would not hold of these terms.Again we come to the problem of world-knowledge, which tells us that fingers are prototypically parts of hands, versus word-knowledge: is it the case that the meaning of 'finger' necessarily contains the information that it forms part of a hand and thus that some aspect of the meaning of 'hand' is contained in the meaning of 'finger'? If that were the case, how do we account for the lack of any such inference in extensions of the word to cover (e.g.) emerging shoots of plants (cf. *finger of asparagus*)? cf. 33. World knowledge vs. word knowledge.

This short paragraph does not do justice to the extensive discussions of meronymy, but it should be clear that it is by far the most problematic of the paradigmatic relations to pin down, a situation that has led some scholars to reject its existence as a different type of sense relation altogether. (See further Croft and Cruse 2004, 159-163, Murphy 2003, 216-235)

2.5 Syntagmatic relations

Syntagmatic relations between words appear to be less amenable to the sort of taxonomies associated with paradigmatic relations. However, there is no doubt that some words 'go naturally' with each other, beyond what may be determined by general syntactic rules of combination. At one extreme, there are fixed idioms where the words must combine to yield a specific meaning. Hence we have idiomatic expressions in English meaning 'die' such as *kick the bucket* (a reference to death by hanging) or *pass away* or *pass over (to the other side)* (references to religious beliefs) and so on. There are certain words also that only have a very limited ability to appear with others such as is the case with *addled* which can only apply to *eggs* or *brains*. Other collocational possibilities may be much freer, although none are constrained solely by syntactic category. For example, *hit* is a typical transitive verb in English that takes a noun phrase as object. However, it further constrains which noun phrases it acceptably collocates with by requiring the thing denoted by that noun phrase to have concrete substance. Beyond that, collocational properties are fairly free (cf. 20. Idioms and collocations):

(7) The plane hit water/a building/#the idea.

That words do have semantic collocational properties can be seen by examining strings of words that are 'grammatical' (however defined) but make no sense. An extreme example of this is Chomsky (1965)'s ubiquitous *colorless green ideas sleep furiously* in which the syntactic combination of the words is licit (as an example of a subject noun phrase containing modifiers and a verb phrase containing an intransitive verb and an adverb) but no information is expressed because of the semantic anomalies that result from this particular combination. There are various sources of anomaly. In the first place, there may be problems resulting from what Cruse (2000) calls *collocational preferences*. Where such preferences are violated, various degrees of anomaly can arise, ranging from marginally odd through to the incomprehensible. For example, the sentence *my pansies have passed away* is peculiar because *pass away* is typically predicated of a human (or pet) not flowers. However, the synonymous sentence, *my pansies have died*, involves no such peculiarity since the verb *die* is predicable of anything which is capable of life such as plants and animals. A worse clash of meaning thus derives from the collocation of an inanimate subject and any verb or idiom meaning 'die'. *My bed has died* is thus worse than *my pansies have passed away*, although notice that metaphorical interpretations can be (and often are) attributed to such strings. For example, one could interpret *my bed has died* as indicating that the bed has collapsed or is otherwise broken and such metaphorical extensions are common. Compare the use of *die* collocated with words such as *computer, car, phone*, etc. Notice further in this context that the antonym of *die* is not *live* but *go* or *run*. It is only when too many clashes occur that metaphorical interpretation breaks down and no information at all can be derived from a string of words. Consider again *colorless green ideas sleep furiously*. Parts of this sentence are less anomalous than the whole and we can assign (by whatever means) some interpretation to them:

(8)
a. *Green ideas*: 'environmentally friendly ideas' or 'young, untried ideas' (both via the characteristic property of young plant shoots);
b. *Colorless ideas*: 'uninteresting ideas' (via lacklustre, dull);
c. *Colorless green ideas*: 'uninteresting ideas about the environment' or 'uninteresting untried ideas' (via associated negative connotations of things without colour);
d. *Ideas sleep*: 'ideas are not currently active' (via inactivity associated with sleeping);
e. *Green parrots sleep furiously*: 'parrots determinedly asleep (?)" or 'parrots restlessly asleep'.

But in putting all the words together, the effort involved in resolving all the contradictions just gets beyond any possible effect on the context by the information content of the final proposition. The more contradictions that need to be resolved in processing some sentence the greater the amount of computation required to infer a non-contradictory proposition from it and the less information the inferred proposition will convey. A sentence may be

said to be truly anomalous if there is no relevant proposition that can be deduced from it by pragmatic means.

A second type of clash involving collocational preferences is induced when words are combined into phrases but add no new information to the string. Cruse calls this *pleonasm* and exemplifies it with examples such as *John kicked the ball with his foot* (Cruse 2000:223). Since kicking involves contact with something by a foot the string final prepositional phrase adds nothing new and the sentence is odd (even though context may allow the apparent tautology to be acceptable). Similar oddities arise with collocations such as *female mother* or *human author*. Note that pleonasm does not always give rise to feelings of oddity. For example, *pregnant female* does not seems as peculiar as *#female mother*, even although the concept of 'female' is included in 'pregnant'. This observation is indicative of the fact that certain elements in strings of words have a privileged status. For example, it appears that pleonastic anomaly is worse in situations in which a semantic head, a noun or verb that determines the semantic properties of its satellites which does not always coincide with what may be identified as the syntactic head of a construction, appears with a modifier (or sometimes complement, but not always) whose meaning is contained within that of the head: *bovine mammal* is better than *#mammalian cow* (what other sort of cow could there be?). Pleonastic anomaly can usually be obviated by substituting a hyponym for one expression or a superordinate of the other since this will give rise to informativity with respect to the combination of words: *female parent, He struck the ball with his foot* and so on.

Collocational preferences are often discussed with respect to the constraints imposed by verbs or nouns on their arguments and sometimes these constraints have been incorporated into syntactic theories. In Chomsky (1965), for example, the subcategorisation of verbs was defined not just in terms of the syntactic categories of their argument but also their semantic selectional properties. A verb like *kick* imposes a restriction on its direct object that it is concrete (in non-metaphorical uses) and on its subject that it is something with legs like an animal, whereas verbs like *think* require abstract objects and human subjects. Subsequent research into the semantic properties of arguments led to the postulation of participant (or case or thematic) roles which verbs 'assign' to their arguments with the effect that certain roles constrained the semantic preferences of the verb to certain sorts of subjects and objects. A verb like *fear*, therefore, assigns to its subject the role of *experiencer*, thus limiting acceptable collocations to things that are able to fear such as humans and other animals. Some roles such as *experiencer, agent, recipient*, etc. are more tightly constrained by certain semantic properties, such as animacy, volition, and mobility than others such as *theme, patient* (Dowty 1991).

We have seen that paradigmatic relations cannot always be separated from concepts of syntagmatic relatedness. So Lyons' attempts to define hyponymy in terms of the modification of a superordinate while the basic relation of antonymy holds only if the word being modified denotes something that can be appropriately predicated of the relevant properties. Given that meanings are constructed in natural languages by putting words together, it would be unsurprising if syntagmatic relations are, in some sense, primary and that paradigmatic relations are principally determined by collocational properties between words. Indeed the primacy of syntagmatic relations is supported by psycholinguistic and

acquisition studies. It is reported in Murphy (2003) that in word association experiments, children under 7 tend to provide responses that reflect collocational patterns rather than paradigmatic ones. So to a word like *black* the response of young children is more likely to give rise to responses such as *bird* or *board* rather than the antonym *white*. Older children and adults, on the other hand, tend to give paradigmatic responses. There is, furthermore, some evidence that knowledge of paradigmatic relations is associated with metalinguistic awareness: that is, awareness of the properties of, and interactions between, those words. The primacy of syntagmatic relations over paradigmatic relations seems further to be borne out by corpus and computational studies of collocation and lexis. For example, there are many approaches to the automatic disambiguation of *homonyms*, identical word forms that have different meanings (see below), that rely on syntagmatic context to determine which sense is the most likely on a particular occasion of the use of some word. Such studies also rely on corpus work from which collocational probabilities between expressions are calculated. In this regard, it is interesting to consider experimental research in computational linguistics which attempts to induce automatic recognition of synonyms and hyponyms in texts. Erk (2009) reports research which uses vector spaces to define representations of words meanings where such spaces are defined in terms of collocations between words in corpora. Without going into any detail here, she reports that (near) synonyms can be identified in this manner to a high degree of accuracy, but that hyponymic relations cannot be identified easily without such information being encoded, but that the use of vector spaces allows such encoding to be done and to yield good results. Although this is not her point, Erk's results are interesting with respect to the possible relation between syntagmatic and paradigmatic sense relations. Synonymy may be defined not just semantically as involving sameness of sense, but syntactically as allowing substitution in the all the same linguistic contexts (an idealisation, of course, given the rarity of full synonymy, but probabilistic techniques may be used to get a definition of degree of similarity between the contexts in which two words can appear). Hence, we might expect that defining vector spaces in terms of collocational possibilities in texts will yield a high degree of comparability between synonyms. But hyponymy cannot be defined easily in syntactic terms, as hyponyms and their superordinates will not necessarily collocate in the same way (for example, *four-legged animal* is more likely than *four-legged dog* while *Collie dog* is fine but # *Collie animal* is marginal at best). Thus, just taking collocation into account, even in a sophisticated manner, will fail to identify words in hyponymous relations. This implies that paradigmatic sense relations are 'higher order' or 'metalexical' relations that do not emerge directly from syntagmatic ones.

I leave this matter to one side from now on, because, despite the strong possibility that syntagmatic relations are cognitively primary, it remains the case that the study of paradigmatic relations remains the focus of studies of lexical semantics.

2.6 Homonymy and Polysemy

Although not sense relations of the same sort as those reviewed above in that they do not structure the lexicon in systematic ways, *homonymy* and *polysemy* have nevertheless an important place in considerations of word meaning and have played an important part in

the development of theories of lexical semantics since the last two decades of the twentieth century. Homonymy involves formal identity between words with distinct meanings (i.e. interpretations with distinct extensions and senses) which Weinreich (1963) calls "contrastive ambiguity". Such formal identity may involve the way a word is spoken (*homophony* 'same sound') such as *bank, line, taxi, can, lead (noun) led (verb)* and/or orthography *bank, line, putting*, in which case it is referred to as *homography* 'same writing'. It is often the case that the term *homonymy* is reserved only for those words that are both homophones and homographs, but equally often the term is used for either relation. Homonymy may be full or partial: in the former case, every form of the lexeme is identical for both senses such as holds for the noun *punch* (the drink or the action) or it may be partial in which only some forms of the lexeme are identical for both senses, such as between the verb *punch* and its corresponding noun. Homonymy leads to the sort of ambiguity that is easily resolved in discourse context, whether locally through syntactic disambiguation (9a), the context provided within a sentence (9b) or from the topic of conversation (9c).

(9) a. His illness isn't terminal.
b. My terminal keeps cutting out on me.
c. I've just been through Heathrow. The new terminal is rubbish.

In general, there is very little to say about homonymy. It is random and generally only tolerated when the meanings of the homonyms are sufficiently semantically differentiated as to be easily disambiguated.

Of more interest is polysemy in which a word has a range of meanings in different local contexts but in which the meaning differences are taken to be related in some way. While homonymy may be said to involve true ambiguity, polysemy involves some notion of vagueness or underspecification with respect to the meanings a polyseme has in different contexts (cf. 23. Ambiguity and vagueness). The classic example of a polysemous word is *mouth* which can denote the mouth of a human or animal or various other types of opening, such as bottle, and more remotely of river. Unlike homonymy no notion of contrast in sense is involved and polysemes are considered to have an apparently unique basic meaning that is modified in context. The word *bank* is both a homonym and a polyseme in its meaning of 'financial establishment' between its interpretation as the institution (*The bank raised its interest rates yesterday*) and its physical manifestation (*The bank is next to the school*). One of the things that differentiates polysemy from homonymy is that the different senses of polysemes are not 'suppressed' in context (as with homonyms) but one aspect of sense is foregrounded or highlighted. Other senses are available in the discourse and can be picked up by other words in the discourse:

(10) a. Mary tried to jump through the window (aperture), but it was closed (aperture/physical object) and she broke it (physical object).
b. *Mary walked along the bank of the river. It had just put up interest rates yet again.

Polysemy may involve a number of different properties: change of syntactic category (11); variation in valency (12); and subcategorisation properties (13).

(11) a. Rambo picked up the hammer (noun).
b. Rambo hammered (verb) the nail into the cat.

(12) a. The candle melted.
b. The heat melted the candle.

(13) a. Rambo forgot that he had buried the cat (clausal complement - factive interpretation)
b. Rambo forgot to bury the cat (infinitival complement - non-factive interpretation)

Some polysemy may be hidden and extensive, as often with gradable adjectives where the adjective often picks out some typical property associated with the head noun that it modifies which may vary considerably from noun to noun, as with the adjective *good* in (16), where the interpretation varies considerably according to the semantics of the head noun and contrasting strongly with other adjectives like *big*, as illustrated in (15). Note that one might characterise the meaning of this adjective in terms of an underspecified semantics such as that given in (16f).

(14)

(15) *big car/big computer/big nose*: 'big for N

(16) a. *good meal*: 'tasty, enjoyable, pleasant'
b. *good knife*: 'sharp, easy to handle'
c. *good car*: 'reliable, comfortable, fast'
d. *good typist*: 'accurate, quick, reliable'
e. *good N*: 'positive evaluation of some property associated with N

There are also many common alternations in polysemy that one may refer to as *constructional (or logical) polysemy* since they are regular and result from the semantic properties of what is denoted.

(17) a. Figure/Ground: *window, door, room*
b. Count/Mass: *lamb, beer*
c. Container/Contained: *bottle, glass*
d. Product/Producer: *book, Kleenex*
e. Plant/Food: *apple, spinach*
f. Process/Result: *examination, merger*

Such alternations depend to a large degree on the perspective that is taken with respect to the objects denoted. So a window may be viewed in terms of an aperture (e.g. when it is open) or in terms of what it is made of (glass, plastic in some sort of frame) while other nouns can be viewed in terms of their physical or functional characteristics, and so on.

Polysemy is not exceptional but rather the norm for word interpretation in context. Arguably every content word is polysemous and may have its meaning extended in context, systematically or unsystematically. The sense extensions of *mouth*, for example, are clear examples of unsystematic metaphorical uses of the word, unsystematic because the metaphor cannot be extended to just any sort of opening: *?# mouth of a flask, #mouth of a motorway, ?# mouth of a stream, # mouth of a pothole.* Of course, any of these collocations could become accepted, but it tends to be the case that until a particular collocation has become commonplace, the phrase will be interpreted as involving real metaphor rather than the use of a polysemous word. Unsystematic polysemy, therefore, may have a diachronic dimension with true (but not extreme) metaphorical uses becoming interpreted as polysemy once established within a language. It is also possible for diachronically homonymous terms to be interpreted as polysemes at some later stage. This has happened with the word *ear* where the two senses (of a head and of corn) derive from different words in Old English (*ēare* and *ēar* , respectively).

More systematic types of metaphorical extension have been noted above, but may also result from *metonymy*: the use of a word in a non-literal way, often based on a partwhole or 'connected to' relationships. This may happen with respect to names of composers or authors where the use of the name may refer to the person or to what they have produced. (18) may be interpreted as Mary liking the man or the music (and indeed listening to or playing the latter).

(18) Hans likes Beethoven.

Ad hoc types of metonymy may simply extend the concept of some word to some aspect of a situation that is loosely related to, but contextually determined by, what the word actually means. *John has new wheels* may be variously interpreted as John having a new car or, if he was known to be paraplegic, as him having a new wheelchair. A more extreme, but classic, example is one like (19) in which the actual meaning of the food *lasagna* is extended to the person who ordered it. (Such examples are also known as 'ham sandwich' cases after the examples found in Nunberg 1995).

(19) The lasagna is getting impatient.

Obviously context is paramount here. In a classroom or on a farm, the example would be unlikely to make any sense, whereas in a restaurant where the situation necessarily involves a relation between customers and food, a metonymic relation can be easily constructed. Some metonymic creations may become established within a linguistic community and thus become less context-dependent. For example, the word *suit(s)* may refer not only to the garment of clothing but also to people who wear them and thus the word gets associated with types of people who do jobs that involve the wearing of suits, such as business people.

3. Sense relations and word meaning

As indicated in the discussion above, the benefit of studying sense relations appears to be that it gives us an insight into word meaning generally. For this reason, such relations have often provided the basis for different theories of lexical semantics.

3.1 Lexical fields and Componential Analysis

One of the earliest modern attempts to provide a theory of word meaning using sense relations is associated with European structuralists, developing out of the work of de Saussure in the first part of the twentieth century. Often associated with theories of componential analysis (see below), lexical field theory gave rise to a number of vying approaches to lexical meaning, but which all share the hypothesis that the meanings (or senses) of words derive from their relations to other words within some thematic/conceptual domain defining a semantic or lexical field. In particular, it is assumed that hierarchical and contrastive relations between words sharing a conceptual domain is sufficient to define the meaning of those words. Early theorists such as Trier (1934) or Porzig (1934) were especially interested in the way such fields develop over time with words shifting with respect to the part of a conceptual field that they cover as other words come into or leave that space. For Trier, the essential properties of a lexical field are that:

(i) the meaning of an individual word is dependent upon the meaning of all the other the words in the same conceptual domain;
(ii) a lexical field has no gaps so that the field covers some connected conceptual space (or reflects some coherent aspect of the world);
(iii) if a word undergoes a change in meaning, then the whole structure of the lexical field also changes.

One of the obvious weaknesses of such an approach is that the identification of a conceptual domain cannot be identified independently of the meaning of the expressions themselves and so appears somewhat circular. Indeed, such research presented little more than descriptions of diachronic semantic changes as there was little or no predictive power in determining what changes are and are not possible within lexical fields, nor what lexical gaps are tolerated and what not. Indeed, it seems reasonable to suppose that no such theory could exist, given the randomness that the lexical development of contentive words displays and so there is no reason to suppose that sense relations play any part in determining such change. (See Ullman 1957, Geckeler 1971, Coseriu & Geckeler 1981, for detailed discussions of field theories at different periods of the twentieth century.)

Although it is clear that 'systems of interrelated senses' (Lyons 1977:252) exist within languages, it is not clear that they can usefully form the basis for explicating word meaning. The most serious criticism of lexical field theory as more than a descriptive tool is that it has unfortunate implications for how humans could ever know the meaning of a word: if a word's meaning is determined by its relation to other words in its lexical field, then to know that meaning someone has to know all the words associated with that lexical field. For example, to know the meaning of *tulip*, it would not be enough to know that it is a hyponym of *(plant) bulb* and a co-hyponym of *daffodil, crocus, anemone, lily, dahlia* but also to *trillium, erythronium, bulbinella, disia, brunsvigia* and so on. But only a botanist specialising in bulbous plants is likely to know anything like the complete list of names, and even then this is unlikely. Of course, someone can be said to know the meaning of *tulip* independently of whether they have any knowledge of any other bulb or even flowering plant. Of course, one might say that individuals might have a shallower or deeper knowledge

of some lexical field, but the problem persists, if one is trying to characterise the nature of word meaning within a language rather than within individuals. And it means that the structure of a lexical field and thus the meaning of a word will necessarily change with any and every apparent change in knowledge. But it is far from clear that the meaning of *tulip* would be affected if, for example, botanists decided that that a disia is not bulbous but rhizomatous, and thus does not after all form part of the particular lexical field of plants that have bulbs as storage organs.

Field theory came to be associated in the nineteen-sixties with another theory of word meaning in which sense relations played a central part. This is the theory of *componential analysis* which was adapted by Katz & Fodor (1963) for linguistic meaning from similar approaches in anthropology. In this theory, the meaning of a word is decomposed into semantic components, often conceived as features of some sort. Such features are taken to be cognitively real semantic primitives which combine to define the meanings of words in a way that automatically predicts their paradigmatic sense relations with other words. For example, one might decompose the two meanings of *dog* as consisting of the primitive features [CANINE] and [CANINE,MALE,ADULT]. Since the latter contains the semantic structure of the former, it is directly determined to be a hyponym. Assuming that *bitch* has the componential analysis [CANINE,FEMALE,ADULT], the hyponym meaning of *dog* is easily identified as an antonym of *bitch* as they differ one just one semantic feature. So the theory provides a direct way of accounting for sense relations: synonymy involves identity of features; hyponymy involves extension of features; and antonymy involves difference in one feature. Although actively pursued in the nineteen sixties and seventies, the approach fell out of favour in mainstream linguistics for a number of reasons. From an ideological perspective, the theory became associated with the Generative Semantics movement which attempted to derive surface syntax from deep semantic meaning components. When this movement was discredited, the logically distinct semantic theory of componential analysis was mainly rejected too. More significantly, however, the theory came in for heavy criticism. In the first place, there is the problem of how primitives are to be identified, particularly if the assumption is that the set of primitives is universal. Although more recent work has attempted to give this aspect of decompositional theories as a whole a more empirically motivated foundation (Wierzbicka 1996), nevertheless there appears to be some randomness to the choice of primitives and the way they are said to operate within particular languages. Additionally, the theory has problems with things like natural kinds: what distinguishes [CANINE] from the meaning of *dog* or [EQUINE] from *horse*? And does each animal (or plant) species have to be distinguished in this way? If so, then the theory achieves very little beyond adding information about sex and age to the basic concepts described by *dog* and *horse*. Using Latinate terms to indicate sense components for natural kinds simply obscures the fact that the central meanings of these expressions are not decomposable. An associated problem is that features were often treated as binary so that, for example, *puppy* might be analysed as [CANINE,-ADULT]. Likewise, instead of MALE/FEMALE one might have ±MALE or [-ALIVE] for *dead*. The problem here is obvious: how does one choose a non-arbitrary property as the unmarked one? ±FEMALE and ±DEAD are just as valid as primitive features, as the reverse. Furthermore, restriction to binary values excludes the inclusion of relational concepts that are necessary for any analysis of meaning

in general. Overall, then, while componential analysis does provide a means of predicting sense relations, it does so at the expense of a considerable amount of arbitrariness

3.2 Lexical decomposition

Although the structuralist concept of lexical fields is one that did not develop in the way that its proponents might have expected, nevertheless it reinforced the view that words are semantically related and that this relatedness can be identified and used to structure a vocabulary. It is this concept of a structured lexicon that persists in mainstream linguistics. In the same way, lexical decompositional analyses have developed in rather different ways than were envisaged at the time that componential semantic analysis was developed. (See also 17. Lexical decomposition.)

Decomposition of lexical meaning appears in Montague (1974), one of the earliest attempts to provide a formal analysis of a fragment of a natural language as one of two different mechanisms for specifying the interpretations of words. Certain expressions with a logical interpretation, like *be* and *necessarily*, are decomposed, not into cognitive primitives, but into complex logical expressions, reflecting their truth-conditional content. For example, *necessarily* receives the logical translation $\lambda p[\Box p]$, where the abstracted variable, p, ranges over propositions and the decomposition has the effect of equating the semantics of the adverb with that of the logical necessity operator, $\Box$. Montague restricted decomposition of this sort to those grammatical expressions whose truth conditional meaning can be given a purely logical characterisation. In a detailed analysis of word meaning within Montague Semantics, however, Dowty (1979) argued that certain entailments associated with content expressions are constant in the same way as those associated with grammatical expressions and he extended the decompositional approach to analyse such words in order to capture such apparently independent entailments.

Dowtys exposition is concerned primarily with inferences from verbs (and more complex predicates) that involve tense and modality. By adopting three operators DO, $BECOME$ and $CAUSE$, he is able to decompose the meanings of a range of different types of verbs, including activities, accomplishments, inchoatives and causatives, to account for the entailments that can be drawn from sentences containing them. For example, he provides decomposition rules for de-adjectival inchoative and causative verbs in English that modify the predicative interpretation of base adjectives in English. Dowty uses the propositional operator BECOME for inchoative interpretations of (e.g.) *cool*: $\lambda x[BECOME\ cool'(x)]$ where *cool* is the semantic representation of the meaning of the predicative adjective and the semantics of $BECOME$ ensures that the resulting predicate is true of some individual just in case it is now cool but just previously was not cool. The causative interpretation of the verb involves the $CAUSE$ operator in addition: $\lambda y \lambda x[x\ CAUSE\ BECOME\ cool'(y)]$ which guarantees the entailment between (e.g.) *Mary cooled the wine* and *Mary caused the wine to become cool*. Dowty also gives more complex (and less obviously logical) decompositions for other content expressions, such as *kill* which may be interpreted as x causes y to become not alive.

The quasi-logical decompositions suggested by Dowty have been taken up in theories such as Role and Reference Grammar (van Valin & LaPolla 1997) but primarily for account-

ing for syntagmatic relations such as argument realisation, rather than for accounting for paradigmatic sense relations. The same is not quite true for other decompositional theories of semantics such as that put forward in the Generative Lexicon Theory of Pustejovsky (1995). Pustejovsky presents a theory designed specifically to account for structured polysemous relations such as those given in (11-13) utilising a complex internal structure for word meanings that goes a long way further than that put forward by Katz & Fodor (1963). In particular, words are associated with a number of different 'structures' that may be more or less complex. These include: argument structure which gives the number and semantic type of logical arguments; event structure specifying the type of event of the lexeme; and lexical inheritance structure, essentially hyponymous relations (which can be of a more general type showing the hierarchical structure of the lexicon). The most powerful and controversial structure proposed is the qualia structure. *Qualia* is a Latin term meaning 'of whatever sort' and is used for the Greek *aitiai* 'blame', 'responsibility' or 'cause' to link the current theory with Aristotles modes of explanation. Essentially the qualia structure gives semantic properties of a number of different sorts concerning the basic sense properties, prototypicality properties and encyclopaedic information of certain sorts. This provides an explicit model for how meaning shifts and polyvalency phenomena interact. The qualia structure provides the structural template over which semantic combinatorial devices, such as co-composition, type coercion and subselection, may apply to alter the meaning of a lexical item. Pustejovsky (1991, 417) defines qualia structure as:

- The relation between [a word's denotation] and its constituent parts
- That which distinguishes it within a larger domain (its physical characteristics)
- Its purpose and function
- Whatever brings it about

Such information is used in interpreting sentences such as those in (20)

(20) a. Bill uses the train to get to work.
b. This car uses diesel fuel.

The verb *use* is semantically underspecified and the factors that allow us to determine which sense is appropriate for any instance of the verb are the qualia structures for each phrase in the construction and a rich mode of composition, which is able to take advantage of this information. For example, in (20a) it is the function of trains to take people to places, so *use* here may be interpreted as 'catches', 'takes' or 'rides on'. Analogously, cars contain engines and engines require fuel to work, so the verb in (20b) can be interpreted as 'runs on', 'requires', etc. Using these mechanisms Pustejovsky provides analyses of complex lexical phenomena, including coercion, polysemy and both paradigmatic and syntagmatic sense relations.

Without going into detail, Pustejovskys fundamental hypothesis is that the lexicon is generative and compositional, with complex meanings deriving from less complex ones in structured ways, so that the lexical representations of words should express only as

much information as they need to express a basic concept that allows as wide a range of combinatorial properties as possible. Additionally, lexical information is hierarchically structured with rules specifying how phrasal representations can be built up from lexical ones as words are combined. A view which contrasts strongly with that discussed in the next section. (See also 17. Lexical decomposition.)

3.3 Meaning postulates and semantic atomism

In addition to decomposition for logico-grammatical word meaning, Montague (1974) also adopted a second approach to accounting for the meaning of basic expressions, Meaning Postulates were introduced in Carnap (1956) and consist of universally quantified conditional or bi-conditional statements in the logical metalanguage which constrain the denotations of the constant that appears in the antecedent. For example, Montague provides an example that relates the denotations of the verb *seek* and the phrase *try to find*. (21) states (simplified from Montague) that for every instance of x seeking y there is an instance of x trying find y:

(21) $\Box\forall x\forall y[seek'(x,y) \leftrightarrow try\text{-}to(x,^{\wedge} find'(x,y)]$

Note that the semantics of *seek*, on this approach, does not contain the content of *try to find*, as in the decompositional approach. The necessity operator, $\Box$, ensures that the relation holds in all admissible models, i.e. in all states-of-affairs that we can talk about using the object language. This raises the bi-conditional statement to the status of a logical truth (an axiom) which ensures that on every occasion in which it is true to say of someone that she is seeking something then it is also true to say that she is trying to find that something (and vice versa). Meaning postulates provide a powerful tool for encoding detailed information about non-logical entailments associated with particular lexemes (or their translation counterparts).

A theory that utilises meaning postulates treats the meaning of words as atomic with their semantic relations specified directly. So, although traditional sense relations, both paradigmatic and syntagmatic, can easily be reconstructed in the system (see Cann 1993 for an attempt at this) they do not follow from the semantics of the words themselves. For advocates of this theory, this is taken as an advantage. In the first place, it allows for conditional, as opposed to bi-conditional, relations, as necessary in a decompositional approach. So while we might want to say that an act of killing involves an act of causing something to die, the reverse may not hold. If *kill* is decomposed as $x\ CAUSE(BECOME(\neg alive'(y)))$, then this fact cannot be captured. A second advantage of atomicity is that even if a word's meaning can be decomposed to a large extent, there is nevertheless often a 'residue of meaning' which cannot be decomposed into other elements. This is exactly what the feature CANINE is in the simple componential analysis given above: it is the core meaning of *dog/bitch* that cannot be further decomposed. In decomposition, therefore, one needs both some form of atomic concept and the decomposed elements whereas in atomic approaches word meanings are individual concepts (or denotations), not further decomposed. What relations they have with the meanings of other words is a matter of the world (or of experience of the world) not of the meanings of the words themselves. Fodor & Lepore (1998)

argue extensively against decompositionality, in particular Pustejovsky, in a way similar to the criticism made against field theories above. They argue that while it might be that a dog (necessarily) denotes an animal, knowing that dogs are animals is not necessary for knowing what dog means. Given the non-necessity of knowing these inferences for knowing the meaning of the word means that they (including interlexical relations) should not be imposed on lexical entries, because these relations are not part of the linguistic meaning.

Criticisms can be made of atomicity and the use of meaning postulates (see Pustejovsky 1998 for a rebuttal of Fodor & Lepore's views). In particular, since meaning postulates are capable of defining any type of semantic relation, traditional sense relations form just arbitrary and unpredictable parts of the postulate system, impossible to generalise over. Nevertheless it is possible to define theories in which words have atomic meanings, but the paradigmatic sense relations are used to organise the lexicon. Such a one is WordNet developed by George A. Miller (1995) to provide a lexical database of English organised by grouping words together that are cognitive synonyms (a synset), each of which expresses a distinct concept with different concepts associated with a word being found in different synsets (much like a thesaurus). These synsets then are related to each other by lexical and conceptual properties, including the basic paradigmatic sense relations. Although it remains true that the sense relations are stated independently of the semantics of the words themselves, nonetheless it is possible to claim that using them as an organisational principle of the lexicon provides them with a primitive status with respect to human cognitive abilities. WordNet was set up to reflect the apparent way that humans process expressions in a language and so using the sense relations as an organisational principle is tantamount to claiming that they are the basis for the organisation of the human lexicon, even if the grouping of specific words into synsets and the relations defined between them is not determined directly by the meanings of the words themselves. (See also 125. Semantics in computational lexicons.)

A more damning criticism of the atomic approach is that context-dependent polysemy is impossible because each meaning (whether treated as a concept or a denotation) is in principle independent of every other meaning. A consequence of this, as Pustejovsky points out, is that every polysemous interpretation of a word has to be listed separately and the interpretation of a word in context is a matter of selecting the right concept/denotation a priori. It cannot be computed from aspects of the meaning of a word with those of other words with which it appears. For example, the meanings of gradable adjectives such as *good* in (16) will need different concepts associated with each collocation that are in principle independent of each other. Given that new collocations between words are made all the time and under the assumption that the number of slightly new senses that result are potentially infinite in number, this is a problem for storage given the finite resources of the human brain. A further consequence is that, without some means of computing new senses, the independent concepts cannot be learned and so must be innate. While Fodor (1998) has suggested the possibility of the consequence being true, this is an extremely controversial and unpopular hypothesis that is not likely to help our understanding of the nature of word meaning.

4. Conclusion

In the above discussion, I have not been able to more than scratch the surface of the debates over the sense relations and their place in theories of word meaning. I have not discussed the important contributions of decompositionalists such as Jackendoff, or the problem of analyticity (Quine 1960), or the current debate between contextualists and semantic minimalists (Cappelen & Lepore 2005, Wedgwood 2007). Neither have I gone into any detail about the variations and extensions of sense relations themselves, such as is often found in Cognitive Linguistics (e.g. Croft and Cruse 2004). And much more besides. Are there any conclusions that we can currently draw? Clearly, sense relations are good descriptive devices helping with the compilation of dictionaries and thesauri, as well as the development of large scale databases of words for use in various applications beyond the confines of linguistics, psychology and philosophy. It would, however, appear that the relation between sense relations and word meaning itself remains problematic. Given the overriding context dependence of the latter, it is possible that pragmatics will provide explanations of observed phenomena better than explicitly semantic approaches (see for example, Blütner 2002, Murphy 2003, Wilson & Carston 2006). Furthermore, the evidence from psycholinguistic and developmental studies, as well as the collocational sensitivity of sense, indicates that syntagmatic relations may be cognitively primary and that paradigmatic relations may be learned, either explicitly or through experience as part of the development of inferential capability, rather than as being a central part of the semantics of words themselves.

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Sense relations, lexical meaning, .

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