ROUTLEDGE

An Introduction to Lexical Semantics

A Formal Approach to Word Meaning and its Composition

EunHee Lee

An Introduction to Lexical Semantics

An Introduction to Lexical Semantics provides a comprehensive theoretical overview of lexical semantics, analysing the major lexical categories in English: verbs, nouns, adjectives, adverbs and prepositions. The book illustrates step-by-step how to use formal semantic tools.

Divided into four parts, covering the key aspects of lexical semantics, this book:

- introduces readers to the major influential theories including the syntax-lexical semantics interface theory by Levin and Rappaport and Pinker, the generative lexicon theory by Pustejovsky and formal semantic analyses
- discusses key topics in formal semantics including metonymy, metaphor and polysemy
- illustrates how to study word meaning scientifically by discussing mathematical notions applied to compositional semantics.

Including reflection questions, summaries, further reading and practice exercises for each chapter, this accessible guide to lexical semantics is essential reading for advanced students and teachers of formal semantics.

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Symbols

Symbol	Meaning
D	domain of discourse
a ∈	A a is a member of set A
a ∉	A a is not a member of set A
∅	empty set
A ⊆ B	A is a subset of B
A ∩ B	intersection of sets A and B
A ∪ B	union of sets A and B
A – B	difference of sets A and B
{0, 1}	set of truth values
$p, q, r, \ldots$	variables for propositions
¬ or ~	negation
∧	conjunction
∨	disjunction
→	conditional or implication
↔	biconditional
e	entity type
t	truth value type
$\langle e, t \rangle$	function type from entities to truth values
s	world/intensional type
c	structured/gradable entity of type
f: A → B	f is functions from A to B
f(x)	f applied to x or the value of f for the argument x
iff	if and only if
λ	lambda operator
f, g, s, …	constants
$x, y, z, \ldots$	variables
∀	universal quantifier
∃	existential quantifier
$d \preccurlyeq d'$	d is smaller than or equal to d'
$d \succ d'$	d is larger than d′
$x \leq y$	x is part of y

$x < y$	x is proper part of y
$\sqcap$	meet (please delete this)
$\sqcup$	join (wrong symbol. $\sqcup$ is the correct one.)
$[\![\ ]\!]$	interpretation function
D_τ	the set of possible denotations for an expression of type τ.
D_e	the set of individuals
D_t	the set of truth values {1, 0}
$D_{\langle e,\, t\rangle}$	the set of functions from the domain D_e to the range D_t
c_u	the utterance contextual argument
pos	the function for positive degree
stnd	function from gradable predicate meanings to degrees that gives a standard of comparison for the predicate in the context of utterance
m_Δ	measure of change function
d	degree
d_c	contextually given standard of comparison of degree
GEN	the generic operator
$^\cap$	the nominalization function
$^\cup$	the predicativization function
•	("dot") the type construction that reifies the two elements into a new type
Ind	individuation function
+	sum
$\oplus$	fusion
*	the operator that generates all the individual sums of members of the extension of a one-place property P (need space between "the" and "extension")
$pos_{\mathrm{c}}(P)(x)$	x is in the positive extension of P in context c
$neg_{\mathrm{c}}(P)(x)$	x is in the negative extension of P in context c
$gap_{\mathrm{c}}(P)(x)$	x is in the extension gap of P in context c
$loc(w, s)$	w contains s
−A	the inverse of an axis A
⊥A	the orthogonal complement of A
loc	the location function
vert	the set of vectors pointing upward
front	the set of vectors pointing forward
lat	the set of vectors pointing right/leftward
dist	function that measures the distance between points
trace	function that maps events to their spatial trace
$\boldsymbol{\Theta}$	path function from the real interval $[0, 1] \subset \mathrm{R}$ to vectors

Part I

Preliminaries

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1 Introduction

1.1 Lexical and Compositional Semantics

What do speakers know about word meaning? The answer is "a lot." This book is an investigation of such rich knowledge, called **lexical semantics**, from a theoretical perspective. A common practice in the scientific study of linguistic meaning, semantics, is to draw a line between lexical and **compositional semantics**. While lexical semantics largely deals with the meanings of words and their relations, compositional semantics is mostly concerned with how phrasal and sentential meanings are assembled through productive grammatical rules and principles. For instance, (1a) is a statement about lexical semantics, and (1b) is a statement about compositional semantics.

(1) a. The opposite of *dead* is *alive*.
b. *Fido chases Garfield* means something different from *Garfield chases Fido*.

Remarkably, native speakers of any language can understand the meanings of an infinite number of phrases and sentences despite the fact that every language contains only a finite number of words and a finite number of grammatical rules. Since they obviously cannot memorize an infinite number of sentence meanings, the meaning of a sentence must be "computed" based on the meanings of the words in it and the way in which they combine. This assumption is called the **principle of compositionality**. Since the creativity and productivity of language is highly regarded as a unique feature that sets human language apart from all other communicative systems, traditional linguistic theorizing concentrated on compositional semantics, while word meaning, which was assumed to simply provide raw material for productive assembly by grammar, largely remained at a descriptive level. Bloomfield (1933) even viewed words as nothing more than an "appendix" of the grammar that contains a list of irregularities and idiosyncratic properties of language. Such a view, however, is not remotely compatible with the rich and systematic knowledge that a speaker demonstrates with respect to lexical items.

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We will discover in this book that words have a structure and systematicity just as grammar does. Contrary to the traditional view, word meaning is the mechanism that controls the structure of a language and connects us to the outside world. Lexical semantics has become a vibrant and growing field in formal semantics today, complementing compositional semantics. This book will introduce the research outcome to date, which has shown that the investigation of lexical meaning has the potential to solve some of our most fundamental and recalcitrant problems in linguistic theorizing.

Reflection

- What is your motivation for studying lexical semantics? How do you think a knowledge of lexical semantics will help you?
- What do you think about the traditional attitudes toward lexical semantics? Can you give evidence to refute the claim that word meanings are idiosyncratic and unsystematic?
- How would you describe the relationship between lexical semantics and compositional semantics? Is the boundary clear-cut?

1.2 Defining Lexeme, Word and Meaning

1.2.1 Lexeme

We commonly assume that words are the basic unit of lexical semantics investigation. In fact, it is the **lexeme** that lexical semanticists are concerned about. Lexemes are defined as linguistic expressions whose forms are conventionally associated with non-compositional meaning (Murphy, 2010). Let us unpack this definition a little bit. Form–meaning associations are conventional if such mappings are learned from other members of a speech community. For example, an infant born in English-speaking household does not know that *dog* refers to the canine species, but later gains such knowledge from other people, like her parents. Non-compositional meanings are those that are not built out of the meanings of their parts. For example, the meaning of *dog* is non-compositional because we cannot predict the meaning from the sounds [d], [ɔ], and [g] that make up the word. The meaning of *the cute dog*, by contrast, is compositional because it is built out of the meaning of its parts, *the*, *cute* and *dog*. The predictability criteria also allow us to exclude different grammatical forms (e.g., *barks, barking, barked*) from lexemes because their meaning follows from the meaning of grammatical categories, such as the third-person singular, the progressive and the past, etc. To avoid redundancy, dictionaries do not normally list different grammatical forms of a single lexeme as separate entries. The grammatical categories are called **function morphemes** with abstract and nonreferential meanings, whereas lexemes are **content morphemes** with substantial descriptive meanings.[1] Function morphemes do not denote objects, events or properties in the world, but rather they act as the nuts and bolts that connect lexical items to build larger linguistic structures. They belong to a **closed class** because new grammatical morphemes cannot be freely added to a language; instead, they slowly evolve from lexical morphemes via grammaticalization (Bybee et al., 1994). By contrast, content morphemes are called an **open class** because adding new words is easy and common. Given this definition, lexemes include the following expressions listed in (2).

(2) a. Simple words (free morphemes) that cannot be broken down into smaller meaningful parts, such as *dog, Fido* and *bark*;
b. Bound derivational morphemes, like *un-* as in *unhappy* and *-ness* as in *happiness*;
c. Morphologically complex words whose meaning is not predictable from the meanings of the parts, including compounds like *greenhouse* ("a glass building for growing plants in")
d. Set phrases whose meaning is not compositional, such as phrasal verbs like *give up* ("quit") and idioms like *kick the bucket* ("die").

1.2.2 Word

Most examples lexical semanticists focus on are lexemes that are also words, rather than bound morphemes or multi-word lexemes. Therefore, it is a good idea to define words in addition to lexemes. Defining what word is, however, turns out to be a complex matter as there are different ways of doing so. We commonly define them orthographically based on the written form, as we are used to putting spaces between words. A little thought, however, soon reveals that such definition is circular: We must already know which expressions are words before we know where to put the spaces. Moreover, not all orthographic systems in the world indicate a word boundary with spaces. For instance, Lao, a Southeast Asian language, only puts spaces at the ends of sentences (Murphy, 2010). Let us then try defining words semantically based on meaning. Although it seems intuitively appealing to say that a word represents a single, complete concept, it is far from clear what a "complete concept" is. It is often the case that the same meaning is variously realized in different numbers of words across languages. How about defining word phonologically based on the word's pronunciation? A phonological word would be subject to the language's phonotactic constraints (i.e., which sounds can appear next to each other) and other phonological rules. In English, for example, a phonological word has one major stress. This definition, however, will exclude most function words because they are usually unstressed in English, leading to a clearly wrong conclusion that there is only one word in phrases like *a dog.* Furthermore, phonological criteria are highly language-specific, e.g., the stress test in English would not work for languages like Chinese or Korean. Finally, let us define word grammatically based on positions in phrases. It turns out that this definition is the one we want, as it is subject to least problems. A **grammatical word** is an expression that cannot be interrupted, moves as a unit and has a part of speech identifiable by its morphological inflections and its distribution in phrases (Murphy, 2010). Therefore, whereas lexemes are defined semantically, words are grammatical units. In this book, like others, we will focus on lexemes that are also words. Consequently, meaning of bound morphemes, compounds, phrasal verbs and idioms, although important and interesting, will not be discussed extensively.

A word is a pairing of its form (phonetic and/or orthographic representation) and its meaning, or what might be called a "form–meaning complex." Let us explore the relationship between form and meaning a little bit. First, according to Saussurean structuralism, the relationship between the form and the meaning(s) of a linguistic sign is said to be "arbitrary," that is, no iconic or natural relation exists between the form and the meaning of a word, and therefore the meaning cannot be predicted from the form and vice versa. For example, there is nothing inherently dog-like in the word *dog*. The canine species is called *dog* [dɔg] in English but called differently in other languages, e.g., [kɛ] in Korean. Even onomatopoetic words, which are meant to imitate natural sounds, are different across languages. The dog sound is [bɑʊwɑʊ] in English and [mʌŋmʌŋ] in Korean, which are not similar at all. There is a danger, however, in overly emphasizing the arbitrariness of the form–meaning relationship in words. It is important to keep in mind that the specific choice of a sign to be associated with a particular referent in a language may be arbitrary, but the original decision to choose a sign to consistently refer to a referent is by no means arbitrary. Instead, it is controlled by the pressure of fundamental communicative needs. Second, for many words, the relationship between form and meaning is not one-to-one but many-to-many. This means that there are at most patterns or correlations within the domain of meaning and the domain of form, which makes language a flexible and creative communicative system. In the domain of meaning or function, we have **homonyms** which have the same form but different meanings, like *bank* (financial institution or the edge of a river), we have **synonyms** which have almost the same meaning but different forms, like *pit*, *stone* and *seed*. **Polysemy** refers to multiple senses of the same lexical item. *Pit* means "inner core of a peach" but also means "a large deep hole in the ground." Context gives us clues to narrow down and eventually home in on a single referent. In the domain of form, **allomorph** refers to the multiple forms of the same meaning. There is competition between irregular forms learned by memorization (e.g., *went*) and regular forms learned by rules (**goed*). The cue to settle on the correct form is sometimes determined by sound, neighboring lexical items, or simply by convention (Bates and MacWhinney, 1989).

1.2.3 Meaning

When we want to know the meaning(s) of an unfamiliar word, we look it up in a dictionary. Dictionary definitions of words, however, are simply different paraphrases in the same object language, and therefore run the risk of being circular. For example, Merriam Webster dictionary defines *pride* as "the quality or state of being proud," and defines *proud* as "feeling or showing pride." Then how should we go about studying meaning of words? For example, is a word like *dog* connected to our mental image or idea of dogs? Is it connected to our agreement to call canine species "dog" as members of a particular language community like English? Or is it connected simply to actual dogs we see out there in the world?

Formal semantics takes the view that the meaning of a linguistic expression (like *dog*) is what it denotes or refers to in the actual and possible worlds/situations to avoid difficulties involved with the other views. Mental representations or ideas can vary significantly from one speaker to another, failing to explain how communication is possible. Moreover, many words are associated with no obvious mental images or ideas. We successfully pick out a specific individual by using a name not because we share common ideas about that person, but because we intend to refer to the same person. Similarly, our intention to refer to all the things that are actually dogs in real or possible situations enables us to use the word *dog*, not our ability to list the necessary and sufficient conditions to be counted as a dog. The same reasoning applies to event-denoting words like *walk* and abstract words like *peace*. Although they may appear more elusive, concepts are basically generalizations across experiences. If language is nothing but arbitrary social conventions, on the other hand, the fact that typologically diverse languages display universal patterns due to the way our mind is built remains unexplained. It is also surprising why we never find a human community that has not bothered to reach a social agreement to use language. Crucially, both theories lack a precise logical metalanguage describing and explaining how meanings combine to produce more complex meanings and how they interact with each other. Without such means, we cannot account for the productivity of language that allows us to routinely understand and produce sentences that we have not heard or said before.

Most research done so far in lexical semantics, however, has been representational, taking word meaning to be mind-dependent concepts which consist of a certain set of semantic primitives. For example, we may define *dog* as four-legged, furry, domesticated canines. Influential works by Jerrold Katz, Ray Jackendoff, Steven Pinker, Beth Levin and James Pustejovsky belong to this line of research. Formal semantics, by contrast, tends to treat word meanings as primitives instead of decomposing them, while explaining semantic components of a word and relations between words using an independent inferential system. We will adopt the formal perspective in this book to present a fresh and coherent way to approach the subject which will complement the rich cognitive literature in lexical semantics.

While we view denotations as primary in defining meaning, we cannot ignore the fact that words are often associated with connotations or social meanings in addition to denotations. Compare the sentences in (3), which contain words with the same denotation but different connotations. *Canine* sounds more scientific and less domestic than the neutral *dog*, and *cur* is a word loaded with the speaker's negative attitude toward its referents. Despite such differences, the sentences in (3) are true in the same circumstances, due to the same denotative meaning of *canine, dog* and *cur*.

(3) a. A <u>canine</u> was barking all night.
b. A <u>dog</u> was barking all night.
c. A <u>cur</u> was barking all night.

Based on the connotations, we might make a variety of inferences, e.g., (3a) may have been uttered at a lab or a zoo, while (3b) was uttered in a residential area and the speaker of (3c) might have been bitten by a dog in the past or is sensitive to noise. However, these inferences are defeasible and pragmatic, and must be set apart from inferences that cannot be cancelled, i.e., **entailments**.

Reflection

- What are the differences between lexemes and words? Why do you think lexical semanticists focus on lexemes that are also words? Why is it difficult to define words? Do you agree that the grammatical definition is the best one?
- Come up with word pairs with the same denotation and different connotations. List the different inferences you may make about them. Are they pragmatic or semantic? If the meaning of words is equated with their denotations, as formal semanticists claim, how can we represent and analyze the connotative meaning?
- If the form–meaning mapping were strictly one-to-one, what do you think will happen? Would it be easier for the child to acquire language? Would language be a better communicative system?

1.3 Meaning-to-Form Perspective

Since words are form–meaning mappings, to investigate word meaning, we can take as our starting-point the word as a form and study the meanings to which the form can be mapped. In the opposite direction, we can take as our starting-point a meaning and investigate the way in which the meaning is lexicalized (Geeraerts, 2002, 2010). The meaning-to-form perspective, which more or less corresponds to a representational/cognitive view of lexical meaning, led to the inquiry into the structure of semantically related expressions in the lexical field theory, componential analyses and prototype theories. The other perspective goes from the form of a word to the meanings it signifies, which aligns with formal approaches and leads to an investigation of logical polysemy, metonymy, metaphor and coercion. We will first briefly survey the theories from the meaning-to-form perspective in this section.

1.3.1 Lexical Field Theory

The lexical field theory holds that the words in a conceptual field, like mosaic pieces, are separated by clear boundaries, and that different fields are connected to one another in the same definitive manner. The entire lexicon, then, can be viewed as a vast super-field broken down into clearly delineated areas of smaller fields, covering the totality of the conceptual space. Let us look at an example of an individual lexical field. The English terms for the notion "cooking" in Lehrer's (1974) analysis are given in Table 1.1, based on two analytic features—the type of the cooking heat and the medium (oil, water and/or vapor). We observe lexical gaps for certain concepts, which are unexpected if we take the mosaic metaphor seriously.

In the network of words, various semantic relations can be identified. Words can be divided taxonomically as a hierarchical organization of **hyponyms** and **hypernyms** (or hyperonyms) of kinds and species. For example, *robin* and *swallow* are both hyponyms of *bird*. Hyponyms inherit all of the attributes of their hypernymic category and have additional semantic features. Synonymy is a relationship of semantic identity, such as *pail* and *bucket*. Antonyms are related in terms of a single semantic opposition within the same analytic dimension and are divided into gradable and complementary antonyms. **Gradable antonyms**, such as *tall* versus *short*, denote opposing endpoints on a gradable scale, whereas **complementary antonyms** like *dead* versus *alive* mark different choices between two complementary alternatives. **Converses**, which express reversing actions (e.g., *inflate* vs. *deflate*), and **inverses**, which describe opposing perspectives in an event (e.g., *buy* vs. *sell*) are sometimes treated as antonyms, as well. **Meronymy** is a part–whole relation that holds between

Table 1.1 The field of English cooking terms

	conducted warmth (oven)	*radiated warmth (fire)*	*hot surface (pan)*
+water, –oil, –vapor		*boil*	
+water, –oil, +vapor		*steam*	
–water, +oil	*oven-fry*		*fry*
–water, –oil	*bake, roast*	*broil, roast*	

pairs such as *hand* and *finger*, where *hand* is the holonym and *finger* is the meronym of each other.

There is a more recent word meaning representation system called "word-space model," which can be seen as a modern incarnation of semantic field theory but with much more sophisticated distributional methods in Natural Language Processing (Baroni, 2013; Jurafsky and Martin, 2009; Sahlegren, 2006). In this model, semantic similarity between words is measured by their contextual distribution and is visualized as their spatial proximity in a vector space.[2]

1.3.2 Componential Analyses

Since a field representation requires analytic dimensions to put words in opposition, a **componential analysis** is a prerequisite. It assumes that meanings can be described on the basis of a restricted set of conceptual building blocks—the semantic primitive features, that is, elements that cannot be decomposed any further (Katz and Fodor, 1963; Katz, 1972). For example, the meaning of the word *boy* may be composed of the binary features [+male] and [–adult], and distinguished from *man*, *woman* and *girl* by differences in these features, as illustrated in Table 1.2 below.

Another example is given in (4), which is the simplified lexical entry for *chair*, from Katz (1972) cited in Saeed (2016).

(4) *chair*
(Object),(Physical),(Non-living),(Artefact),(Furniture),(Portable),
(Something with legs),
(Something with a back),(Something with a seat),(Seat for one)

The internal structure of components in (4) explains entailment relations between (5a) and (5b) and contradictory relations between (5a) and (5c). If (5a) is true, then (5b) is true as well and there is no situation in which both (5a) and (5c) are true.

(5) a. There is a chair in the room.
b. There is a physical object in the room.
c. There isn't a physical object in the room.

Table 1.2 Componential analysis of *boy*

	[male]	*[adult]*
boy	+	–
man	+	+
woman	–	+
girl	–	–

1.3.3 Conceptual Semantics

A decompositional approach to meaning also lies at the basis of Jackendoff's (2002) Conceptual Semantics (CS) and Pustejovsky's (1995) Generative Lexicon (GL). We will discuss GL in detail in later chapters, so let us focus on how CS deals with lexical meaning. Like other decompositional approaches, it postulates a small number of major ontological categories, such as EVENT, STATE, PLACE, AMOUNT, THING, PATH, PROPERTY, that play the role of universal semantic primitives in the theory. For example, the semantic component named GO, like the English verb *go*, has two slots that must be filled by its arguments. The arguments, which must belong to the ontological categories THING and PATH, are separated by a comma and follow GO within the parentheses, as in (6). The subscripted EVENT refers to the ontological type of GO.

(6) $[_{\text{EVENT}}$ GO ([THING], [PATH])]

The component GO is part of the meaning that many verbs other than *go*, such as *enter*, *walk*, *cross* and *turn* have. The rule in (6) provides the basic template for all motion events, which can be filled in with details. PATH can be further defined with complex internal structures, as in (7). That is, a PATH consists of a directional component TO and a PLACE, and a PLACE is made up of a locating component IN and a THING.

(7) a. $[_{\text{PATH}}$ TO ([PLACE])]
b. $[_{\text{PLACE}}$ IN ([THING])]

The sentence (8a) has the semantic representation in (8b) in CS.

(8) a. Fido went into/entered the house.
b. $[_{\text{EVENT}}$ GO ($[_{\text{THING}}$ Fido], $[_{\text{PATH}}$ TO ($[_{\text{PLACE}}$ IN ($[_{\text{THING}}$ the house])])])]

Jackendoff argues that syntax is not the only generative system; phonology and semantics are also generative and composed of different tiers (e.g., propositional tier and information structure tier). In this framework, interface mappings that regulate the parallel and equally generative structures become very important. The lexicon itself is perceived as a small-scale **interface rule**, which is a long-term memory linkage of a piece of morphology, a piece of syntax, and a piece of semantics and their correlation rules to form a well-formed sentence, as illustrated in the lexical entries of *go* in (9). Co-subscripts are meant to indicate a long-term memory association between the structures.

(9) [*go* Phonology: $[\text{goʊ}_1]$
Syntax: V_1 PP
Semantics: $[_{\text{event}}$ GO_1($[_{\text{thing}}$ x], $[_{\text{path}}$ y])]]

1.3.4 Natural Semantic Metalanguage

Wierzbicka's (1996) Natural Semantic Metalanguage (NSM) paradigm is another version of the decompositional analysis. It assumes a universal set of semantic primitives that are involved in a process of reductive paraphrase to define words, as (10) illustrates. The metalanguage used to represent this sense draws from a small range of universal semantic primitives, such as WANT, THINK, FEEL, THING, PERSON, NOT and GOOD.[3]

(10) X feels happy = sometimes someone thinks something like this:
something good happened to me
I want this
I don't want other things now
because of this, someone feels something good
X feels like this

Proponents of NSM assume that all languages share a core vocabulary, which is supported by Goddard and Wierzbicka's (1994, 2002) survey of languages from different language families.

1.3.5 Prototype Theory

The compartmentalization of the lexicon has been criticized because the borderline between concepts tends to be blurred, often making it difficult to determine a clear boundary between fields. A prototype theory is an alternative to the classical Aristotelian theory of concepts defined by necessary and sufficient conditions. Rosch (1975, 1978) argues that within a category of entities, certain members are judged to be more representative of the category than others. For example, the members of the category/concept BIRD do not have an equal status but differ in terms of the degree of which they instantiate typical members. For example, robins are higher than chickens in representativeness of the category.

(11) a. High: *robin, sparrow, blue jay, bluebird, canary, blackbird, dove*
b. Intermediate: *raven, goldfinch, pheasant, crow*
c. Low: *chicken, turkey, ostrich, penguin, peacock*

Other categories investigated include furniture, toys, sports, clothing, vegetables, fruit, carpenter's tools, vehicles and weapons. Prototypical categories exhibit degrees of typicality, possess a family resemblance structure, are blurred at the edges and cannot be defined by means of a single set of criterial (necessary and sufficient) attributes.

1.3.6 Frame Semantics

The actual choices made from among a set of related expressions and differences in the probability of their occurrences have been investigated quantitatively using large corpora, with regard to the prototype and collocations. Projects such as WordNet or FrameNet provide more detailed information about words than traditional dictionaries by contextualizing them within a larger background knowledge structure and by deriving their meaning and syntactic realizations from the underlying structure.[4] Fillmore's frame semantics (Fillmore, 1977; Fillmore and Atkins, 1992, 2000) advocates the idea that concepts never exist in isolation, but are embedded in a larger body of knowledge called semantic frames (or scenes, scenarios, etc.). The shared conceptual structures that provide a necessary background for beliefs and experiences are used to interpret the lexical meaning of words. Taking the REVENGE concept as an example, it involves a situation in which A has done something to harm B, whereupon B takes an action to harm A in turn, and B's action is performed outside of any legal or other institutional setting. After identifying words which evoke the revenge frame, such as the ones listed in (12), Fillmore and Atkins develop a descriptive vocabulary for the components of each frame, called frame elements.

(12) a. Nouns: *revenge*, *vengeance*, *reprisal*, *retaliation*
b. Verbs: *avenge*, *revenge*, *retaliate* (*against*), *get back* (*at*), *get even* (*with*)
c. Adjectives: *vengeful*, *vindictive*

Frame elements names are in turn used in labeling the constituents of sentences exhibiting the frame. For example, the frame element list for the revenge frame includes AVENGER, OFFENDER, INJURY, INJURED PARTY and PUNISHMENT. Then corpus examples (mostly from the British National Corpus) of sentences showing the uses of each word in the frame and sentences exhibiting common collocations are extracted, showing all major syntactic contexts. The constituents of sentences that express the relevant frame elements are annotated and can be automatically summarized in a search.

Reflection

- What difficulty can you think of when trying to determine the meaning of a word based on some fixed set of universal features or prototypes?
- What do you think of using a natural language like English as a metalanguage in reductive paraphrases, as in NSM?
- What are similarities and differences between different theories discussed in this section? Which theory do you find most convincing and interesting?

1.4 Form-to-Meaning Perspective

Instead of worrying about how a word meaning may be decomposed into a set of primitive features or how some universal pre-linguistic concepts may be lexicalized, formal approaches to lexical semantics examine the range of meanings an existing form in a particular language can express, how a word meaning may or may not compose with other meanings, and how it changes in different contexts. In this section, we will discuss the aspects of word meaning that theories from the form-to-meaning perspective are interested in. Investigating word meaning from the form-to-meaning perspective allows us to immediately notice that certain words do not combine, like (13a) and (13b), and that the grammatical distribution of certain words is restricted, as in (13c) and (13d). A standard explanation of (13a) is appealing to the **selection restriction** of the predicate. Each predicate comes with a specification on what kind of argument they can take. In (13a), the verb *drink* only selects an argument that denotes liquid, but an argument denoting a solid object *the bone* is given to it, resulting in a sortal mismatch leading to anomaly. (13b) shows that relative adjectives such as *tall* and *short* cannot be modified by proportional modifiers such as *half* and *mostly*, and maximality modifiers like *fully* and *completely*, which are only compatible with absolute adjectives such as *full* and *empty*. In (13c), *know* is a stative verb and *chase* is a process verb, and only the latter can occur in the progressive form, which describes an action in progress. (13d) shows that evaluative adverbs like *unfortunately* cannot appear in a question, whereas a speech act adverb *honestly* can. An adequate theory of lexical semantics should be able to provide a systematic account of these and similar constraints in terms of the inherent meaning of the lexical items.

(13) a. Fido drank <u>the water/*the bone</u>.
b. The glass is half/mostly/completely <u>full/empty/*tall/*short</u>.
c. Fido is <u>chasing/*knowing</u> Garfield.
d. *<u>Unfortunately/honestly</u> are you drunk?

When words do combine to form well-formed phrases and sentences, their meanings interact and influence each other. The relationship between words and larger phrasal expressions is a busy two-way street. Although words contribute to constructing the meaning of sentences, the sentential (and discourse) context also affects the way words are interpreted. Different predicates can affect the meaning of their arguments. Consider (14), in which a *glass* changes its meaning depending on the verb it combines with. It refers to a container in (14a), while it refers to its content in (14b).

(14) a. I broke a <u>glass</u>.
b. I drank a <u>glass</u>.

The opposite direction of influence is also frequent, where arguments change the meaning of predicates. In (15a), *take* means "ingest," and in (15b) the same verb means "use as transportation."

(15) a. I <u>take</u> the pill every day.
b. I <u>take</u> the train to work.

These examples demonstrate that the meaning of individual words cannot be determined without also taking their composition into consideration. As such, lexical and compositional semantics are necessarily complementary, so building an adequate theory that explains the connection and interaction is essential for a deeper understanding of linguistic meaning.

1.4.1 Polysemy

Polysemy concerns the multiple meanings or senses to which a word refers. As previously discussed, almost all words—particularly high-frequency words—are polysemous, and (discourse) context plays a significant role in determining which meaning, among many possible meanings, is intended. When different meanings are completely unrelated, it is called accidental polysemy or homonymy. A frequently cited example of homonymy is given in (16). *Bank* refers to the edge of a river or a financial institution, which are not connected in any logical way.

(16) a. The boat was moored to the <u>bank</u>.
b. She works as a teller in a <u>bank</u>.

When different senses of the same word are closely connected, we call it **logical polysemy**. (17) illustrates that the different meanings of *fast*, which bring out different aspects of the noun it modifies, are closely related, maintaining its "high speed" sense.

(17) a. <u>fast</u> car (capable of moving at high speed)
b. <u>fast</u> trip (taking only a short time)
c. <u>fast</u> reader (able to perform a certain type of action quickly)
d. <u>fast</u> lane (allows the traffic to move quickly)
e. <u>fast</u> food (prepared quickly and easily)
f. <u>fast</u> life (engaging in exciting activities)

We are interested in logical polysemy, rather than homonymy, because the latter renders no systematic patterns that can be scientifically studied. In studying logical polysemy, though, it would be highly unsatisfactory to merely list the multiple meanings of the same form, since that leaves unexplained any relation between the senses. Such a method is called **sense enumerative**

lexical model. If we simply adopt this, we will need six or more separate lexical entries for the same word *fast* to explain the data in (17) even though the meanings are closely related. The inadequacy of the sense enumerative model is highlighted by another common phenomenon such that a single word can participate in different grammatical alternations. For example, the same word *open* can be used as a causative in (18a), an inchoative in (18b) and a state in (18c).

(18) a. Fido <u>opened</u> the door.
b. The door <u>opened</u>.
c. The door is <u>open</u>.

Listing three separate lexical entries for *open* will lead to a mushrooming of lexical meanings in each and every grammatical alternation, sacrificing significant generalizations.

1.4.2 Coercion

If simply listing different senses of a word is always an option to make the meaning composition work, a type mismatch between predicates and arguments would never be expected to occur. However, such examples are not hard to find, as illustrated in (19). This involves a process characterized as **type coercion**, an operation that allows an argument to change its type if it does not match the type requested by the verb. In (19a), the aspectual verb *finish* requires an event, not an object, and thus can be said to "coerce" the object *the book* to refer to the event related to it, such as reading or writing. (19b) gives rise to a similar effect; *the cake* is coerced to denote an event of eating it by the psychological verb *enjoy*.

(19) a. I finished <u>the book</u>.
b. Are you enjoying <u>the cake</u>?

These phenomena reveal that semantic composition is much more complex and richer than has traditionally been assumed. A mechanical application of grammatical rules to combine arguments and predicates does not yield the desired outcome when the predicate selects only certain attributes or aspects of the argument, or the argument introduces new information over and above what it contributes as an argument to the predicate. Pustejovsky (2012) uses the term **co-compositionality** to reflect this fact. Instead of listing each sense separately for polysemous words for the sake of a strict observation of the compositionality principle, we will enrich the word meaning to explain the polysemy and coercion in Chapter 5.

1.4.3 Metonymy

Metonymy, along with metaphor, is considered to be a "figurative" use of language because interpreting them literally does not lead to the intended meaning or may even result in absurdities. Contrary to a common assumption, however, they are not restricted to poetic or rhetorical usages (hence, not so "figurative" after all), but are instead commonplace in the everyday use of language. When a word denotes something that is conventionally related to the actual denotation of the word, we call it **metonymy**. The relationship can vary, as illustrated in (20), raising important theoretical questions regarding the nature of relations and the constraints placed on metonymic extensions.

(20) a. There were new <u>faces</u> at the party. (part for whole)
b. Your <u>shoes</u> are untied. (whole for part)
c. The <u>kettle</u> is boiling. (container for contained)
d. He has a <u>Picasso</u> in his den. (producer for product)
e. The <u>car</u> is waiting in the driveway. (possessed for possessor)
f. The <u>newspaper</u> telephoned today. (institution for people)
g. <u>Washington</u> is insensitive to people's needs. (place for institution)
h. We should not forget <u>Vietnam</u>. (place for event)

In a metonymic relation A → A′, part-to-whole, whole-to-part or part-to-part relations of an entity are inferred, but they are not strictly entailed. Kettles do not need to contain water, shoes need not have shoelaces, and a product may not have a known producer. We also have a sense that the literal referent results in a sortal mismatch between the argument and the predicate. For example, *boil* requires a liquid argument but instead a solid artifact argument *kettle* is given to it. To resolve the sortal mismatch, *kettle* is interpreted as denoting the liquid contained within it.

The relationship between A and A′ is tight and conventional in metonymy. For example, containers are artifacts whose main function is to contain something, and institutions are for the people affiliated with them. Because both A and A′ come from the same referential domain, no shift in reference actually occurs in metonymy, which is evidenced by the acceptability of anaphora, as shown in (21).

(21) <u>The pot</u> is boiling. <u>It</u> is made of metal.

In this respect, metonymy must be distinguished from actual reference shifts supported only by a specific discourse situation (Nunberg, 1979). A clear linguistic difference between the two is that an anaphoric link with the original referent becomes unacceptable in case of reference shifts, as shown in (22). The example demonstrates that the ham sandwich and the person who ordered it do not come from the same semantic domain but are only loosely connected via a restaurant scene.

(22) The ham sandwich left in a hurry. *It was too salty.

An important theoretical question regarding metonymy is whether it is governed by linguistic rules. If so, the information that a pot is for boiling or cooking something is not only part of our world knowledge but will have to be encoded in the lexical entry of *pot* and available for syntactic selection (Copestake and Briscoe, 1995; Dölling, 1995; Pustejovsky, 1995). Alternatively, it may derive naturally from our general cognitive and pragmatic knowledge and capacity (Nunberg, 1979; Papafraugou, 1996). Answers to this question will lead to different positions regarding the primacy of literal meaning and the relationship between literal and metonymic senses; metonymy either constitutes irregular reinterpretations that are triggered by semantic conflicts arising in sortal mismatches, or it is a natural phenomenon that does not require language-specific rules.

1.4.4 Metaphor

The projection of the conceptual structure appropriate to a familiar domain (called a source domain) onto a different and less familiar domain (called a target domain) is called **metaphor**. Its effectiveness depends on a sufficient similarity between the two semantic domains to make the projection comprehensible. Metaphoric extension of word meaning is pervasive in everyday language. (23) lists just a few examples from Ježek (2016, p. 61). Note that in these examples, the target domains are more abstract (e.g., story) than the source domains, which are more concrete and physically observable (e.g., food). As such, metaphor allows us to comprehend abstract entities in terms of familiar objects, reducing our cognitive load.

(23) a. Swallow a pill (lit.) vs. swallow a story (fig.) (story as food)
b. Grasp an object (lit.) vs. grasp an idea (fig.) (idea as physical object)
c. Cultivate a plant (lit.) vs. cultivate a habit (fig.) (habit as plant)
d. The animal died (lit.) vs. The battery died (fig.) (battery as living being)
e. Arrive at the airport (lit.) vs. arrive at a conclusion (fig.) (conclusion as location)

Metaphors like (24a) differ from a comparison statement in (24b) or a categorization statement in (24c), in which the target and the source domains belong to the same semantic domain, causing no compositional problem. By contrast, the target and the source domains in metaphoric extension come from different semantic domains, resulting in a sortal mismatch. In (24a), the target is an abstract entity, the mind, and the source is a complex machine, a computer. Metaphors often motivate conceptual changes more effectively than their literal cousins. Equating the mind to a computer in (24a) influenced the way psychologists view cognition—as symbolic and serial information processing and manipulation (Browdie and Gentner, 2005).

(24) a. The mind is a computer.
b. The mind is like a computer.
c. A computer is a complex machine.

Like metonymy, an important theoretical question regarding metaphor is whether metaphoric extension is grounded in pre-existing pre-linguistic conceptual systems, as the influential Conceptual Metaphor Theory (Lakoff and Johnson, 1980) argues, or whether it still requires linguistic knowledge, differing from literal meaning only in degree of figurativity (Evans, 2007). The latter view would render metaphor amenable to formal analyses (Asher and Lascarides, 2001; Borschev and Partee, 2001; van Ganabith, 2001; Vogel, 2001, 2011). Metonymy and metaphor are covered more extensively in Chapter 8.

We have now identified the subject matters from the form-to-meaning perspective, briefly describing polysemy, coercion, metonymy and metaphor. We have also touched upon diverging theoretical attitudes toward these phenomena, which will be taken up and explored in greater depth in the subsequent chapters. We will provide a standard logical tool to represent the meanings of individual lexical items and the mechanisms by which their meanings are shaped in the process of semantic composition, which we turn to in the next chapter.

Reflection

- What are the problems of sense enumerative lexical model? How can we abide by the compositionality principle given that word meaning changes in composition?
- Why it is difficult to distinguish between accidental polysemy (homonymy) and logical polysemy sometimes? What are some examples of borderline cases?
- Why do you think there is an ongoing debate concerning whether figurative languages are conventional or not? Which position do you find more plausible?

1.5 Conclusion

In this chapter, we have defined the lexeme and the word and surveyed the subject matter of lexical semantics from two contrasting perspectives. We have adopted the form-to-meaning perspective to avoid the difficulties involved with the meaning-to-form perspective, like determining a set of semantic primitives, and to provide a fresh and systematic account to lexical semantics to complement the mainstream representational theories. The rest of this book will walk the readers through the ways in which the various lexical phenomena from the form-to-meaning perspective can be systematically analyzed, answering important questions about the nature of semantic composition and the role of pragmatic world knowledge in theorizing word meaning.

Points to Remember

- Lexical semantics is the scientific study of meaning of lexemes, which are form–meaning mappings that are conventional and non-compositional.
- Words are grammatical units that cannot be interrupted, move together and have a lexical category based on their syntactic functions. Lexical semantics focuses on lexemes that are also words.
- A lexical semantic investigation can start with a meaning or a concept and examine how it is lexicalized. This meaning-to-form perspective includes the traditional lexical field theory, feature-based componential analyses, Conceptual Semantics, Natural Semantic Metalanguage, frame semantics and the prototype theory.
- Alternatively, we can start with a form and examine various meanings that it represents. The form-to-meaning perspective focuses on logical polysemy and metonymic, metaphoric and coercive meaning extensions. We will adopt this view in this book.

Technical Terms to Remember

1. **Lexical semantics:** The study of the meanings of words and their relations.
2. **Compositional semantics:** The study of how phrasal and sentential meanings are assembled through productive grammatical rules and principles.
3. **Principle of compositionality:** The meaning of a complex expression is a function of the meanings of its constituent parts in it and the way in which they are put together.

4. **Lexeme:** Linguistic expressions whose forms are conventionally associated with non-compositional meaning.
5. **Function morphemes:** Morphemes with abstract and nonreferential meanings.
6. **Content morphemes:** Morphemes with substantial descriptive meanings.
7. **Closed class:** Function morphemes are closed class because new grammatical morphemes cannot be freely added, but they slowly evolve from lexical morphemes via grammaticalization.
8. **Open class:** Content morphemes are open class because adding new words is easy and common.
9. **Grammatical word:** An expression that cannot be interrupted, moves as a unit, and has a part of speech identifiable by its morphological inflections and its distribution in phrases.
10. **Homonyms:** Words that have the same form but different meanings.
11. **Synonyms:** Words that have almost the same meaning but different forms.
12. **Polysemy:** Multiple senses of the same lexical item.
13. **Allomorph:** Multiple forms of the same meaning.
14. **Entailments:** Logical inferences based on truth that cannot be cancelled.
15. **Hyponymy:** Words which denote super- and sub-categories in the taxonomy in a hierarchical organization.
16. **Gradable antonyms:** Antonyms which denote opposing endpoints on a gradable scale.
17. **Complementary antonyms:** Antonyms which mark different choices between two complementary alternatives.
18. **Converses:** Antonyms which express reversing actions.
19. **Inverses:** Antonyms which describe opposing perspectives in an event.
20. **Meronymy:** Words standing in a part–whole relation.
21. **Componential analysis:** Meanings are described on the basis of a restricted set of semantic primitive features, which cannot be decomposed any further.
22. **Interface rule:** Rules that involve more than one sub-modules of the grammar.
23. **Selection restriction:** A specification on what kind of argument a predicate can take.
24. **Logical polysemy:** Different senses of the same word that are closely connected.
25. **Sense enumerative lexical model:** A lexical representation model that simply lists the multiple meanings of the same form.

26. **Type coercion:** An operation that allows an argument to change its type if it does not match the type requested by the verb.
27. **Metonymy:** The phenomenon of a word denoting something that is conventionally related to the actual denotation of the word.
28. **Metaphor:** The projection of the conceptual structure appropriate to a familiar domain (source domain) onto a different and less familiar domain (target domain).

Suggested Reading

The discussion on representational/cognitive theories of lexical semantics was very brief as they are not the main focus of this book. Saeed (2016, Ch. 9) contains a more detailed exposition. Also see Cruse (1986) for a more through discussion on lexical relations. See Levin and Pinker (1992) for an in-depth discussion of decompositional semantics. See Jackendoff (1990, 2002) for his Conceptual Semantics theory and Pustejovsky (1995) for his Generative Lexicon theory. See Baroni (2013) for a possible connection between formal semantics and word-space model in computational linguistics.

Practice

1. Determine whether the following expressions are lexemes, words or lexemes that are also words.

(a) *anti*

a lexeme but not a word

(b) *ice cream*
(c) *girlfriend*
(d) *revitalize*
(e) *throw up*
(f) *chip on one's shoulder*
(g) *textbook*
(h) *doughnut*
(i) *unusable*
(j) *air-conditioner*

2. Name the structural relation expressed by each of the following pairs of words.

(a) *casual/informal*

synonym

(b) *expand/shrink*
(c) *terrier/dog*
(d) *right/left*
(e) *roof/house*

(f) *long/short*
(j) *shatter/break*
(h) *odd/unusual*
(i) *give/receive*
(j) *wind/breeze*

3. Antonyms are in fact very similar to each other because they share all features except for one contrasting feature. Identify the common and contrasting features in the pairs of antonyms.
(a) *easy/difficult*
degree of difficulty, low vs. high

(b) *open/close*
(c) *rise/fall*
(d) *buy/sell*
(e) *buy/steal*
(f) *clean/soil*
(g) *lengthen/shorten*
(h) *accept/reject*
(i) *pass/fail*
(j) *awake/asleep*

4. Try to analyze the following words in terms of the feature-based componential analysis. Did you encounter any difficulty? What were the problems of such analysis?
(a) *bachelor*
[+male], [+adult], [+unmarried]

(b) *mother*
(c) *mare*
(d) *bed*
(e) *dream*

5. List the prototypes of the following categories. Were your selections influenced by your culture or personal experiences?
(a) *hobbies*
sports, music, movies, arts

(b) *furniture*
(c) *sports*
(d) *clothing*
(e) *food*

6. Which of the following words are homonyms and which are polysemous? List the different senses and make up sentences that reveal each sense. What were your criteria for these decisions?
(a) *bat*
homonyms (animal bat, baseball bat)

(b) *kind*
(c) *high*

(d) *sole*
(e) *mouth*
(f) *coach*
(g) *coat*
(h) *file*
(i) *hand*
(j) *duck*

7. Do the italicized words involve metonymy, metaphor, coercion or polysemy? Explain your answers.
(a) I *finished* the book.
Coercion: the aspectual verb *finish* coerces *the book* to denote an event related to it, e.g., reading and writing.

(b) *Wall Street* is in a panic.
(c) The argument is *shaky*.
(d) Your *shoes* are untied.
(e) I hate *flat* beer and *flat* shoes.
(f) The Giants need a stronger *arm* in right field.
(g) The theory needs more *support*.
(h) He bought a *Ford*.
(i) This is a *comfortable* chair.
(i) *Pearl Harbor* still has an effect on our foreign policy.

8. Explain why the following sentences are anomalous.
(a) I smelled it with my nose.
redundant, uninformative

(b) The glass is half big.
(c) Unfortunately, are you injured?
(d) I had a toast for breakfast.
(e) I built a house for two days.

9. What kinds of metaphor are involved in the following examples? Identify the source and target domains. What aspect(s) of the source domain maps onto those in the target domain?
(a) There's going to be trouble down the road.
time as space metaphor, down the road = future

(b) The market plummeted.
(c) This relationship is a dead-end street.
(d) The theory needs more support.
(e) The fund dried up.

10. The same verb can describe a number of different situations, as in the following examples. If you do not want to adopt a sense enumerative lexical model, how would you describe these phenomena?
(a) *help*
She is helping him.
She is helping him clean the house.
She helped him into the car.

A purpose or goal adjunct can optionally be added to specify what the subject helps the object with. This does not change the meaning of *help*.

(b) *open*
She opened the window.
The window opened.
The window is open.

(c) *bake*
She baked a potato.
She baked a cake.

(d) *break*
I broke a glass.
I broke a promise.

(e) *take*
I take the pill every day.
I take the train to work.

Notes

1 Function words or morphemes are not limited to bound inflectional morphemes, such as past -*ed*, progressive -*ing*, comparative -*er,* superlative -*est*, possessive -*s*, past participle -*en* or -*ed* and third-person singular present -*s*. Free morphemes or words, such as pronouns (*I, you, he, she, it, they, himself, herself*), connectives (*and*, *or*, *if*, *not*), articles (*a*, *the*, *this*) and modal auxiliary verbs (*must*, *can*) are also function words. The semantics of function morphemes and words is the domain of compositional semantics.

2 We will discuss this model in some more detail in the Epilogue, but the goal and techniques of this model differ significantly from those of this book.

3 The number of primes was 14 in Wierzbicka (1972) but increased to 60 in Goddard and Wierzbicka (2002), and it currently stands at 65 (Goddard and Wierzbicka, 2014).

4 The FrameNet is an ongoing project that contains more than 13,000 English word senses with annotated examples and more than 1,200 semantic frames with semantic role labeling, which can be used in computational applications such as information extraction, machine translation, event recognition, and sentiment analysis, among others. Frequency data is not included, which is postponed until methods of automatic tagging are perfected (www.icsi.berkeley.edu/~framenet).

2 Methods

2.1 Logical Language

To represent the meaning of words systematically and lucidly, adequately capturing their contributions to the meaning of a sentence in which they occur, we need a logical language free from the ambiguity, imprecision and vagueness common in natural language. This chapter will introduce a logical language to analyze word meaning. Although rather technical and somewhat difficult to grasp, understanding the concepts and learning how to read logical symbols are essential to follow the formalizations in the rest of the book and to gain literacy for the literature in the field.

When we try to scientifically study the elusive subject of meaning, the notion of "truth" is extremely useful. Let us begin with a foundational assumption about the speaker's semantic competence: Knowing the meaning of a sentence is (at the very least) knowing its **truth condition**, the condition under which a sentence is true or false. For example, we may or may not know whether (1) is true in the real world, but we do know what the world would have to be like in order for it to be true.

(1) Fido is barking.

The actual **truth value** of a sentence, on the other hand, can only be determined in a particular world/circumstance in terms of the states of affairs in that world/circumstance. Obviously, we do not know everything about the world we live in, but that does not affect our ability to understand an infinite number of sentences. Therefore, the truth conditions of a sentence are not to be equated with actual verifications of its truth. Assuming that knowing the truth condition of a sentence is knowing its meaning, the meaning of words can be fruitfully studied by examining the contribution they make to the truth condition of the sentence in which they occur. Logical tools in formal semantics provide a well-developed method for compositionally obtaining meaning from the meanings of words and syntactic rules.

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2.1.1 Propositional Calculus

The study of logical relationships between sentences is called **propositional calculus**. A **proposition** is what a sentence expresses, which is true in some possible worlds and false in others. A **possible world** is a way that our actual world could have been. It is assumed that there are infinitely many possible worlds, and each possible world is a complete specification of a way the world could be (Lewis, 1986). In propositional calculus, p, q and r stand for propositions, and they are connected by various logical connectives. Let us begin with the logical **negation** ("not," symbolized ~ or ¬). The negation reverses the truth value of an input proposition; anytime p is true, $\neg p$ is false, and anytime p is false, $\neg p$ is true, as illustrated with actual sentences in (2).

(2) a. Fido barks.
    b. Fido does <u>not</u> bark.

We can visualize this using a **truth table**, in which each input proposition occupies a column, and the last column gives all possible output values of the given logical operation. As shown in the truth table for the negation in Table 2.1, it is a function that maps t (true) in the first column onto f (false) in the second, and vice versa.

The logical **conjunction** ("and," symbolized & or ∧) involves two propositions. In order for (3) to be true, it has to be the case that Fido barks is true, and Garfield dances is true.

(3) Fido barks <u>and</u> Garfield dances.

The truth table for the conjunction in Table 2.2 says $p \wedge q$ is only true when both p and q are true. In all other cases, $p \wedge q$ is false.

Table 2.1 Truth table for negation

p	p
t	f
f	t

Table 2.2 Truth table for conjunction

p	q	$p \wedge q$
t	t	t
t	f	f
f	t	f
f	f	f

Table 2.3 Truth table for disjunction

p	q	$p \vee q$
t	t	t
t	f	t
f	t	t
f	f	f

Table 2.4 Truth table for conditional

p	q	$p \rightarrow q$
t	t	t
t	f	f
f	t	t
f	f	t

The logical **disjunction** ("or," symbolized as ∨) requires the truth of either disjunct. (4) is true if Fido barks is true and/or Garfield dances is true.

(4) Fido barks or Garfield dances.

The truth table for the disjunction in Table 2.3 says $p \vee q$ is false only when both p and q are false and in all other cases, it is true. This is the **inclusive disjunction**, meaning "one or the other or both."

The logical **implication** ("if then," symbolized as →) is true if the antecedent is true and the consequent is true, or the antecedent is false. (5) is true if Fido barks is true and Garfield is afraid is true. It is also true if Fido doesn't bark because in that case there is no way of falsifying the whole proposition. It is false only if Fido barks is true and Garfield is afraid is false.

(5) If Fido barks, then Garfield is afraid.

The truth table for the implication in Table 2.4 says that the only case in which $p \rightarrow q$ is false is when p is true, and q is false. If p is false, $p \rightarrow q$ is still true because there is no way of falsifying it.

The **biconditional** ("if and only if," symbolized as ↔) requires identical truth value of the two propositions. (6) is true if Fido barks is true and Garfield dances is true, or Fido barks is false and Garfield dances is false.

(6) Fido barks if and only if Garfield dances.

The truth table for the biconditional in Table 2.5 states that $p \leftrightarrow q$ is true when p and q have the same truth value; otherwise, it's false.

Table 2.5 Truth table for biconditional

p	q	$p \leftrightarrow q$
t	t	t
t	f	f
f	t	f
f	f	t

Note that some complex propositions, by virtue of their forms, are true in all possible worlds and that some are false in all possible worlds. For example, (7a) is a **tautology** that is true in all possible worlds. There is no possible world in which this proposition could be false; it is necessarily true. Even if we replace p and q with different sentences, it remains a tautology.

(7) a. If a dog is cute and he is smart, then he is smart and he is cute.
b. $(p \wedge q) \rightarrow (q \wedge p)$

A proposition that is necessarily false in all possible worlds is a **contradiction**. An example is given in (8).

(8) a. Fido is cute and he is not cute.
b. $p \wedge \neg p$

Tautologies and contradictions are called **analytic**, meaning their truth value is independent of what a particular world is like; all other sentences are **synthetic**, meaning that they depend for their truth value on what the world is like.

2.1.2 Predicate Calculus

While the propositional calculus deals with relationships between propositions, the **predicate calculus** looks at the truth-conditional meaning within individual sentences. For example, the sentence *Fido is a dog*, which is just p in propositional calculus, can be translated in predicate calculus as dog′(f), where dog′ stands for *dog* and f stands for *Fido*. The whole formula states that dog-hood is predicated of Fido. Note that dog′ here is not the English word *dog* but is used as metalanguage, that is, a part of logical translations. The predicates are fully spelled out, while the arguments (individuals) are represented as just a single letter f, which is called an individual **constant**; each constant represents a specific individual. We can also have **variables**, as with **dog**(x), which means "x is a dog," where x is some unspecified entity. Constants include names or any descriptive vocabulary, both individuals (e.g., f) and predicates (e.g., dog′). We usually use letters a-u in alphabet for individual constants and letters v-z for variables. To distinguish between the two more clearly, we will italicize the variables from now on. Some predicates have more than one argument, e.g., chase′(f, g) stands for *Fido chases Garfield.* In this case, *Fido* and *Garfield* are the arguments of *chases*, and the whole formula describes a chasing relation holding between Fido and Garfield.

The predicate calculus also includes **quantifiers**, which make a more general statement about the quantity of entities that a predicate applies to. The two most basic quantifiers are the **universal quantifier** (which specifies that the predicate applies to all entities, paraphrased as "for all") and the **existential quantifier** (which specifies that the predicate applies to some entities, paraphrased as "there exist"). Some examples of predicate calculus formulas containing quantifiers are given in (9).

(9) a. $\forall x.\text{dog}'(x)$ "For all x, x is a dog." or "Everything is a dog."
b. $\exists x.\text{dog}'(x)$ "There exists an x such that x is a dog." or "Something is a dog."

We can combine predicate calculus and propositional calculus to build more complex formulas, as in (10).

(10) a. $\forall x.\text{dog}'(x) \rightarrow \text{bark}'(x)$ "For all x, if x is a dog, then x barks." or "All dogs bark."
b. $\exists x.\text{dog}'(x) \wedge \text{bark}'(x)$ "For some x, x is a dog and x barks." or "Some dogs bark."

2.1.3 Lambda Calculus

We have translated *Fido chases Garfield* using the predicate calculus as in (11).

(11) chase′(f, g)

The proper names *Fido* and *Garfield* pick out particular objects, namely, the dog Fido and the cat Garfield. Therefore, we represent them as individual constants, f and g, respectively. The transitive verb, *chases,* denotes a binary relation, translated as chase′. It is not clear, however, what a verb phrase like *chases Garfield* denote. The best way to translate it is to use a formula like (12), where the first argument of chase′ is left blank.

(12) chase′(__, g)

The verb phrase in this case is said to be **unsaturated**, meaning that it is incomplete and requires things that can fill in the blank argument position. To formally express this idea, we will use a variable as a placeholder for the empty slot, as well as an abstraction operator, called λ ("lambda"), to bind the variable. This process is called **lambda abstraction**. Using the λ operator, we can abstract over the missing piece, as shown in (13), which corresponds to what *chases Garfield* means. Lambda operator therefore offers a logical means to represent sub-constituents of a sentence, aligning better with the natural language structure than the predicate calculus.

(13) $\lambda x.\text{chase}'(x, \text{g})$

Technically, (13) denotes a **function**, which is a set of ordered pairs in which the second member of each pair is "uniquely" determined by the first. Every function has a domain and a range, which are sets of individuals. When A is the domain and B is the range of a function f, we say that "f is a function from A to B" and write it as f: A → B. Members in the domain of a function are called **arguments**, and members in the range to which the arguments are mapped are called **values**. The function expressed by (13) maps all individuals in the domain to either true or false depending on whether they chase Garfield or not, as exemplified in (14) in a table form (assuming there are only three dogs in the universe of discourse, namely, Fido, Spot and Bingo).

(14) $\begin{bmatrix} \text{Fido} \rightarrow 1 \\ \text{Spot} \rightarrow 0 \\ \text{Bingo} \rightarrow 1 \end{bmatrix}$

More formally, it is a function from the domain of individuals to the truth values (i.e., f: $D \rightarrow \{0, 1\}$) such that for all x in D, f(x) = 1 if and only if x chases Garfield. The symbol f(x) is read as "f applied to x or the value of f for the argument x." This kind of function, called **characteristic function**, basically gives the set of all things that chase Garfield, in this case, the set containing Fido and Bingo.

A **set** is a collection of any (random) objects, either finite or infinite. Sets can be defined not only by either listing all their members, e.g., {Fido, Bingo} where members of a set are put inside curly brackets separated by commas, but also by stating a property that an object must possess to qualify as a member. To define it this way by abstraction, we state a condition or a property that all the members of the set share after a vertical line following the first occurrence of a variable, which stands for no particular objects but rather indicates what the property applies to. For example, $\{x \mid x \text{ is a dog}\}$ is read "the set of all x such that x is a dog." The objects in a set are called the **members** or elements of that set, symbolized as a ∈ A. a ∉ A means that a is not a member of the set A. Two sets are identical (A = B) if and only if they have exactly the same members, e.g., {a, b} = {b, a, a}. There is a set with no members. The symbol for an empty set is ∅. |A| is the **cardinality** of the set A, i.e., the number of its members. A ⊆ B means set A is a **subset** of set B and B is a **superset** of A, which holds when all of the members of the set A are also members of the set B. By this definition, every set is a subset of itself. When B contains other members beside the members of A, A is a **proper subset** of B and the symbol for it is A ⊂ B. Given two sets A and B, we can perform some set theoretic operations on them, defined in (15). **Intersection** of set A and set B, $A \cap B$, includes common members of A and B. **Union** of set A and B, $A \cup B$, includes all members of A and B. **Complement** or difference of set A and B, $A - B$, includes all members of A which are not in B.

(15) a. $A \cap B =_{def} \{x \mid x \in A \text{ and } x \in B\}$
b. $A \cup B =_{def} \{x \mid x \in A \text{ or } x \in B\}$
c. $A - B =_{def} \{x \mid x \in A \text{ and } x \notin B\}$

Reflection

- Why do we use a logical language to translate words and sentences? Why can't we use a natural language like English for paraphrases?
- What is truth-conditional semantics? In what ways does meaning go beyond truth conditions?
- What is the utility of the lambda calculus? What is its relationship with the principle of compositionality? Can you think of other applications of it than representing unsaturated meanings?

2.2 Model Theory

2.2.1 Truth Relative to a Model

We have so far equated knowing the meaning of a sentence with knowing its truth condition, but not with the actual verification of its truth. This is because knowing the actual truth value requires more world knowledge than we actually have. We do not know for every dog in the world whether it is barking, for instance. Is it then impossible to find out a truth value of a sentence? How do we capture the fact that, when a speaker encounters an actual situation in the world, she can easily map that situation with a sentence that truthfully describes it? Since we do not know everything in the world, semanticists often interpret linguistic expressions as true or false relative to a model, a simulated or made-up specification of what the world is like. In formal semantics, meanings are the range of the **interpretation function** $[\![\ ]\!]$, which assigns each expression in the language its meaning. For example, $[\![dog]\!]$ is the denotation of *dog*, the set of all dogs in each possible world. We represent the relativity of denotation to a model using a superscript, i.e., the denotation of any expression *a* relative to a model M is $[\![a]\!]^M$. A model M consists of the **domain of individuals** or **universe of discourse** *D*, which is the set of individuals, and an interpretation function $[\![\ ]\!]^M$, which assigns a denotation to each linguistic expression. Let us look at an example of a simple model, given in (16). The domain D includes a set of individuals, and the interpretation function $[\![\ ]\!]^M$ takes descriptive vocabulary as its input and gives a set of things as output. Among the descriptive vocabulary, one-place predicates like *bark* denote a set of individuals, in this case, a set of barkers, and two-place predicates like *chase* denote a set of ordered pairs, in which the first member of the pair chases the second member.

(16) Model M = $\langle D, [\![\ ]\!]^M \rangle$
D = {Fido, Garfield, Spot}
$[\![bark]\!]^M$ = {Fido, Spot}
$[\![chase]\!]^M$ = {⟨*Fido*, *Garfield*⟩}

Let us verify the truth of the following sentences relative to this model.

(17) a. $[\![$*Fido bark*$]\!]^M$ = 1 iff Fido ∈ $[\![bark]\!]^M$
Because Fido is a member of {Fido, Spot}, it is TRUE in M.
b. $[\![$*Spot chases Garfield*$]\!]^M$ = 1 iff ⟨*Spot*, *Garfield*⟩ ∈ $[\![chase]\!]^M$
Because ⟨*Spot*, *Garfield*⟩ is not a member of {⟨*Fido*, *Garfield*⟩}, it is FALSE in M.
c. $[\![$*Fido barks and it is not the case that Spot chases Garfield*$]\!]^M$ = 1 iff $[\![$*Fido bark*$]\!]^M$ = 1
and $[\![$it is not the case that *Spot chases Garfield*$]\!]^M$ = 1
$[\![$*Fido bark*$]\!]^M$ = 1 iff Fido ∈ $[\![bark]\!]^M$, which is the case.
$[\![$it is not the case that *Spot chases Garfield*$]\!]^M$ = 1 iff $[\![$*Spot chases Garfield*$]\!]^M$ = 0.
$[\![$*Spot chases Garfield*$]\!]^M$ = 0 iff ⟨*Spot*, *Garfield*⟩ ∉ $[\![chase]\!]^M$, which is the case, so the whole sentence is TRUE in M.

2.2.2 Intensional Models

If the meaning of an expression is its denotation and nothing else, substitution of co-referring NPs in the same sentence will not change its truth condition, which is confirmed in (18). If (18a) and (18b) are true, (18c) is also true.

(18) a. Fido chased Garfield.
b. Garfield is an orange cat.
c. Fido chased an orange cat.

However, substitution of co-referring NPs fails in so-called **intensional contexts**. Verbs like *seek*, *try*, *believe*, *want*, *hope*, *doubt*, etc. create an intensional context. We cannot conclude (18c) from (18a) and (18b).

(19) a. Fido tries to find Garfield.
b. Garfield is an orange cat.
c. Fido tries to find an orange cat.

Tense and modality also create intensional contexts. For example, the truth value of the past tense sentence (20b) cannot be determined by the denotation of *is barking* in the model. To determine whether (20b) is true or not, we need to know the denotation of *is barking* in situations that held at earlier times.

(20) a. Fido is barking.
b. Fido was barking.

Similarly, to evaluate (21), it is not enough to know the denotation of *is barking* in the model. Modality such as possibility creates an intensional context, as well.

(21) Fido might be barking.

In order to interpret intensional sentences, we need alternative sets of states of affairs other than the given one, which we called possible worlds. Taking intensionality into account, denotation becomes a function from possible worlds/times to extensions. Our model is expanded to consist of not only domain of individuals, D, but also a set of worlds, W, a set of temporal instants, T, and ordering on T, $<$. (22) is an example of an intensional model. As we can see, the denotation of *bark* is now relativized in terms of worlds and times. It denotes different sets in different times and different worlds. $< = \{\langle t_1, t_2\rangle\}$ means t_1 is earlier than t_2.

(22) $D = \{\text{Fido, Garfield, Spot}\}$
$W = \{w_1, w_2\}$
$T = \{t_1, t_2\}$
$< = \{\langle t_1, t_2\rangle\}$
$[\![bark]\!]^{M} =$

	t_1	t_2
w_1	{Fido}	{Spot}
w_2	{Spot}	$\emptyset$

Intuitively, the past tense sentence in (20b) above evaluated in t_2 is true because Fido is in the set of barkers at an earlier time t_1. Similarly, the modalized sentence in (21) above is also true because we can find at least one world, w_1, where Fido is in the set of barkers. Table 2.6 describes intensional and extensional meanings. Extensional meanings are called **reference** and intensional meanings are called **sense** (Frege, 1892). As in Table 2.6, the intension

Table 2.6 Extensional and intensional meanings

Syntactic category	*Example*	*Extension*	*Intension*
VP	*bark*	set of individuals	function from possible circumstances (i.e., world-time pairs) to sets of individuals; property
S	*Fido barks*	truth values	function from possible circumstances to truth values; proposition
NP	*the dog*	individual	function from possible circumstances to individuals; individual concept

of one-place predicates is called **property**, the intension of sentences is called **proposition**, and the intension of individuals is called **individual concept**.

2.3 Type Theory

2.3.1 Basic and Functional Types

A **type** represents the kind of denotation an expression has. We will start with two basic types, namely, the type of **entities** e for individual-denoting expressions, in (23a), and the type of **truth values** t for formulas in (23b). From these types we can construct function types such as (23c) for expressions denoting functions from individuals to truth values. Angle brackets are used only for function types. The input to the function (argument) is on the left-hand side in the angle bracket separated by a comma from the output to the function (value) on the right-hand side.

(23) a. e
b. t
c. $\langle e, t\rangle$

The set of types is recursively defined, building up types with increasing complexity. In (24), σ ("sigma") and τ ("tau") stand for any arbitrary types.

(24) a. e is a type
b. t is a type
c. If σ is a type and τ is a type, then $\langle\sigma, \tau\rangle$ is a type.
d. Nothing else is a type.

Given (24), $\langle e, t\rangle$ is a type since both e (= σ) and t (= τ) are types. Since $\langle e, t\rangle$ is a type and e is a type, $\langle e, \langle e, t\rangle\rangle$ is also a type. The set of types is infinite.

These types are syntactic objects, but they are associated with categories of denotations. For any type τ, we use D_τ to refer to the set of possible denotations for an expression of type τ. An expression of type e denotes an individual, so D_e is the set of individuals, corresponding to our universe of discourse that contains everything in the world or a model of it. An expression of type t is a formula, so its denotation must be either 1 (for true) or 0 (for false); $D_t = \{1, 0\}$. An expression of type $\langle e, t\rangle$ denotes a function from individuals to truth values. $D_{\langle e, t\rangle}$ is in turn the set of functions from the domain D_e to the range D_t; that is, functions that take an individual as input, and yield a truth value as output.

When performing a semantic composition as a function application, the type of argument must match the type required by the functor. The intransitive verb, *barks,* is an expression of type $\langle e, t\rangle$, as translated in (25a) using the lambda calculus. Since it is a function that takes an argument of type e, the constant f (for Fido) meets the input requirement and thus can be supplied to it, as shown in (25a). To simplify (25a), we replace the variable x with the constant f, simultaneously removing the lambda operator, as in (25b), indicating that the unsaturated predicate is now saturated. This process is called **lambda conversion** (or beta reduction). The result is a formula of type t in (25c), which translates *Fido barks.*

(25) a. $\lambda x.\text{bark}'(x)$ $\langle e, t\rangle$
b. $[\lambda x.\text{bark}'(x)](\text{f})$
c. $\text{bark}'(\text{f})$ t

To translate the verb *chases*, we need to use a more complex expression of type $\langle e, \langle e, t\rangle\rangle$, as in (26a). We have $\lambda y\lambda x.\text{chase}'(x, y)$ because the verb combines first with the object and then with the subject. This allows us to first simplify the outer lambda λy that binds the variable in the object position. After the function takes the object argument, Garfield, (26b) will serve as the translation for the verb phrase *chases Garfield,* which yields a simpler type $\langle e, t\rangle$. It denotes a function that maps all things that chase Garfield to the truth value t. Finally, by adding the subject, *Fido*, we obtain a complete formula in (26c). After simplifying the lambda, it will serve as the translation for *Fido chases Garfield*, a formula of type t.

(26) a. $\lambda y\lambda x.\text{chase}'(x, y)$ $\langle e, \langle e, t\rangle\rangle$
b. $[\lambda y\lambda x.\text{chase}'(x, y)](\text{g}) = \lambda \text{x}.\text{chase}'(x, \text{g})$ $\langle e, t\rangle$
c. $[\lambda \text{x}.\text{chase}'(x, \text{g})](\text{f}) = \text{chase}'(\text{f}, \text{g})$ t

As previously mentioned, meanings are the range of the interpretation function $[\![\ ]\!]$, which assigns each expression in the language its meaning. $[\![\textit{dog}]\!]$ is a function that gives a set of dogs in each possible world, and $[\![\textit{bark}]\!]$ is a function that yields a set of individuals who bark in each possible world, as formally represented using the lambda calculus in (27). The subscript w after each predicate indicates its sensitivity to possible worlds. The interpretation function picks out the actual denotation/referent of an expression in each world/circumstance. The type s is the type of worlds (i.e., **intensional type**) which appears before t to express a function from possible world/time pairs to truth values.

(27) a. $[\![dog]\!] = \lambda w \lambda x.\mathrm{dog}'_w(x)$ $\langle e, st\rangle$
b. $[\![bark]\!] = \lambda w \lambda x.\mathrm{bark}'_w(x)$ $\langle e, st\rangle$

The logical interpretation of *a dog barks* is given in (28), in which λw collects the set of worlds in which the described condition hold. That is, the proposition *a dog barks* denotes a set of possible worlds/circumstances that contain a barking dog.

(28) $[\![a\ dog\ barks]\!] = \lambda w \exists x.\mathrm{dog}'_w(x) \wedge \mathrm{bark}'_w(x)$ st

In this book, we will use intensional types as sparingly as possible, and mostly ignore the world variable unless an explicit reference to possible worlds is required. However, this is for convenience only, and it is assumed that linguistic expressions are always interpreted with respect to a set of possible worlds/circumstances.

2.3.2 Many-Sorted Types

We have now introduced the bread and butter of formal semantic tools. For lexical semantics, we need to be a bit more creative. Consider sentences in (29), in which the predicate of type $\langle e, t\rangle$ combines with the subject of type e, but (29b) is still semantically anomalous. This shows that we cannot explain why a composition can break down even when the type requirements are met, since we have only two basic types (e and t) at our disposal. Intuitively, the predicate *is orange* requires a physical or concrete object as its argument, but the argument given to it, *the fight*, denotes an eventuality (events, processes and states), which cannot have color. (29a), by contrast, exemplifies a successful application, since the argument *Garfield* denotes a physical object, satisfying the input type requirement of the predicate.

(29) a. <u>Garfield</u> is orange.
b. *<u>The fight</u> is orange.

To explain this, we need a more fine-grained type distinction within the broadest entity type e, which includes basically everything in the world/model. To explain (29), we may postulate *eventuality* and *physical-object* as sub-types of the entity type e. There are many ontological categories that languages reflect in their grammar. The distinction between eventualities (events, processes and states) and non-eventualities including physical objects allows us to distinguish between well-formed (29a) and anomalous (29b) above. Once we decide to enrich and expand our domain, a question arises as to the semantic status of these more fine-grained types. Leading formal semanticists like Barbara Partee and Nicholas Asher have different opinions regarding this question. Borschev and Partee (2014) promote sorts to types and treat these enriched types extensionally by assuming that they are associated with categories of denotations. In such system, an expression of type *physical-object* denotes a physical object; $D_{physical\text{-}object}$ is the set of all physical objects in the world/model. An expression of type *eventuality* is an eventuality, so $D_{eventuality}$ is the set of all eventualities in the world/model. An expression of type $\langle physical\text{-}object, t\rangle$ denotes a function from physical objects to truth values. $D_{\langle physical\text{-}objects,\ t\rangle}$ is the set of functions with domain $D_{physical\text{-}object}$ and range D_t; that is, functions that take as input a physical object, and give a truth value as output. An expression of type $\langle eventuality, t\rangle$ denotes a function from eventualities to truth values. $D_{\langle eventuality,\ t\rangle}$ is the set of functions with domain $D_{eventuality}$ and range D_t; that is, functions that take as input an eventuality, and give a truth value as output. This means that entities in D are now partitioned into sub-domains of $D_{physical\text{-}object}$ and $D_{eventuality}$. Intuitively, physical objects exist in three-dimensional space, at any point in time and they are publicly observable. Eventualities, on the other hand, are located in time, and occur or obtain rather than exist. The domain of physical objects and the domain of eventualities are sub-domains of the domain of entities, as represented in set-theoretic notations in (30a). We also assume that these two domains do not overlap, as represented in (30b).

(30) a. $D_{physical\text{-}object} \cup D_{eventuality} \subseteq D_e$
b. $D_{physical\text{-}object} \cap D_{eventuality} = \emptyset$

Asher (2011), on the other hand, argues that types cannot be such extensional set-theoretical objects, given the existence of non-referential expressions like fictional names. He argues that they must be mind-dependent entities or concepts, which he represents using small caps. Each lexeme is in principle associated with an independent type/concept, but only general types, those at the upper level of type hierarchy, are relevant for type checking in predication. For example, PHYSICAL OBJECT and EVENTUALITY are among such general types that are incompatible. The subtype $\sqsubseteq$ relation on types can be used to encode entailment relations without invoking lexical decompositions and to explain general patterns of predication, as illustrated in (31). In (31b), a_1 and a_2 are called "parameters," which correspond to variables in logical translations. Parameterized types are called "dependent types," which are functions from a sequence of types/parameters to types.

(31) a. FIGHT $\sqsubseteq$ EVENTUALITY
b. KILL$(a_1, a_2) \sqsubseteq$ DIE(a_2)

Since Asher's (2011) theory requires an additional dimension of types that come with its own complex logical system apart from our standard lambda calculus and the model-theoretic interpretation, we will adopt Partee-style semantics, which is a more conservative extension of standard formal semantics. A type or sortal incorrectness can now be modeled as an inability of a function to apply to its argument. (32) shows the compositional calculation of the meaning of (29a), where the predicate *is orange* is of type ⟨*physical-object*, *t*⟩, a function from the domain of physical objects (a subdomain of entities) to truth values. The argument, *Garfield*, belongs to the physical object type required by the predicate so the composition proceeds normally.

(32)	a. ⟦*Garfield*⟧ = g	*physical-object*
	b. ⟦*is orange*⟧ = λx.orange′(x)	⟨*physical-object*, *t*⟩
	c. ⟦*is orange*⟧(⟦*Garfield*⟧) = [λx.orange′(x)] (g) = orange′(g)	*t*

(33) illustrates why (29b) above is unacceptable. An eventuality is not the right type of argument for the given predicate, since the domain of physical objects and the domain of eventualities are disjoint, i.e., they have no common members (See (30b) above). An eventuality cannot be a member of the set of objects that can have colors, resulting in a semantic anomaly caused by a type mismatch. The representation of definite noun phrases that are not crucial to our goal, such as *the fight,* will be hereafter abbreviated with single letter constants, such as f.[1]

(33)	a. ⟦*the fight*⟧ = f	*eventuality*
	b. ⟦*is orange*⟧ = λx.orange′(x)	⟨*physical-object*, *t*⟩
	c. *⟦*is orange*⟧(⟦*the fight*⟧) = *[λx.orange′(x)](f)	

Reflection

- What does it mean for a theory of meaning to be compositional? How does the type theory help explain the compositionality?
- Why do we need many-sorted types? How can we determine the sorts we need? Are there predicates that are completely insensitive to the fine-grained type distinctions of their arguments? Are there predicates that have very specific requirements? Which do you think is more common?
- Using a rich system of semantic types to analyze predication is viable only if there is empirical evidence cross-linguistically. Asher

(2011) argues that there is indeed such evidence; the type distinction between eventualities and objects is reflected in Japanese in the system of particles and in Chinese in the classifier system. Can you think of other cross-linguistic evidence for type distinctions influencing the grammar?

2.4 Lexical Entailments

2.4.1 Grammatical Distributions of Words

Researchers of lexical semantics use grammatical distributions of words as a probe of their complex structure and meaning (Hale and Keyser, 2002; Levin and Rappaport, 2005; Pinker, 1989/2013; Rappaport and Levin, 1998; inter alia). To appreciate such a method, consider the minimal pair in (34).

(34) a. Fido <u>broke</u> the bowl.
b. Fido <u>hit</u> the bowl.

(34a) and (34b) may well describe the same real-world event, but the verbs *break* and *hit* are not equally acceptable in various grammatical alternations. A **grammatical alternation** describes a change in the realization of the argument structure of a verb by means of deletion, movement and switch between noun phrases (NPs) and prepositional phrases (PPs), among others. One of those alternations is the transitive-conative alternation, in which the direct object of the verb in the transitive variant (i.e., (34) above) changes into the object of the preposition at in a PP in the intransitive conative variant. Only *hit* is compatible with it, as the contrast between (35a) and (35b) shows.

(35) a. *Fido <u>broke at</u> the bowl.
b. Fido <u>hit at</u> the bowl.

Another difference in patterning between the two verbs appears in the part–whole alternation. A possessor and a possessed body part may be expressed as the direct object NP of the verb or as two separate constituents: The possessor as the direct object and the body part in a PP headed by a locative preposition. The part, which is the complement of a preposition, identifies the specific location on which the action of the verb is performed. As it was the case with the conative alternation, this alternation is only acceptable with *hit*, as evidenced by (36).

(36) a *Fido <u>broke</u> Garfield <u>on the tail</u>.
b. Fido <u>hit</u> Garfield <u>on the tail</u>.

The causative-inchoative alternation, on the other hand, reverses the direction of acceptability, permitting only *break*, as (37) illustrates. The direct object of its transitive variant becomes the sole argument in the subject position in an inchoative construction.

(37) a. The bowl <u>broke</u>.
b. *The bowl <u>hit</u>.

A similar alternation called the transitive-middle alternation is also only compatible with *break*, as (38) demonstrates. As in the case with inchoative alternation, middles put the direct object of their transitive variants in the subject position, while modifying the event with a manner adverb.

(38) a. The bowl <u>breaks easily</u>.
b. *The bowl <u>hits easily</u>.

It is important to recognize that these distributions cannot be merely coincidental since many other verbs listed in (39) pattern similarly.

(39) a. Verbs that pattern like *break*: *crack, rip, shatter, splinter, split, snap*, etc.
b. Verbs that pattern like *hit*: *kick, pound, punch, slap, tap, whack*, etc.

This means that verbs in the *break* group in (39a) share certain semantic properties that the verbs in the *hit* group in (39b) lack, and vice versa. Intuitively, verbs in (39a) describe actions resulting in some change of state, whereas verbs in (39b) describe processes that do not necessarily result in an outcome. Negating the entailment about a result triggered by *break* is contradictory, as (40a) shows. On the other hand, *hit* does not entail that the bowl broke, though it may have, as it describes an action that potentially damages objects, as (40b) demonstrates.

(40) a. *Fido <u>broke</u> the bowl, but nothing is different about it.
b. Fido <u>hit</u> the bowl, but nothing is different about it.

Rappaport and Levin (1998) propose an additional semantic component of "manner of motion" to the "failed outcome" entailment for verbs in (39b). That is, verbs like *hit* specify a certain kind of action, e.g., moving one's hand at the target, that leads to an act of hitting. For verbs like *break*, they argue, the unnamed action that leads to the result is not part of their meaning. While one can break something without being in direct contact with it, e.g., by throwing a stone, the act of hitting something inherently involves a direct contact with the object. As evidence, negating the contact entailed by a manner verb *hit* is anomalous, as shown in (41a), but it is not contradictory with *break*, as shown in (41b).

(41) a. *Fido <u>hit</u> the bowl without touching it.
b. Fido <u>broke</u> the bowl without touching it.

Rappaport and Levin (1998) conclude that verbs in the *break* group are "result verbs," while those in the *hit* group are "manner verbs."

2.4.2 Lexical Decomposition

As we will discuss in the next chapter, influential theories of verb semantics propose different internal structures for these verbs, given in (42) (Beavers and Koontz-Garboden, 2020; Dowty, 1979; Rappaport and Levin, 1998). This is a type of lexical decomposition analysis using primitive features, such as ACT, CAUSE and BECOME, which create templates hosting idiosyncratic roots either as arguments (*broken*) or as modifiers (*hitting*).

(42) a. *break* = $[[x \text{ ACT}] \text{ CAUSE } [y \text{ BECOME } \langle \textit{broken} \rangle]]$
b. *hit* = $[x \text{ ACT}_{\langle \textit{hitting} \rangle}\, y]$

If the lexical entries in (42) are correct, internally complex words like *break* decomposed in the fashion of (42a) are expected to be semantically equivalent to the syntactically complex expression assigned as their translation. However, while (43a) entails (43b), the opposite direction of entailment does not seem valid. For example, in a situation where Fido makes Garfield to break the bowl, which can be described by (43b), speakers judge (43a) false (Chierchia and McConnell-Ginet, 2000). That is, it is not entirely clear whether "result" verbs really lack manner/direct involvement meaning.

(43) a. Fido broke the bowl.
b. Fido caused the bowl to become broken.

The decompositional analysis predicts that there is only a single root per lexeme and a root meaning can either contribute manner (as modifiers of ACT) or contribute result (argument of BECOME), but not both. Beavers and Koontz-Garboden (2012) argue against the manner-result complementarity by showing that verbs of killing (e.g., *crucify, electrocute, hang, drown*) respond positively both to manner and result diagnostics. (44) shows that these verbs are manner verbs, but (45) demonstrates that they entail results.

(44) a. #The governor crucified the prisoner but didn't move a muscle.
b. # The rusty blade guillotined the queen.
c. It took five minutes to drown Jim.

(45) a. #Jane just crucified Joe, but nothing is different about him.
b. *All last night, the executioner drowned.
c. #Shane electrocuted the prisoner to a crisp.

They argue that ditransitive ballistic motion verbs (e.g., *throw*) and manner of cooking verbs (e.g., *poach*) behave similarly. Beavers et al. (2021), based on a large-scale typological study, show that result roots entail a change independent of the template, suggesting that there is no clear-cut division of labor between the template and the root meanings. Directly encoding the complex syntactic structure into the lexical meaning is inflexible and cannot capture these borderline cases.

2.4.3 Meaning Postulates

Instead of decomposing words, we can directly formulate constraints on how lexical items are related to each other using **meaning postulates**. Meaning postulates, which were originally proposed by Carnap (1952) and productively used by Dowty (1979), are axioms which describe the properties of the intended interpretations of lexical (non-logical) constants. Basically, they make more specific assumptions about the model-theoretic interpretation of our logical language, restricting the class of admissible models. It is assumed that meaning postulates hold true in any model if they are meant to reflect natural language use. We already characterize an intended interpretation by saying that $[\![dog]\!]$ is the set of dogs, for instance. Using meaning postulates, we can further elucidate what $[\![dog]\!]$ means by making explicit its relation to other entities (*cat, animal*, etc.) (Chierchia and McConnell-Ginet, 2000). The meaning postulates for *hit* and *break* in (46) can mimic (42), providing the same information, while allowing us to treat these verbs uniformly as transitive verbs that differ only in their semantic types.

(46) a. $\forall x \forall y.\text{hit}'(x, y) \rightarrow \text{act}'(x, y)$
b. $\forall x \forall y.\text{break}'(x, y) \rightarrow \text{cause}'(x, \text{become}'(\text{broken}'(y)))$

Chierchia and McConnell-Ginet (2000, Chapter 8) point out several differences between decompositional analyses and meaning postulate approaches. First, in the former, vocabulary items in the semantic calculus do not match natural language words like *break* but are assembled from more basic concepts like CAUSE and BECOME and associated with *broken*, suggesting that certain concepts are more complex than others. The latter, on the other hand, does not make such assumption as all concepts are basic and directly labeled by vocabulary items in the logical language rather than being identified with assemblages of more basic concepts. Experimental studies showing that there is no additional processing time or cost incurred for supposedly more complex words support the latter view (Aitchison, 2012). Moreover, children acquire words like *kill* and *die* before they learn words like *cause* and *become* and know about fathers before they know about males and parents (Fodor, 1987). The decompositional approach, to be coherent, must assume that the simple concept *father* that children first acquire is different from and later replaced by the complex one that they build from *male* and *parent*. The meaning postulate approach, on the other hand, predicts a continuity in children's concept development by saying that children's concepts become enriched by adding basic expressions like *male* and *parent* and connecting them to the earlier acquired *father*. Some decompositional approaches are very reductionist, seeking to reduce the basic concepts to a minimum and to determine for their binary feature system which of two closely related words (e.g., *male* and *female*) is more basic/unmarked. Meaning postulates do not commit to such view and view such decisions unnecessary. Thus, the meaning postulate approach, which is more compatible with empirical evidence on semantic processing, seems to be a better-designed tool as an abstract characterization of the speaker's knowledge.

Reflection

- What are some problems involved in decomposing the meaning of result verbs (or any others)? Is there evidence that these verbs in fact have more complex internal syntactic structures than their manner counterparts?
- What are meaning postulates? Why do we want to use meaning postulates rather than lexical decomposition? Can you think of arguments for separating the type assignment of a word from specifying its lexical entailments?
- Can you think of other methods of encoding lexical entailments than lexical decomposition or meaning postulates? Can we use subtype relations in the type hierarchy in the domain, for example?

2.5 Conclusion

In this chapter, we discussed the research methodology used in lexical semantics. We employed a logical language to translate their meanings more systematically and precisely. The type-restricted application, together with many-sorted types, provides a straightforward and coherent account to the syntactic co-occurrence restrictions, which ultimately derive from semantic type composition restrictions. Lexical entailment relations were expressed via meaning postulates, which put more constraints on permissible models. The many-sorted typed lambda calculus has an explanatory power to elucidate why the composition fails when the type match requirement is not satisfied, and why certain groups of words behave similarly in terms of their grammatical distributions.

Points to Remember

- Logical language is free from ambiguity, imprecision and vagueness pervasive in natural language. The propositional calculus deals with logical relationships between propositions, and the predicate calculus looks into the internal predicate-argument structure of a proposition. The lambda calculus offers a logical tool to compositionally represent syntactic constituents.
- By enforcing a type-restricted application at a more fine-grained level, including the domain of eventualities, as well as drawing on our knowledge about the lexical entailment relations in terms of meaning postulates, we have modeled the meaning composition that is sensitive to lexical semantics in an accurate and elegant manner.

Technical Terms to Remember

1. **Truth condition:** The condition under which a sentence is true or false.
2. **Truth value:** The actual truth or falsity which is determined in a particular world/circumstance in terms of the states of affairs in that world/ circumstance.
3. **Propositional calculus:** The study of logical relationships between sentences.
4. **Proposition:** What a sentence expresses, which is true in some possible worlds and false in others.
5. **Possible world:** A way that our actual world could have been.
6. **Negation:** The logical operation that reverses the truth value of the input proposition.
7. **Truth table:** A table where each input proposition occupies a column, and the last column gives all possible output values of the given logical operation.
8. **Conjunction:** The logical operation with two propositions such that the whole proposition is true only when both conjuncts are true.
9. **Disjunction:** The logical operation with two propositions such that the whole proposition is false only when both disjuncts are false and in all other cases, it is true.
10. **Inclusive disjunction:** Disjunction that means one or the other or both.

11. **Implication:** The logical operation with two propositions such that the whole proposition is true if the antecedent is true and the consequent is true, or the antecedent is false.
12. **Biconditional:** The logical operation with two propositions whose truth requires identical truth value of the two propositions.
13. **Tautology:** A proposition that is true in all possible worlds.
14. **Contradiction:** A proposition that is necessarily false in all possible worlds.
15. **Analytic propositions:** Propositions whose truth value is independent of what a particular world is like, i.e., tautologies and contradictions.
16. **Synthetic propositions:** Propositions whose truth value depends on what the world is like.
17. **Predicate calculus:** The logical system that studies truth-conditional meanings within individual sentences.
18. **Individual constant:** Terms representing a specific individual.
19. **Variable:** Terms representing some unspecified entity.
20. **Quantifiers:** Operators that make a more general statement about the quantity of entities that a predicate applies to.
21. **Universal quantifier:** The quantifier that specifies that the predicate applies to all entities, paraphrased as "for all."
22. **Existential quantifier:** The quantifier that specifies that the predicate applies to some entities, paraphrased as "there exist."
23. **Unsaturated:** A proposition that is incomplete and requires things that can fill in the blank argument position.
24. **Lambda abstraction:** The process where an abstraction operator, called λ ("lambda"), binds a variable used as a placeholder for the empty slot for unsaturated proposition to denote properties.
25. **Function:** A set of ordered pairs in which the second member of each pair is uniquely determined by the first.
26. **Arguments:** Members in the domain of a function.
27. **Values:** Members in the range to which the arguments are mapped.
28. **Set:** A collection of any (random) objects, either finite or infinite.
29. **Members:** The objects in a set.
30. **Empty set:** A set with no members.
31. **Cardinality:** The number of the members of a set.
32. **Superset:** A set A is a superset of a set B when A includes all of the members of B.
33. **Subset:** A set A is a subset of a set B when B includes all of the members of A.
34. **Proper subset:** A set A is a proper subset of a set B when B contains other members beside the members of A.
35. **Intersection:** The set that includes common members of two sets.

36. **Union:** The set that includes all members of two sets.
37. **Complement:** The set that includes all members of set A which are not in set B.
38. **Type:** The kind of denotation an expression has.
39. **Entity:** The type *e* for individual-denoting expressions.
40. **Truth value:** The type of *t* for formulas.
41. **Lambda conversion:** The saturation process where we replace the variable *x* with the constant, simultaneously removing the lambda operator.
42. **Interpretation function:** A function that assigns each expression in the language its meaning.
43. **Sense:** The interpretation function that picks out the actual denotations/referents of an expression in each world/circumstance.
44. **Intensional type:** The type of worlds, which expresses a function from possible worlds to truth values.
45. **Grammatical alternation:** A change in the realization of the argument structure of a verb by means of deletion, movement and switch between noun phrases and prepositional phrases.
46. **Meaning postulates:** Axioms which describe the properties of the intended interpretations of lexical (non-logical) constants that put constraints on admissible models.

Suggested Reading

We refer the reader to the introductory formal semantics textbooks, such as Chierchia and McConnell-Ginet (2000), Gamut (1990) and Heim and Kratzer (1998), for a more detailed and complete exposition of the (intensional) predicate logic and the lambda calculus.

Practice

1. Explain why the *-marked sentences are unacceptable.

(a) a. **Fido shattered at the bowl.*
b. *Fido tapped at the bowl.*

The conative construction allows manner verbs like *tap* but not result verbs like *shatter*.

(b) a. *Fido slapped Garfield on the back.*
b. **Fido snapped Garfield on the tail.*

(c) a. *The bowl cracked.*
b. **The bowl touched.*

(d) a. *The bowl breaks easily.*
b. **The bowl hits easily.*

(e) a. *The hammer broke the bowl.*
   b. **The brush scrubbed the bowl.*

2. For each of the following, use a truth table to determine whether the formula is analytic or synthetic. If it is analytic, tell whether it is a tautology or a contradiction; if it is synthetic, tell what the world must be like in order for it to be true (i.e., give its truth condition).

(a) $p \land q$

$\boldsymbol{p}$	$\boldsymbol{q}$	$\boldsymbol{p \land q}$
t	**t**	**t**
t	**f**	**f**
f	**t**	**f**
f	**f**	**f**

Synthetic: both *p* and *q* must be true.

(b) $p \lor q$
(b) $(p \land q) \rightarrow (q \land p)$
(c) $(p \land q) \lor (q \land p)$
(d) $(p \land q) \land \neg q$

3. Translate the following sentences in the predicate calculus.

(a) *Fido is a dog.*
dog′(f)

(b) *Fido barks.*
(c) *Fido chases Garfield.*
(d) *Every dog likes some cats.*
(e) *Every dog barks and some cat meows.*

4. Are the following relations a function or just a relation?

(a) x is the mother of y
Relation (because a mother can have multiple children).

(b) x is a child of y
(c) $x + 1 = y$
(d) x is the capital of y
(e) x sits next to y

5. What are the values of the following set theoretic operations?

(a) {Fido, Garfield, Spot} ∪ {Fido, Bingo, Kitty}
= {Fido, Garfield, Spot, Bingo, Kitty}

(b) {Fido, Garfield, Spot} ∩ {Fido, Bingo, Kitty} =
(c) {Fido, Garfield, Spot} – {Fido, Spot} =

6. Specify the semantic types of the following expressions.

(a) *Fido*
Physical-object

(b) *run*
(c) *small*
(d) *the cat on the mat*
(e) *Fido chases Garfield*

7. Provide the truth condition of the following sentences and describe a situation in which it is true and a situation in which it is false.
(a) *Fido runs.*
= 1 iff. Fido runs. True: ⟦*run*⟧ = {Fido, Spot}, False: ⟦*run*⟧ = {Spot, Bingo}

(b) *Fido kicks the bowl.*
(c) *Fido likes Garfield.*
(d) *The dog chases the cat.*
(e) *Fido is royal.*

8. Translate the following phrases and sentences using the lambda calculus and describe what kind of function the expressions denote. (We are assuming a possible world semantics.)
(a) *apple*
$\lambda w \lambda x$.apple'$_w$(x); a function that gives a set of apples in each possible world; type ⟨*e*, *st*⟩.

(b) *tall*
(c) *A boy is tall.*
(d) *A boy eats an apple.*
(e) *Every boy eats an apple.*

9. Using a many-sorted typed lambda calculus, provide compositional analyses of the following sentences, specifying the semantic type of each step.
(a) *Fido runs.*

⟦*Fido*⟧ = f	***physical-object***
⟦*runs*⟧ = λx.run′(x)	**⟨*physical-object*, *t*⟩**
⟦*runs*⟧(⟦*Fido*⟧) = [λx.run′(x)](f) = run′(f)	***t***

(b) *Garfield dances.*
(c) *Fido shattered the mirror.*
(d) *Garfield kicked the mat.*
(e) *Fido hits Garfield.*

10. Provide meaning postulates to explain the following entailments.
(a) *Fido runs.* ⇒ *Fido moves.*
$\forall x$.run′(x) → move′(x)

(b) *Fido hits Garfield.* ⇒ *Fido touches Garfield.*
(c) *Fido broke the bowl.* ⇒ *The bowl is broken.*
(d) *Fido shattered the mirror.* ⇒ *The mirror broke into pieces.*
(e) *Fido killed the bird.* ⇒ *The bird is dead.*

Note

1 To be more precise, the definite NP *the fight* is not an individual but a quantifier (Russell, 1905). *The fight* means that a single fight exists (in the relevant domain) and any such has the property described by the following predicate ($\exists x.\text{fight}'(x) \wedge \forall y.\text{fight}'(y) \rightarrow y = x$) or in short $\exists! x.\text{fight}'(x)$). We will ignore this detail and treat the whole NP as denoting an entity, because our goal is to understand and represent the meaning of lexical items, not the grammatical meaning of definiteness, which belongs to the empirical domain of compositional semantics.

Part II

Verbs

3 Common Classifications of Verbs

3.1 Ingredients of Verb Semantics

In this and the next two chapters, we will discuss the verb meaning. The verb is the core constituent of the clause, whereas other major constituents in the clause like subject and object, called arguments, are selected dependents of the verb.

3.1.1 Valency and Argument Order

The number of arguments that a verb calls for is called **valency** or **arity**. For example, an intransitive verb like *bark* in (1a) has one argument and a valency of one (i.e., a unary or one-place predicate). A transitive verb like *bury* in (1b) requires two arguments and has a valency of two (i.e., a binary or two-place predicate). A ditransitive verb like *give* in (1c) selects three arguments and a valency of three (i.e., a ternary or three-place predicate).

(1) a. Fido <u>barked</u>.
b. Fido <u>buried</u> the bone.
c. Fido <u>gave</u> Spot the bone.

Natural language predicates appear to be restricted to three places. English also has zero-place predicates, as illustrated in (2). The weather verbs can describe events without the help of an argument. The expletive *it* in the subject position is required for a purely syntactic reason, without contributing semantically to the expressed proposition.

(2) It <u>rains</u>.

When there is more than one argument selected by the verb, the order matters. The compositional process of a sentence containing a transitive verb like *bury* explain the order in which the arguments combine with the predicate. We first apply the function expressed by *bury* as in (3a) to the object argument, *the bone*, to obtain (3b). Next, we apply the resulting function (3b) to the subject

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argument *Fido* to reach (3c). Therefore, the order of arguments is built in the denotation of the verb.

(3) a. $[\![bury]\!] = \lambda y \lambda x.\text{bury}'(x, y)$ $\langle object, \langle object, t\rangle\rangle$
b. $[\![bury]\!]([\![the\ bone]\!]) = [\lambda y \lambda x.\text{bury}'(x, y)](\text{b}) = \lambda x.\text{bury}'(x, \text{b})$ $\langle object, t\rangle$
c. $[\![bury\ the\ bone]\!]([\![Fido]\!]) = [\lambda x.\text{bury}'(x, \text{b})](\text{f}) = \text{bury}'(\text{f}, \text{b})$ t

3.1.2 Event Semantics

To investigate the verb meaning more thoroughly, however, we need more than arity and order of arguments. The reason is, as we have observed in the previous chapter, that verbs fall into grammatically significant classes, suggesting that they display systematic semantic structures. To recapitulate, a key difference between *break*-type and *hit*-type verbs is that the former entails a change and a result state, whereas the latter does not, which are manifested by their participation in different syntactic and case alternation patterns, such as conatives in (4a), inchoatives in (4b), part–whole alternations in (4c) and middles in (4d), repeated from Chapter 2.

(4) a. Fido *<u>broke at/hit at</u> the bowl.
b. Fido *<u>broke/hit</u> Garfield <u>on the back</u>.
c. The bowl <u>broke/*hit</u>.
d. The bowl <u>breaks/*hits easily</u>.

To apply the lambda calculus to translate the meaning of these verbs, we need to make an explicit reference to the types of events which they describe. To accomplish this, we will treat verbs as taking an extra argument for event, an idea pioneered by Davidson (1967). In this system, the denotation of *bark* is a function that not only takes an individual argument (a barker), as in (5a), but also an eventuality argument (an event of barking), as in (5b). This treatment is called Davidsonian **event semantics**, which is a widely used tool among semanticists as it has proven to have significant explanatory power (Parsons, 1990).

(5) a. $[\![bark]\!] = \lambda x.\text{bark}'(x)$ $\langle object, t\rangle$
b. $[\![bark]\!] = \lambda x \lambda e.\text{bark}'(x, e)$ $\langle object, \langle eventuality, t\rangle\rangle$

As mentioned in the previous chapter, Beavers and Koontz-Garboden (2012) question the manner-result dichotomy based on the behaviors of verbs of killing, ditransitive ballistic motion verbs and manner of cooking verbs. Since it has been questioned whether result verbs completely lack manner component, we will use more uncontroversial terms, **process** and **event**. Processes lack a natural endpoint, and events typically have a built-in culmination. Processes are homogeneous; parts of hitting is also hitting. Events are not; parts of breaking is not breaking (Krifka, 1998). To represent the meaning of *break* and *hit* using event semantics, let us distinguish between process type *process* and event type *event*, respectively, as sub-types of the event type *eventuality*. Now we can associate *hit* with a function from the domain of objects (the direct object argument) to a function from the domain of objects (the subject argument) to a function from the domain of processes (the eventuality argument) to the truth values, as shown in (6a). On the other hand, the verb *break* denotes a function from the domain of objects (the direct object argument) to a function from the domain of objects (the subject argument) to a function from the domain of events (the eventuality argument) to the truth values, given in (6b).

(6) a. $[\![hit]\!] = \lambda y \lambda x \lambda e.\text{hit}'(x, y, e)$ $\langle object, \langle object, \langle process, t\rangle\rangle\rangle$
b. $[\![break]\!] = \lambda y \lambda x \lambda e.\text{break}'(x, y, e)$ $\langle object, \langle object, \langle event, t\rangle\rangle\rangle$

These verbs take arguments to yield propositions.

(7) a. $[\![hit]\!]([\![the\ bowl]\!]) = [\lambda y \lambda x \lambda e.\text{hit}'(x, y, e)]$
(b) $= \lambda x \lambda e.\text{hit}'(x, \text{b}, e)$ $\langle object, \langle process, t\rangle\rangle$
b. $[\![hit\ the\ bowl]\!]([\![Fido]\!]) = [\lambda x \lambda e.\text{hit}'(x, \text{b}, e)]$
(f) $= \lambda e.\text{hit}'(\text{f}, \text{b}, e)$ $\langle process, t\rangle$
c. $[\![Fido\ hit\ the\ bowl]\!] = \exists e.\text{hit}'(\text{f}, \text{b}, e)$[1] t

(8) a. $[\![broke]\!]([\![the\ bowl]\!]) = [\lambda y \lambda x \lambda e.\text{broke}'(x, y, e)]$
(b) $= \lambda x \lambda e.\text{broke}'(x, \text{b}, e)$ $\langle object, \langle event, t\rangle\rangle$
b. $[\![broke\ the\ bowl]\!]([\![Fido]\!]) = [\lambda x \lambda e.\text{broke}'(x, \text{b}, e)]$
(f) $= \lambda e.\text{broke}'(\text{f}, \text{b}, e)$ $\langle event, t\rangle$
c. $[\![Fido\ broke\ the\ bowl]\!] = \exists e.\text{broke}'(\text{f}, \text{b}, e)$ t

Within each broad class of verbs, each verb's meaning differs from all the others in the class in subtle ways. For example, event verbs describe different kinds of outcomes, yielding different impressions about properties of a made-up word like *twarge* depending on different choices of the verb, as illustrated in (9) (Fillmore, 1970).

(9) a. The twarge <u>folded</u>. (a twarge has continuity and malleability)
b. The twarge <u>shattered</u>. (a twarge is decomposable into bits)
c. The twarge <u>bent</u>. (a twarge is rigid with some malleability)

To analyze the verb meaning, then, we need the following beyond arity and order of arguments. First, we need to identify the broader aspects of verb meaning grammar is sensitive to, which will help define their upper-level semantic types. Second, we should investigate the principles that relate them to the grammar, explaining (in)compatibility of function compositions due to a type (mis)match. Finally, we need to inquire into the systematic semantic variation of individual verbs within a broadly defined class, which is equally important. The research focus so far has been on broader, more regular aspects of verb meaning relevant for predicting a verb's grammatical behavior and inference patterns.

In the remainder of this chapter, we will discuss three widely used methods of categorizing verbs into broad grammatical and semantic classes. We will first introduce thematic role-based approaches, which divide verbs depending on the semantic roles they assign to their arguments. We will then discuss aspect-based approaches, which categorize verbs based on their internal temporal makeup. Finally, the event-templatic verb classification will be explored, which classify verb meaning into common event templates and idiosyncratic roots.

Reflection

- Why do you think natural language predicates are restricted to three places? Why do you think English has zero-place predicates? Are they restricted to weather verbs?
- Why do we need more than arity and order of arguments to investigate the verb meaning?
- Due to the research focus on broader, more regular aspects of verb meaning, systematic semantic variations of individual verbs within a broadly defined class have received less attention. Are there any negative consequences of this practice?

3.2 Thematic Roles

3.2.1 Major Theta-Roles

Verbs in the same broad semantically defined grammatical classes assign the same semantic roles to their arguments. The semantic roles of the verb's arguments are called **thematic roles** or in short **Θ (theta)** roles. We can relate these to the event semantics we discussed in the previous section for more precise definitions: A thematic role is a relation between eventualities and individuals. Let us examine some concrete examples to understand what this means. The lexical meaning of *run* in (10a) involves an animate being that performs an action of running. The animate argument that plays a role of an initiator or an effector of an eventuality is called **agent**. The transitive verb *catch* in (10b) requires two arguments, the catcher and the caught. The catcher is the agent, and the caught is the **theme** or patient. Themes/patients are not causally or mentally involved in the initiation of the eventuality; instead, they simply undergo a change of state or location as a result, as in (10b), or have certain property in a state, as in (10c). *His paw* in (10b) bears an **instrument** role that the agent uses to perform an event. This is not an argument selected by the verb *catch* but an optional adjunct modifying the event of catching. Inanimate initiators of events such as *the rock* in (10d) have the **causer** role. The stative predicate *be happy* in (10e) involves an animate being that experiences a state rather than causing it into existence, whose **Θ**-role is the **experiencer**. The ditransitive verb *give* in (10f) requires three arguments, a giver, a receiver and an object that is given. The giver is the agent, the receiver is the **goal** and the object is the theme. A goal is an entity that an event is done to or for. Animate goals are sometimes called a **recipient**. A **location** is a place of a state of affairs; in (10g), *in the backyard* has the location role. Finally, a route, such as *along the river* in (10h), bears a **path** role.

(10) a. Fido runs every day.
b. Fido caught a rabbit with his paw.
c. Garfield is lazy.
d. The rock broke the bowl.
e. Fido is happy.
f. Fido gave a mouse to Garfield.
g. Fido barked in the backyard.
h. Fido ran along the river.

Table 3.1 contains a list of major **Θ**-roles and their definitions.

Intransitive verbs can be divided into two sub-groups depending on the **Θ**-role they assign to their only argument: **unergative** verbs like *run* in (11a) assign an agent role to their sole argument, whereas **unaccusative** verbs like *fall* in (11b) assign a theme role to their single argument.[2]

(11) a. Fido ran.
b. Garfield fell.

Table 3.1 Major theta roles

Theta role names	*Definitions*
Agent	an animate entity that deliberately brings about an event
Causer	an entity responsible for (initiating) an event
Experiencer	an animate entity that experiences an event
Theme/patient	an entity that is affected by an event or that has a property
Instrument	an entity that is used to bring about an event
Goal/recipient	an entity that an event is done to or for
Location	a spatial entity in which an event takes place or a state holds
Path	a spatial entity with length on which another entity moves in an event

If verbs are listed in the mental lexicon with their **Θ**-roles matching their valency as the logical formula (12) translates, we can explain why **Θ**-roles assigned by the verb, albeit purely semantic, have syntactic effect. In (12) the verb is a predicate over an event only, and individual arguments are introduced as separate conjoined conditions related to the event via **Θ**-roles. This treatment is called **neo-Davidsonian event semantics**. *Agent* is a function that maps an eventuality to its agent and *theme* is a function that maps an eventuality to its theme.

(12) $\lambda y \lambda x \lambda e.\mathrm{catch}'(e) \wedge agent(e) = x \wedge theme(e) = y$

If a predicate is missing a **Θ**-role-assigned argument, as in (13a), or has too many arguments, as in (13b), the sentence becomes ungrammatical. (13a) also illustrates the fact that the same NP cannot be assigned different **Θ**-roles; it cannot mean that Fido caught himself, which would have been possible if Fido had been assigned both agent and theme roles.

(13) a. *Fido caught.
b. *Fido caught a rabbit a cat.

To capture the one-to-one correspondence between the argument and the theta roles, Chomsky (1981) and Williams (1981) proposed a foundational grammatical principle, called **theta criterion**. It states that every **Θ**-role of the verb should be assigned to a constituent in the sentence, summarized in (14).[3]

(14) Theta criterion: Each NP of predicate in lexicon is assigned a unique **Θ**-role.

The theta criterion enables us to predict the syntactic structure of a sentence from the lexical meaning of the verb. Being able to do so significantly contributes to the economy of the linguistic system since lexical semantic properties of verbs need to be specified in the mental lexicon anyway.

3.2.2 UTAH and the Thematic Hierarchy

Having established a mechanism to determine the number and semantic role of arguments based on the meaning of the verb, a remaining, equally fundamental question is how to relate the syntactic selection structure and the semantic thematic structure. This question basically concerns the order of argument selection when a verb takes more than one argument, as in the case of transitive verbs. Intuitively, the agent is usually the grammatical subject, and the theme is the grammatical object. It would be desirable, however, if there was a uniform way that particular **Θ**-roles are represented in the syntax so that one can predict the syntactic structures that predicates project based on the semantic roles they assign. Baker (1988) postulates **Uniformity of Theta Assignment Hypothesis (UTAH)** to achieve this.

(15) UTAH: Identical thematic relationships between items are represented by identical structural relationships when items are merged.

UTAH should be augmented with a fixed order of thematic roles, called the **thematic hierarchy**, because we still need to determine the structural position of a particular theta role-assigned argument. Such hierarchy is given in (16), where the higher an argument is on the thematic hierarchy, the higher it is in the syntactic structure.

(16) Thematic hierarchy: agent > causer > experiencer > theme > goal > location

For example, if a verb takes an agent and a theme, the agent is invariably higher than the theme, occupying the subject position, as (17a) illustrates. If the sentence lacks an agent but has a causer, as in (17b), the causer is still higher than the theme and becomes the subject. (17c) shows that an experiencer is higher than a theme and thus occupies the subject position. (17d) exemplifies a case in which a theme is the subject, and a location is an adjunct that is lower than the theme subject.

(17) a. <u>Fido</u> broke <u>the bowl</u>.
b. <u>The hammer</u> broke <u>the bowl</u>.
c. <u>Garfield</u> felt <u>the earthquake</u>.
d. <u>Garfield</u> fell on <u>the ground</u>.

Despite the intuitive appeal of **Θ**-roles and their contribution to the economy of the linguistic system, a major drawback of the **Θ**-role-based approach is that there seems to be no principled way of delimiting their number and names. Furthermore, the same argument can be assigned multiple theta roles. For example, in *Fido intentionally rolled down the hill*, Fido is the theme and the agent. Dowty (1991) points out that in examples like (18), the subjects and the complements are both themes, and there is no method of distinguishing and ordering between the two.

(18) a. Fido <u>resembles</u> his father.
b. This <u>is similar to</u> that.

Belleti and Rizzi (1988) cite examples like (19a) as a clear counterexample to the thematic hierarchy because a theme is higher than an experiencer.

(19) a. Fido pleases me.
b. I like Fido.

To solve this problem, Pesetsky (1995) proposes a more fine-grained distinction among **Θ**-roles by dividing themes into a causer and a "subject matter/target," with the former being placed higher and the latter lower than an experiencer on the thematic hierarchy. In (19a), *Fido* bears the causer role, whereas in (19b), it has the subject matter/target role. If we adopt this as a general strategy, however, the determination of a particular theta role could easily become subjective, and identifying a universal, linguistically significant set of them can become arbitrary. Another problem of **Θ**-role concerns the treatment of each role as discrete and primitive, which fails to explain generalizations holding across different **Θ**-roles. For example, the agent and the experiencer, on the one hand, and the agent and the causer, on the other, have something in common, namely, mental involvement and causality, respectively, but such a connection is lost because each **Θ**-role is treated as an unanalyzable primitive.[4]

3.2.3 Proto Roles

Dowty (1991) has tried to evade the attack on **Θ**-roles by abandoning discrete roles, instead postulating only two **proto-roles**, proto-agent and proto-patient, each characterized by a number of verbal entailments listed in (20) and (21). Incremental themes in (21b) refer to an argument that is incrementally affected by an event described by the verb, i.e., a one-to-one mapping exists between parts of the events and the parts of the theme arguments.

(20) Agent proto-role properties:
a. Volitional involvement in an event or a state
b. Sentient and/or perception
c. Causing an event or change of state in another participant
d. Movement relative to the position of another participant
e. Exists independently of the event named by the verb

(21) Patient proto-role properties:
a. Undergoes a change of state
b. Incremental themes
c. Causally affected by another participant
d. Stationary relative to movement of another participant
e. Does not exist independently of an event

(22) contains some examples of proto-agent entailments.

(23) a. Fido is being mean. (volition)
b. Fido sees Garfield. (sentient/perception)
c. Teenage unemployment causes delinquency. (causation)
d. Water filled the boat. (movement)
e. Fido needs a new bowl. (independent existence)

(24) includes some proto-patient entailment examples.

(24) a. Fido made a mistake. (change of state)
b. Fido crossed the street. (incremental theme)
c. Smoking causes cancer. (causally affected)
d. The bullet entered the target. (stationary)
e. I erased an error. (non-independent existence)

Which argument becomes the subject, and which one becomes the object depend on the number of proto-role properties, as Dowty (1991) delineates in terms of the argument selection principle given in (25).

(25) Argument selection principle:
a. In predicates with grammatical subject and object, the argument for which the predicate entails the greatest number of proto-agent properties will be lexicalized as the subject of the predicate, and the argument having the greatest number of proto-patient properties will be lexicalized as the direct object.
b. If two arguments of a relation have equal numbers of entailed proto-agent and proto- patient properties, either or both may be lexicalized as the subject (and similarly for objects).
c. With a three-place predicate, the non-subject argument having the greater entailed proto- patient properties will be lexicalized as the direct object and non-subject argument having fewer entailed proto-patient properties will be lexicalized as an oblique or prepositional object.

Postulating only two proto-roles and deriving their properties from a set of verbal entailments seem to be superior to the discrete **Θ**-role approaches. **Θ**-roles are still commonly used as a convenient means to describe properties of verbs and their arguments, so we will also make a reference to the basic **Θ**-roles in this book.

Reflection

- What are the utilities and problems of theta roles? What do verbs that take an agent argument have in common? What do verbs that have a theme argument have in common?
- What was the reason behind proposing proto-roles instead of individual theta roles? Do you think proto-roles explain the lexical meaning of verbs better?
- Given our type-driven semantic composition, do we still need the theta criterion and UTAH?

3.3 Aspectual Classes

3.3.1 Aktionsart

Another traditional classification of verbs is based on their aspectual classes, also known as **Aktionsart**. It refers to the internal temporal constituency of events inherent in the verb meaning. The aspectual properties of verbs indicate which part(s) of the schema in Figure 3.1 correspond to the events that they describe.

Vendler (1967) classified verbs into four aspectual classes of state, activity, accomplishment and achievement. (26) contains examples of the four aspectual types.

(26) a. Fido buried the bone.
b. Garfield arrived.
c. Garfield listened to the music.
d. Fido knows Garfield.

Accomplishments, such as (26a), describe durative events that have built-in goals (culmination), corresponding to parts I and II of the schema. **Achievements** in (26b) consist of solely their culmination point II; the phase leading up to the culmination point, I, is not part of such an event. These are instantaneous transitions in a semantic or conceptual sense since even such atomic events do take time in reality. **Activities** (or processes) exemplified in (26c) indicate events that do not have a natural end-point. They only correspond to part

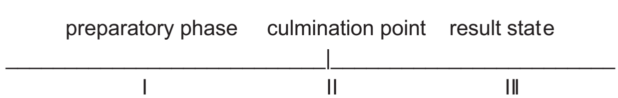

Figure 3.1 A schematic picture of events.

Figure 3.2 A schematic picture of states.

Table 3.2 Aspectual classes and semantic features

	State	*Activity*	*Accomplishment*	*Achievement*
Dynamic	–	+	+	+
Telic	–	–	+	+
Punctual	–	–	–	+

I of the schema and do not provide II by themselves, i.e., II is arbitrary rather than built-in. Therefore, an essential feature of activities is that they are homogeneous, e.g., a part of listening to the music is also listening to the music. Bennett and Partee (1978) call this a sub-interval property. **States** like (26d), on the other hand, lack a culmination point, and thus they contain no intrinsic separation of two distinct periods in the eventuality schema, as represented in Figure 3.2 by a single, unbroken line. A state forms a class of indefinitely extending states of affairs that involves no dynamics.

3.3.2 Operational Tests

Aspectual classes of verbs can be objectively determined utilizing a set of operational tests developed in Dowty (1979) and subsequent literature in accordance with the presence or absence of the semantic features [±dynamic], [±telic] and [±punctual]. Table 3.2 presents the feature descriptions of the aspectual classes.

First, states and activities are distinguished in terms of the feature **[**±dynamic**]**. A state of affair is **dynamic** if it requires a constant input of energy to continue. Activities, which are [+dynamic], can take the progressive form, as (27a) shows, whereas states, which are [-dynamic], cannot, as (27b) demonstrates.

(27) a. Fido is barking.
b. *Fido is being tall.

Activities in the present tense have a habitual reading but states in the present do not. (28a) means that Fido barks regularly, while (28b) lacks such an interpretation.

(28) a. Fido barks.
b. Fido is tall.

Activities, because they are events, occur with manner adverbs, which describe a manner in which an action is carried out, as (29a) shows, but states cannot, as in (29b).

(29) a. Fido barks loudly.
b. *Fido is tall deliberately.

Activities involve agency and therefore can occur in imperatives, as in (30a), but states cannot, as in (30b).

(30) a. Bark!
b. *Be tall!

For the same reason, states cannot be a complement of *force*.

(31) a. Fido forced Garfield to dance.
b. *Fido forced Garfield to be furry.

Second, activities and accomplishments differ in terms of [±telic]. Events are **telic** if they have an inherent, built-in endpoint, and they are **atelic** if their termination needs to be imposed externally. Activities are [-telic] and can be modified by the *for* adverbial, as in (32a). But they cannot be modified by *in*, as in (32b), unless they have an inchoative reading, i.e., Fido ran after two hours.

(32) a. Fido ran for two hours.
b. *Fido ran in two hours.

By contrast, accomplishments, which are [+telic], can be modified by *in*, implying that the described action was ongoing for the time interval specified by *in*. That is, (33a) entails (33b).

(33) a. Fido buried the bone in two minutes.
b. Fido was burying the bone for two minutes.

Activities in the progressive form entail the past form, as in (34a), whereas accomplishments do not allow such entailment relations, as in (34b).

(34) a. Fido is barking. ⇒ Fido barked.
b. Fido is burying the bone. X⇒ Fido buried the bone.

Accomplishments and achievements are different in terms of [±punctual]. An event is **punctual** if it occurs instantaneously and is **durative** if it takes time for the event to take place. Achievements, which are [+punctual], are only compatible with *in*, as (35a) shows, but cannot occur with *for*, as evidenced by (35b).

(35) a. Garfield arrived <u>in</u> two hours.
b. *Garfield arrived <u>for</u> two hours.

Accomplishments are [-punctual]. When modified by *in*, they imply that the described action was ongoing for the time interval specified by *in*. By contrast, achievements modified by *in* do not imply that. Therefore, (36a) does not entail (36b).

(36) a. Garfield arrived <u>in</u> two hours.
b. Garfield was arriving <u>for</u> two hours.

Achievements modified by *in* mean the same as those occurring with *after*. Hence, (37a) with *in* and *after* are equivalent, entailing each other. Accomplishments modified by *in* behave differently, as (37b) with *in* and *after* are not the same.

(37) a. Fido will start his dinner <u>in</u> two minutes/<u>after</u> two minutes.
b. Fido will catch a rabbit <u>in</u> two hours/<u>after</u> two hours.

Moreover, accomplishments, when modified by an adverb *almost*, show an ambiguity between a begin reading, i.e., the event almost started, and an end reading, i.e., accomplishment was almost realized, as (38a) indicates. Achievements are not ambiguous, having only a begin reading, as in (38b).

(38) a. Fido <u>almost</u> buried the bone.
b. Fido <u>almost</u> left Garfield.

Lastly, an adverb such as *halfway* cannot be used with achievements as (39a) shows but is fine with accomplishments as we observe in (39b).

(39) a. *Garfield arrived <u>halfway</u>.
b. Fido buried the bone <u>halfway</u>.

Table 3.3 summarizes the operational tests. *N* means no and *y* means yes.

A more fine-grained classification among achievements can be made. For example, *hit* or *jump* can refer to a one-time event, as in (40a), or a repeated event, as in (40b). Because of this, verbs that are ambiguous between punctual and repeated durative event readings are called **semalfactive**.

(40) a. Fido <u>jumped</u> high.
b. Fido <u>jumped</u> for ten minutes.

Table 3.3 Operational tests for aspectual classes

	state	*activity*	*accomplishment*	*achievement*
progressive	n	y	y	y
habitual in the present	n	y	y	y
manner adverb	n	y	y	y
imperative	n	y	y	y
for	n	y	n	n
in	n	n	y	y
progressive entailing past	n	y	n	n
ongoing action with *in*	n	n	y	n
in = *after*	n	n	n	y
ambiguous with *almost*	n	n	y	n
halfway	n	n	y	n

Some achievements, such as *cool*, are ambiguous between an atelic reading, i.e., the temperature of the soup is getting lower, and a telic reading, i.e., the temperature of the soup reaches some implicit end state of being cool. In (41), in its atelic reading, it is compatible with a *for* adverbial, and only in its telic reading can it be modified by an *in* adverbial.

(41) The soup <u>cooled</u> for/in ten minutes.

The verbs that are ambiguous between telic and atelic readings are called **degree achievements**, which we will discuss in more depth in the next chapter.

Verb classification based on lexical aspect is on a more objective ground than intuitive **Θ**-roles thanks to systematic operational tests. However, this approach only focuses on temporal constituency of events, ignoring other aspects. It is also unclear whether individual verbs themselves out of context can be consistently classified into definite aspectual classes unambiguously. Verkuyl (1972) pointed out that aspectual classes are actually properties of the whole verb phrase rather than the verb alone since they change depending on the type of object. For instance, *bury bones* is an activity, but *bury a bone* is an accomplishment, raising a question regarding the aspectual class of the verb *bury*. Despite these shortcomings, lexical aspects are widely known in the field, so we will use states, activities, etc., as useful descriptive labels in this book.

Reflection

- Why does it make sense to classify verbs in terms of their temporal structures? Do you think the binary features [±dynamic], [±telic], and [±punctual] adequately capture the meaning of all verbs?

- Is it always straightforward to determine an aspectual class of a verb? Are there examples where the determination is not so easy?
- Do you expect the aspectual classes to be universal? Can you think of a language that lacks one of the features, e.g., [±telic], failing to distinguish between activities and accomplishments?

3.4 Event Templatic Structure

3.4.1 Templates and Roots

The event templatic structure approach analyzes verb meaning neither on the basis of classifications of the participants of the described events, nor temporal features of the events alone, but instead in terms of the general types of events themselves. This is a kind of de-compositional analysis, which we discussed in the previous chapters. To help decompose the kinds of events a verb describes into more basic subevents, near paraphrases are utilized. A transitive verb, *break*, in (42a) has the paraphrase in the parentheses, unpacking the internal structure of the event; it describes as an action that causes a change of state. In case of an intransitive verb without an agent (i.e., unaccusative), as in (42b), the paraphrase shows that it maintains the change of state meaning but lacks the causative component. In contrast, paraphrases of an unergative verb *bark* in (42c) include just an action and not a change of state, differing only in which action each verb names.

(42) a. Fido <u>broke</u> the bowl. (= Fido's actions caused the bowl to become broken.)
b. The bowl <u>broke</u>. (= The bowl became broken.)
c. Fido <u>barked</u>. (= Fido did barking actions.)

Whereas frequent and recurring meanings, such as action, change of state and causal relation, set apart major classes of verbs, more specific meaning components, like breaking and barking, differentiate individual verbs within a class that shares common semantic primitives. Beavers and Koontz-Garboden (2020) and Rappaport and Levin (1998) employ some universal set of primitives, such as ACT, CAUSE and BECOME, to build the basic **event templates** or schemas, which are filled out by unique **roots** for real world actions and states, such as *barking* and *broken*. For example, causative verbs like *break* in (42a) have a complex internal structure consisting of predicates CAUSE and BECOME, given in (43a), whereas the intransitive *break* in (42b) lacks CAUSE, as in (43b). Process/activity verbs like *bark* in (42c), on the other hand, contains an implicit predicate ACT with the manner indicated as a subscript, as in (43c). Roots, which are italicized and in angled brackets in (43), are integrated into schemas as arguments or modifiers (indicated by subscript) of the predicate.

(43) a. *break* (transitive) = [[*x* ACT] CAUSE [*y* BECOME ⟨*broken*⟩]]
b. *break* (intransitive) = [*x* BECOME ⟨*broken*⟩]
c. *bark* = [*x* ACT$_{\langle \textit{barking} \rangle}$]

3.4.2 Ontological Types of Roots

Unlike the general event template, the root encodes unique or "idiosyncratic" component of meaning, determining the name of a particular verb. The set of roots, which is in principle open-ended, is characterized by ontological types. As Clark and Clark (1979) describe, evidence for postulating an ontological type for the root comes from denominal verbs, which reveal clear associations between the meaning of the base noun and the meaning of the derived verb, as listed in (44).[5]

(44) a. If the noun names an instrument, the denominal verb means "use the instrument for its purpose." (e.g., *bicycle, brush, chisel, microwave, rake, shovel, spear*)
b. If the noun names a container, the denominal verb means "put something in the container." (e.g., *bag, bottle, cage, garage, pen, pocket, stable*)
c. If the noun names an object/substance, the denominal verb means "put that object/substance some place." (e.g., *butter, carpet, diaper, garland, harness, saddle*)

Systematic associations can be established between roots and event schemas, which are mediated by ontological types. These relations are represented in (45), in which roots are integrated into event templatic schemas as arguments or modifiers. Typically, the roots, rather than the event schema, determine the name of the verb.

(45) a. Manner → [*x* ACT$_{<\textit{MANNER}>}$] (e.g., *jog, run, creak, whistle*)
b. Instrument → [*x* ACT$_{<\textit{INSTRUMENT}>}$] (e.g., *brush, hammer, saw, shovel*)
c. Container → [*x* CAUSE [*y* BECOME AT <*container*>]] (e.g., *bag, box, cage, crate*)
d. Internally caused state → [*x* BECOME <*state*>] (e.g., *bloom, blossom, decay, flower, rot*)
e. Externally caused state (i.e., result) → [[*x* ACT] CAUSE [*y* BECOME <*res-state*>]] (e.g., *break, dry, harden, melt, open*)

3.4.3 Consequences of the Bipartite View

Rappaport and Levin (1998) list the following consequences of the bipartite (i.e., root-template) view of verb meaning. First, the decompositional recursive analysis makes a correct prediction about entailment relations; the causative sentence should entail the corresponding inchoative and the state sentences since the more complex causative event template contains the entailed event template as its sub-components. For example, if *Fido broke the bowl* is true, then *the bowl broke* and *the bowl is broken* are also true, but not the other way around. Second, a finite characterization of an infinite set of verb meanings becomes possible by restricting arbitrary complexity in verb meaning in the verb roots. Third, this analysis provides a way of capturing the phenomenon of **sub-lexical modification**, i.e. the fact that certain classes of modifiers allow multiple interpretations when applied to verbs with complex event structures, as illustrated with the adverb *again* in (46) (Dowty, 1979).

(46) a. Fido broke the bowl again.
b. and it had been broken before.
c. and it had broken before.
d. and Fido had broken it before.

The ambiguity of (46a) can be treated as an attachment ambiguity over how much of the event structure *again* takes scope over; just the root, as represented in (47a), yielding the reading in (46b), or a projection of BECOME, as in (47b), corresponding to the reading in (46c), or a projection of CAUSE, as in (47c), giving rise to the reading in (46d).

(47) a. Restitutive: CAUSE [BECOME [again [broken(b)]]]
"Fido brought it about that the bowl was broken once more."
b. Repeated change of state: CAUSE [again [BECOME (broken(b))]]
"Fido brought it about that the bowl became broken once more."
c. Repeated causal event: again [CAUSE [BECOME [broken(b)]]]
"Fido yet again caused the bowl to become broken."

By contrast, verbs with simple event structures have only a repeated action reading, since there is no sub-event which *again* can take scope over, as shown in (48).

(48) a. Fido kicked the bowl again.
b. again [$\text{ACT}_{\langle \mathit{kicking} \rangle}$ (b)]

Finally, event schemas explain some argument realization patterns. Surface contact verbs allow an implicit object, as in (49a), while change of state verbs do not, as in (49b).

(49) a. Fido <u>kicked</u> (the bowl).
b. *Fido <u>broke</u> again when he ate his dinner.

Although both types of transitive verb classes have two participants, they contrast with regard to the nature of their complement (non-subject) arguments: change of state verbs have a **structure participant**, which is the subject of BECOME, whereas surface contact verbs only have a **pure root participant**. Structure participants are arguments of the event template, whereas pure root participants are arguments of roots. Rappaport and Levin (1998) argue that this difference influences their argument realization options due to the structure participant condition in (50).

(50) The structure participant condition: There must be an argument in the syntax for each structure participant in the event schema.

Despite its strong explanatory powers, the event templatic approach comes with shortcomings associated with decomposition methods in general, e.g., the selection of semantic primitives can become arbitrary (Chierchia and McConnell-Ginet, 2000). Chierchia and McConnell-Ginet (2000) cite examples like (51) used in a certain context to show that the adverbial modification does not provide evidence for the lexical decompositional analysis. Suppose that John's new jacket was made in a factory and thus has never been cleaned before he bought it. When it eventually got dirty and John cleaned it, (51a) is judged false but (51b) is true, that is, it lacks a repeated causal event reading.

(51) a. John cleaned the jacket again.
b. John caused the jacket to be clean again.

As previously mentioned, Beavers et al. (2021) question the bifurcation between roots and templates by pointing out that some result roots have a result meaning regardless of the event template in which they occur. Instead of directly adding BECOME and CAUSE to the denotation of the *break*-type verbs to make them structurally more complex, we have employed meaning postulates to express such entailments in the previous chapter. As a result, Rappaport and Levin's result and manner verbs were given a parallel treatment as simple transitive verbs which only differ in their semantic types, *process* and *event*, and associated entailments.

Reflection

- How are semantic primitive predicates ACT, BECOME and CAUSE extracted? Can you think of other primitive features? What are some problems of such analyses?
- What are the differences between templatic and root meanings? Why is it important to distinguish between the two? What are the implications of the bipartite structure of verb meaning?
- What are advantages of using meaning postulates instead of decompositions?

3.5 Conclusion

In this chapter, we discussed ways of classifying verbs that have been used in the field, relying on thematic roles, aspectual classes or event templatic structures. Instead of directly incorporating action, causality and change of state into verb structures and meanings, as the bipartite view of word meaning claims, we employed meaning postulates to explain the entailment relations while providing a uniform analysis of all transitive verbs.

Points to Remember

- Verbs have been classified depending on the **Θ**-roles that they assign to their arguments, such as agent and theme. In addition, the thematic hierarchy offers an account of the mapping between syntax and **Θ**-roles. A more sophisticated approach adopts proto-roles.
- Verbs have also been classified in terms of their internal temporal constituency into state, activity, accomplishment and achievement, in accordance with the presence or absence of the semantic features [±dynamic], [±telic] and [±punctual]. Aspectual classes of verbs can be objectively determined by a set of operational tests.
- Event templatic structure approaches use the common event templates containing a few primitive predicates such as ACT, BECOME and CAUSE, and idiosyncratic roots that fill out the templates. Using the bipartite structure, a finite characterization of an infinite set of verb meanings becomes possible.

Technical Terms to Remember

1. **Valency/arity:** The number of arguments that a verb calls for.
2. **Eventuality:** A cover term for events, processes and states.
3. **Event semantics:** The assumption that verbs take an extra argument for events.
4. **Thematic (Θ theta) roles:** The semantic roles the verb assigns to its arguments.
5. **Agent:** An animate entity that deliberately brings about an event.
6. **Causer:** An entity responsible for (initiating) an event.
7. **Experiencer:** An animate entity that experiences an event.
8. **Theme/patient:** An entity that is affected by an event or that has a property.
9. **Instrument:** An entity that is used to bring about an event.
10. **Goal/recipient:** An entity that an event is done to or for.
11. **Location:** A spatial entity in which an event takes place, or a state holds.
12. **Path:** A spatial entity with length on which another entity moves.
13. **Neo-Davidsonian event semantics:** The verb is a predicate over an event only, and individual arguments are introduced as separate conjoined conditions related to the event via **Θ**-roles.
14. **Uniformity of Theta Assignment Hypothesis (UTAH):** Identical thematic relationships between items are represented by identical structural relationships when items are merged.
15. **Thematic hierarchy:** A fixed order of thematic roles that determines the syntactic position of arguments.
16. **Proto-roles:** Proto-agent and proto-patient, each characterized by a number of verbal entailments.
17. **Aktionsart:** The internal temporal constituency of events inherent in the verb meaning.
18. **Accomplishments:** Durative events that have built-in goals (culmination).
19. **Achievements:** Instantaneous events consist of solely their culmination point.
20. **Activities:** Events that do not have a natural end-point.
21. **States:** Indefinitely extending states of affairs that involve no dynamics.
22. **Dynamic:** Eventualities that require constant input of energy to continue.
23. **Telic:** Eventualities that have an inherent, built-in endpoint.
24. **Atelic:** Eventualities whose termination needs to be imposed externally.
25. **Punctual:** Eventualities that occurs instantaneously.
26. **Durative:** Eventualities that take time to take place.

27. **Semalfactive:** Verbs that are ambiguous between punctual and repeated durative event readings.
28. **Degree achievements:** Achievement verbs that are ambiguous between telic and atelic readings.
29. **Event templates:** Basic event schemas made up with universal set of primitives, such as ACT, CAUSE and BECOME.
30. **Roots:** Real world actions and states which fill out the event templates.
31. **Sub-lexical modification:** Certain classes of modifiers allow multiple interpretations when applied to verbs with complex event structures.
32. **Structure participant:** Arguments of the event template such as the subject of BECOME.
33. **Pure root participant:** Arguments of roots.

Suggested Reading

See Levin and Rappaport (2005, Chapter 6) for a critical discussion of thematic role hierarchies. See Grimshaw (1990) and Williams (1994) for the interaction between thematic roles and grammar. See Verkuyl (1972, 1993) and Dowty (1991) for a more through exposition of aspectual classes. See Rappaport and Levin (1998) and Beavers and Koontz-Garboden (2020) for details of event templatic structures.

Practice

1. Identify the number of arguments required by the following verbs.

(a) *run*

valency of 1

(b) *walk*
(c) *eat*
(d) *send*
(e) *snow*
(f) *lie between*
(g) *consist of*
(h) *travel*
(i) *destroy*
(j) *arrive*

2. Classify the verbs in the following sentences into unergative and unaccusative verbs.

(a) *Fido ran.*

unergative

(b) *Fido fell.*
(c) *Garfield sings.*
(d) *Garfield arrived.*
(e) *The lake froze.*
(f) *Fido ate.*
(g) *The boat sank.*
(h) *Fido hopped.*
(i) *The ice melted.*
(j) *Garfield danced.*

3. Provide neo-Davidsonian event semantic translation of the following verbs using lambda calculus.
(a) *read* $\boldsymbol{\lambda y \lambda x \lambda e.}\mathbf{read'}(e) \wedge \boldsymbol{agent}(e) = x \wedge \boldsymbol{theme}(e) = y$

(b) *plant*
(c) *swim*
(d) *see*
(e) *is happy*
(f) *is smart*
(g) *give*
(h) *die*
(i) *break*
(j) *lie*

4. Underline all NPs in the sentences and identify their thematic roles.
(a) *<u>Fido</u> hit <u>Garfield</u> with <u>his paw</u>.* **agent, theme, instrument**

(b) *Fido likes bones.*
(c) *Garfield fell.*
(d) *The package came from NY to Seoul.*
(e) *The rock broke the bowl.*
(f) *Fido is smart.*
(g) *Fido gave a bone to Spot.*
(h) *Garfield arrived.*
(i) *Fido ran around the house.*
(j) *Fido runs in the park.*

5. Explain the following data in terms of proto-role inferences. Do the subjects have more proto-agent inferences? Do the objects have more proto-patient inferences?
(a) *People filled the stadium.*
***people*: volitional, movement, *the stadium*: stationary, incremental theme**

(b) *Fido needs food.*
(c) *Fido entered the house.*
(d) *Fido caused Garfield to fall.*
(e) *Fido gave Garfield the toy.*

6. Determine the aspectual classes (Aktionsart) of the verbs using the operational tests. List the semantic features.
(a) *arrive*
achievement; [+dynamic], [+telic], [+punctual]

(b) *sing*
(c) *know*
(d) *build*
(e) *play*
(f) *die*
(g) *destroy*
(h) *love*
(i) *paint*
(j) *cross*

7. Explain why the following sentences are ungrammatical based on the aspectual classes of the verbs.
(a) **Fido is being white.*
State verbs cannot take the progressive form.

(b) **Fido is tall courageously.*
(c) **Be white!*
(d) **Fido forced Garfield to be short.*
(e) **Fido walked in two hours.*
(f) **Garfield died for two hours.*
(g) **Fido finished arriving.*
(h) **Fido finished understanding Garfield.*
(i) **Fido stopped being tall.*
(j) **Garfield died halfway.*

8. Paraphrase the following sentences.
(a) *Fido opened the door.*
Fido caused the door to become open.

(b) *The door opened.*
(c) *The door is open.*
(d) *Garfield dried his mat.*
(e) *The mat dried.*

9. What are the semantic relations between the base noun and the denominal verbs?
(a) *salt*
put salt in something

(b) *box*
(c) *sponge*
(d) *hammer*
(e) *stable*

10. Represent the following verbs using event templatic structures.
(a) *run*
$\mathbf{[}\boldsymbol{x}\ \mathrm{\mathbf{ACT}}_{<\boldsymbol{running}>}\mathbf{]}$

(b) *dry* (intransitive)
(c) *dry* (transitive)
(d) *brush*
(e) *arrive*

(f) *crack* (transitive)
(g) *crack* (transitive)
(h) *crawl*
(i) *kill*
(j) *box*

Notes

1 We infer the existence of the described event due to the past-tensed finite clause. We ignore tense because we are mainly interested in specifying the lexical semantics of verbs, but it is easy to add the condition for the past tense, as in (i), in which $<$ is a temporal precedence relation, and n stands for *now*.

(i) $\exists e.\text{hit}'(\text{f}, \text{b}, e) \wedge e < \text{n}$

2 The term unergative comes from the typology of ergative-absolutive vs. nominative-accusative languages (Dixon, 1994). Ergative languages mark the object and the single argument of intransitive verbs alike (with absolutive marking) while marking the agent subject argument of a transitive verb differently (with ergative marking). Nominative-accusative languages group the single argument of an intransitive and the subject of a transitive verb together, marking them both with nominative, while marking the objects of a transitive verb with accusative.

3 An exception to this principle is English expletives, which receive no **Θ-**role by the verb. Every theta role of the verb needs not be overt. Some languages allow null arguments (e.g., Italian, Chinese, Korean), which is assumed to be assigned a theta role by the verb, just like overt arguments.

4 To remedy these shortcomings, Reinhart (2002) proposes feature-based **Θ**-roles. In this framework, **Θ**-roles are made up of cluster of binary features [±c] for cause change and [±m] for mental involvement. Agent has [+c, +m] and theme has [-c, -m]. The feature-based **Θ-**roles result in a much more restricted set of **Θ**-roles. Since **Θ-**roles are not primitives but further decomposable as binary features, the fact that there is an overlap, e.g. agent and causer have something in common, i.e. [+c], and so do agent and experiencer, i.e. [+m], naturally follows. The order of arguments can be predicted from the feature combinations in this system; arguments with only - values (theme, [-c, -m]) combine with the verb first and arguments with only + values (agent, [+c, +m]) combine last.

5 Clark and Clark (1979), however, already pointed out that innovative denominal verbs rely on context and pragmatic usages rather than rule-based.

4 Types of Verbs

4.1 Many-Sorted Types in the Eventuality Domain

In this chapter, we will assign semantic types to verbs in order to explain their grammatical distributions and lexical entailments. We have so far divided eventualities into processes and events. Further distinction within events will be made based on the types of change they bring about based on the inherent scale structure they presuppose. We will discuss logical properties of each type and rationale for drawing a line between them. This will result in a richer ontology in the eventuality domain.

4.1.1 The Logic of Change

Most verbs describe events, and events entail changes. We will focus on the event- and process-denoting verbs in this chapter and discuss stative verbs in the next chapter. Levin and Rappaport (1991, 1998, 2005) provide systematic analyses of verbs using the logic of change. Changes are classified into either scalar or non-scalar changes. A **scalar change**, as the name suggest, is a change on a scale, which is an ordered set of degrees (points or intervals measuring values) on a single dimension representing a property of an argument of the verb (e.g., size, weight, temperature, cost) (Kennedy, 2001; Kennedy and McNally, 2005). For concreteness let us assume that degrees are numerical values, represented by the real numbers between 0 and 1. This generates a **strict ordering**, on which all values of a scale are connected and ordered with respect to one another. A scale or a strict ordering has the logical properties defined in (1), in which $d \preccurlyeq d'$ means that d is smaller than or equal to d'. (1a) says if one degree is at least as small as a second, and the second at least as small as a third, then the first is at least as small as the third. (1b) means that two degrees can be at least as small as each other only if they are identical. (1c) states that every degree is at least as small as itself. For example, on a scale of weight, if x is heavier than y, and y is heavier than z, x is heavier than z; it is not possible for x and y that x is heavier than y and y is heavier than x; x is as heavy as itself.

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(1) A set of degrees S with the ordering relation $\preccurlyeq$ is a scale if and only if $\forall d, d', d'' \in S$:
a. $\preccurlyeq$ is **transitive**: $[d \preccurlyeq d' \wedge d' \preccurlyeq d''] \rightarrow d \preccurlyeq d''$
b. $\preccurlyeq$ is **antisymmetric**: $[d \preccurlyeq d' \wedge d' \preccurlyeq d] \rightarrow d = d'$
c. $\preccurlyeq$ is **reflexive**: $d \preccurlyeq d$

A **non-scalar change**, by contrast, cannot be simply described in terms of an ordered set of values on a single dimension. This logical distinction between scalar and non-scalar changes is at the heart of the semantics of process and event type verbs. Put simply, process type verbs describe non-scalar changes, whereas event type verbs express scalar changes. For example, *hit* does not describe a directed change on a one-dimensional scale, whereas *break* describes a binary change from a state of an object being intact to a state of it being broken. Section 4.2 will be devoted to the discussion of process and event type verbs in different semantic domains.

Scalar changes can be further divided into those occur on **two-point scales** and those occur on **multiple-point scales**. Two-point scales consist only of two values, describing a polar transition from not having to having a certain property. The transition is conceptualized as instantaneous because there are no intermediate values in between. Multiple-point scales, by contrast, are associated with properties with many values. Figure 4.1 graphically represents the two types of scales, where *P* is a property of an entity *x*.

Verbs lexicalizing changes involving a two-point scale are classic achievements (e.g., *arrive, win, fall*), and verbs with underlying multiple-point scales include classic accomplishments (e.g., *build, cross, destroy*) and degree achievements (e.g., *cool, widen, darken*). Because these verbs are all event verbs that only differ in involving punctual versus durative events, we will assign the former *punctual-event* type, and the latter, *durative-event* type in Section 4.3 and explore their semantic properties in greater depth.

Multiple-point scales underlying durative event type verbs in turn fall into two sub-types: those with bounds (**closed scales**) and those without bounds (**open scales**). Bounded incremental changes on closed scales have a natural endpoint. For example, *build* (*a house*) describes a bounded incremental change, because the described event is telic and durative. Unbounded incremental changes on open scales have no fixed final point of an event,

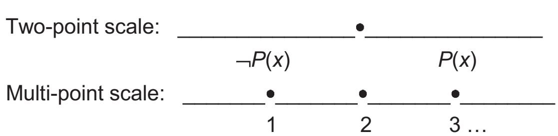

Figure 4.1 Two-point and multi-point scales.

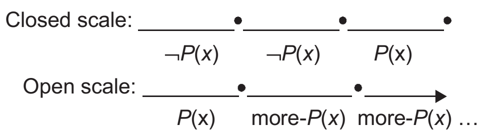

Figure 4.2 Open and closed scales.

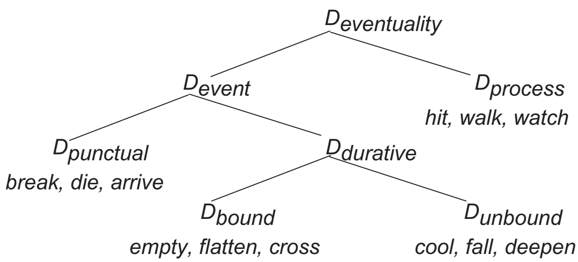

Figure 4.3 The hierarchy of many-sorted types in $D_{eventuality}$.

so the default standard is the minimum degree. For example, *widen* (*the road*) describes an unbounded incremental change because we use this verb (phrase) as long as the object becomes wider than before. Figure 4.2 graphically represents the closed and open scales.

We will assign the verbs lexicalizing the former *bounded-durative-event* type and those denoting the latter *unbounded-durative-event* type, respectively, in Section 4.4, discussing their semantic properties in detail.

4.1.2 The Hierarchy of Many-Sorted Types in the Eventuality Domain

The logic of change allows us to structure the domain of eventualities more systematically. The sub-domains of $D_{eventuality}$ form a hierarchical structure, described in (2).

(2) a. $D_{process} \cup D_{event} \subseteq D_{eventuality}$
b. $D_{punctual} \cup D_{durative} \subseteq D_{event}$
c. $D_{bounded} \cup D_{unbounded} \subseteq D_{durative}$

The hierarchy of the domain of eventualities is graphically represented in Figure 4.3 with some examples from each category. First, the entire domain of eventualities ($D_{eventuality}$) is divided into the domain of processes ($D_{process}$) and the domain of events (D_{event}) in terms of whether they involve scalar (event) or non-scalar (process) changes. Second, the domain of events in turn is composed of the domain of punctual events ($D_{punctual}$) and the domain of durative events ($D_{durative}$) with respect to the underlying two-point or multi-point scales, respectively. Finally, the domain of durative events consists of the domain of bounded durative events ($D_{bounded}$) and the domain of unbounded durative events ($D_{unbounded}$), which involve closed and open (multi-) scales, respectively.

A sub-type inherits all the properties of higher-types while adding more specific information. For example, *cross* (*the street*) will be a bounded, durative and event type verb since it has an endpoint (reached when the street is crossed), is durative (it takes time to cross the street) and yields a result (an agent is on the other side of the street). In the rest of this chapter, we will discuss the meaning of each type of verbs in greater detail, starting with the event and process dichotomy in different content domains.

Reflection

- What is evidence for using the logic of change for the distinctions in verb meaning?
- Do you expect the semantic types of the verbs based on the logic of change to be universal? Why or why not? If not, can you think of some other ways in which verbs can be semantically classified in other languages?
- Pick a verb from each category and describe their properties in terms of the underlying scale structure. Do your descriptions match your intuition about those verbs?

4.2 Process and Event Type Verbs

4.2.1 The Change of State Domain

As previously discussed, Levin and Rappaport (1991) and Rappaport and Levin (1998) argue for the bifurcation of manner versus result in various lexical classes. In Table 4.1, the manner and the result columns are grammatically significant, whereas the semantic classes in the leftmost column are not. They may be perceived as semantic classes simply because they can sometimes describe the same real-world events.

We have decided to classify the "manner" verbs as process type verbs and "result" verbs as event type verbs in light of some counterexamples Beavers and Koontz-Garboden (2012) discovered. We have observed that the "verbs of damaging" (*break* vs. *hit*) respond differently to the same grammatical alternation due to their inherent semantic differences. Let us test whether other classes of verbs in Table 4.1 behave consistently with that observation. As previously discussed, a conative construction is only compatible with a process type verb because it entails a contact but no result. An event type verb,

Table 4.1 Manner and result verbs in the (potential) change of state domain

	Manner	*Result*
verbs of damaging	*hit*	*break*
verbs of putting (2-dim)	*smear*	*cover*
verbs of putting (3-dim)	*pour*	*fill*
verbs of removal	*shovel*	*empty*
verbs of combining	*shake*	*combine*
verbs of killing	*stab*	*kill*
verbs of cleaning	*wipe*	*clear*
verbs of shaping	*pound*	*flatten*

on the other hand, entails a result, so it is incompatible with the conative construction. (3) shows that "verbs of killing" are subject to the same constraint.

(3) a. I stabbed at the monster.
b. *I killed at the monster.

A process type verb cannot occur in an inchoative alternation, whereas an event type verb can, because this construction encodes a change of state. (4) demonstrates three dimensional "verbs of putting" behave as expected.

(4) a. The bucket filled.
b. *The bucket poured.

The part–whole alternation is acceptable only with process type verbs, which is confirmed with "verbs of killing" in (5). Since *kill* describes the killing event as an alteration of the object as a whole, it is impossible to designate where on the direct object the event occurs, as shown in (5a).

(5) a. I stabbed the monster on the chest.
b. *I killed the monster on the chest.

Only event type verbs can occur in the middle construction, combining with only one (object) argument, which is demonstrated with regard to "verbs of shaping" in (6).

(6) a. *The metal pounds easily.
b. The metal flattens easily.

Process type verbs in general are not compatible with middles except when they are in a resultative construction. For example, pounding metal does not necessarily change the state of the metal. As a result, *pound* does not appear in the middle, as we saw in (6a). However, the resultative verb phrase *pound flat*, meaning "to pound something with the result that it becomes flat" involves a change of state. This slight change in the clause alters its ability to appear as a middle, as (7) shows.

(7) The metal pounds flat easily.

The result in the resultative construction is brought about by the process, i.e., the process of wiping results in the clean state of the table in (8a). Since the results described by event type verbs are not associated with the manner, they are not compatible with this alternation, as in (8b).

(8) a. I wiped the table clean.
b. *I cleared the table shiny.

The oblique subject alternation involves verbs that have agent subjects but alternatively may take instrument subjects.[1] When the verbs take an oblique subject, the agent is no longer expressed. Only event type verbs can appear in this alternation, as evidenced by the two dimensional "verbs of putting" in (9).

(9) a. The paint covered the wall.
b. *The paint smeared the wall.

As previously discussed, different event types have ramifications for argument realizations. Process type verbs allow an implicit object, whereas event type verbs do not, as a "verbs of removal" pair in (10) shows. According to Levin and Rappaport (1998, 2005), since the latter invariably entails a change of state event, their object is at the same time the subject selected by the entailed event, and thus cannot be omitted. Process type verbs, on the other hand, do not entail a change of state event, so the (optional) object argument can be left implicit.

(10) a. I shoveled all day.
b. *I emptied all day.

Unlike event type verbs, process type verbs can take non-subcategorized objects, illustrated in (11) with the "verbs of cleaning." The *over* phrase in (11a) can be an argument of a manner verb, whereas the same phrase in (11b) can only be interpreted as a locative adjunct (i.e., clearing the box happened above the table).

(11) a. I wiped the cloth over the table. (= I wiped the table)
b. I cleared the box over the table. (≠ I cleared the table)

The tests so far prove that the process vs. event division is not restricted to some individual class of verbs, such as verbs of damaging, but applies more generally to all kinds of (potential) change of state verbs. In the previous chapter, we represented the meaning of *hit* and *break*, repeated in (12).

(12) a. $[\![hit]\!] = \lambda y \lambda x \lambda e.\text{hit}'(x, y, e)$ $\langle object, \langle object, \langle process, t\rangle\rangle\rangle$
b. $[\![break]\!] = \lambda y \lambda x \lambda e.\text{break}'(x, y, e)$ $\langle object, \langle object, \langle event, t\rangle\rangle\rangle$

4.2.2 Manner of Motion and Directed Motion Verbs

Beyond the potential change of state domain, we find a comparable dichotomy of process and event in the motion domain. We can classify motion verbs with regard to conflation of semantic components. **Directed motion verbs** (or motion and path verbs) in (13a) specify a direction of motion, but not the manner in which the motion is carried out. **Manner of motion verbs** in (13b), by contrast, specify the manner in which the motion is carried out, but is silent about the direction of motion.[2]

(13) a. Directed motion verbs: *leave, arrive, come, go, ascend, descend, rise, fall, climb, etc.*
b. Manner of motion verbs: *walk, run, crawl, hop, jump, gallop, skip, swim, revolve, etc.*

Note that directed motion verbs can be subsumed under event type verbs, whereas manner of motion verbs can be assimilated to process type verbs.[3] For example, *arrive* describes a change of location event, whereas *walk* describes a process but does not entail scalar changes. Reflecting their semantic differences, these two types of motion verbs respond differently to various syntactic alternations. First, manner of motion verbs can be modified by a *for* adverbial, which only modifies processes, whereas directed motion verbs are compatible with an *in* adverbial, which is only acceptable with a telic event which entails a change of location or a change of state, as (14) shows.

(14) a. Fido walked for an hour/*in an hour.
b. Fido arrived in an hour/*for an hour.

Second, manner of motion verbs, like other process type verbs, can appear in the resultative construction, as shown in (15a), but directed motion verbs cannot, as in (15b). (15a) means the process of Fido running resulted in the soreness of his paws. By contrast, since directed motion verbs already encode a result state as a change of location, they are incompatible with resultative constructions.

(15) a. Fido ran his paws sore.
b. *Fido went his paws sore.

Third, the preposition drop alternation happens with directed motion verbs that take directional phrase complements, as in (16a). When the path or goal argument is expressed as a direct object as in (16b), it receives a holistic interpretation, i.e., it is understood as being completely traversed or the goal as attained.

(16) a. Fido climbed up the stairs.
b. Fido climbed the stairs.

On the other hand, a manner of motion verb lacks such holistic meaning, so it does not allow this alternation, as shown in (17b).

(17) a. The spaceship revolves around the earth.
b. *The spaceship revolves the earth.

The observations made so far regarding the different behaviors of directed motion verbs like *arrive* and manner of motion verbs like *walk* in various syntactic alternations confirm that the former is event type verbs, and the latter is process type verbs in the motion domain. The denotations of *walk* and *arrive* are given in (18) with their semantic types.

(18) a. $[\![walk]\!] = \lambda x \lambda e.\text{walk}'(x, e)$ $\langle object, \langle process, t\rangle\rangle$
b. $[\![arrive]\!] = \lambda x \lambda e.\text{arrive}'(x, e)$ $\langle object, \langle event, t\rangle\rangle$

Manner of motion verbs entail that the agent moves on a path in a specific manner, but no location change to a goal/destination is entailed. Directed motion verbs, on the other hand, entail that the theme changes its location as the result of participating in the event. For verbs like *arrive*, the change is perceived as a binary transition from not being at the destination to being there. In that sense, the path is conceptually collapsed into a single point, so the manner in which the movement on the path occurs is not normally part of its meaning.

4.2.3 Mereology

A major difference between the process and event type verbs in both the potential change of state domain and the motion domain we discussed so far is that eventualities described by event type verbs have heterogeneous parts, while those expressed by process type verbs have homogeneous parts. Krifka (1998) applies the notion of part in **mereology**, the theory of parthood, to explicate such distinction. Whenever events described by process type verbs hold at a time interval, they also hold at any part of that interval. Let $e \in D_{process}$ be an event of Fido hitting the bowl from 12:00 to 12:10. Now e will have parts, e.g., a part $e' \leq e$ in which Fido hitting the bowl from 12:00 to 12:05, and a part $e'' \leq e$ in which he hits the bowl from 12:05 to 12:10 ($x \leq y$ means x is part of y, and $x < y$ means x is a proper part of y ($=_{def}$ $x \leq y \wedge x \neq y$)). These parts e' and e'' will themselves be hitting events, and hence be elements of $D_{process}$. This is not the case for event type verbs. If Fido was hitting the bowl from 12:00 to 12:10, finally breaking it at 12:10, he did not break it from 12:00 to 12:05. According to Krifka (1998), process type verbs are **divisive**, whereas event type verbs are **quantized**, as defined in (19a) and (19b). A predicate P is divisive if and only if whenever it holds of something, it also holds of each of its proper parts. A predicate P is quantized if and only if whenever it holds of something, it does not hold of any of its proper parts.

(19) a. Divisive reference: $\text{DIV}(P) =_{def} \forall x.P(x) \rightarrow \forall y.y < x \rightarrow P(y)$
b. Quantized reference: $\text{QUA}(P) =_{def} \forall x.P(x) \rightarrow \forall y.y < x \rightarrow \neg P(y)$

Parallel to the process type verbs in the change of state domain, manner of motion verbs have divisive reference: Let $e \in D_{process}$ be an event of Fido running from his house to the park. Now e will have parts, e.g., a part $e' \leq e$ in which Fido runs from his house halfway to the park, and a part $e'' \leq e$ in which he runs from the halfway point to all the way to the park. These parts e' and e'' will themselves be running events, and hence be elements of $D_{process}$. This does not hold for directed motion verbs, which have quantized reference. If Fido was running from 12 to 12:10, finally arriving at the park at 12:10, he did not arrive at the park at 12:05.

Reflection

- Why do process and event type verbs in different content domains behave similarly in various alternations?
- Do you expect the dichotomy of process vs. event type hold in other languages? Talmy (1985) argues that path- or verb-framed languages (e.g., Romance languages) lexicalize path of motion in the verb and expresses manner optionally outside of the verb, whereas manner- or satellite-framed languages (e.g., Germanic languages) lexicalize manner of motion in the verb and express the path as a complement. If this is correct, what does it say about the process vs. event dichotomy in motion verbs?
- What predictions can you make about verb meaning based on mereology? How is the mereology-based classification different from the traditional distinction between activities and accomplishments/achievements based on the [±telic] feature?

4.3 Punctual and Durative Event Type Verbs

4.3.1 Semantics of Incrementality

We have assigned the punctual event type to the verbs lexicalizing changes involving a two-point scale, and the durative event type to the verbs with multiple-point scales. These two types of verbs behave in predictable ways in various syntactic environments. For example, the former cannot occur in a comparative construction, as shown in (20a), whereas the latter can, as in (20b). Since the former describes a conceptually instantaneous transition between two opposite values, there cannot be any intermediate states with varying degrees. The latter employs multiple values on a strictly ordered scale, allowing us to determine whether an object has higher or lower values than others in terms of an attribute.

(20) a. Fido <u>killed</u> the rabbit *<u>more</u>.
b. Garfield <u>destroyed</u> the house <u>more</u>.

The entailment in (21a) is valid, since there are only two values (*dead* versus *alive*) on the scale for the punctual event type verb *kill*, whereas the entailment in (21b) is invalid, since there are multiple values between being completely destroyed and being fully intact (e.g., *damaged*).

(21) a. Fido did not kill the rabbit. ⇒ The rabbit is alive.
b. Garfield did not (completely) destroy the house. X⇒ The house is (fully) intact.

We therefore assign the punctual event type to verbs like *kill*, and the durative event type to verbs like *destroy* in (22).

(22) a. $[\![kill]\!] = \lambda y \lambda x \lambda e.\text{kill}'(x, y, e)$ $\langle object, \langle object, \langle punctual\text{-}event, t\rangle\rangle\rangle$
b. $[\![destroy]\!] = \lambda y \lambda x \lambda e.\text{destroy}'(x, y, e)$ $\langle object, \langle object, \langle durative\text{-}event, t\rangle\rangle\rangle$

There has been much discussion about what we call durative event type verbs in terms of a structure-preserving mapping between events and objects (Champollion, 2017; Krifka, 1992, 1998; Landman, 2000). This phenomenon has been variously referred to as the "ADD-TO" property (Verkuyl, 1972, 1993), "**measuring out**" (Tenny, 1994) and "**incremental theme**" (Dowty, 1991). We have briefly discussed incremental themes when we introduced proto roles but let us look into this concept in more depth. In a situation described by (23a), the event of Garfield destroying the house ends when the entire house is destroyed. Similarly, in a situation described by (23b), the event of Fido eating a bone reaches its endpoint when the entire bone is consumed. Hence, we can establish a one-to-one mapping between parts of the events and the parts of the theme arguments. When Garfield destroys half of the house, for example, half of the event of him destroying the house will have been completed. Similarly, when Fido ate one-third of the bone, one-third of the event of his eating the bone was over.

(23) a. Garfield <u>destroyed the house</u>.
b. Fido <u>ate a bone</u>.

To explain this phenomenon, Krifka (1992, 1998) employs a homomorphism function from objects to events which preserves the part–whole structure, in which thematic relations mediate between event and object. (24) characterizes these properties, where P is any incremental predicate, $\sqcup$ is the **join operation** that adds individuals or events, and $\leq$ is part-of relation holding between events and objects.

(24) a. Summativity: $\mathrm{SUM}(P) =_{\mathrm{def}} \forall e \forall e' \forall x \forall x'. P(e, x) \wedge P(e', x') \rightarrow P(e \sqcup e', x \sqcup x')$
b. Uniqueness of Objects: $\mathrm{UNI\text{-}O}(P) =_{\mathrm{def}} \forall x \forall x'. P(e, x) \wedge P(e, x') \rightarrow x = x'$
c. Uniqueness of Events: $\mathrm{UNI\text{-}E}(P) =_{\mathrm{def}} \forall e \forall e'. P(e, x) \wedge P(e', x) \rightarrow e = e'$
d. Mapping to Objects: $\mathrm{MAP\text{-}O}(P) =_{\mathrm{def}} \forall e \forall e' \forall x. P(e, x) \wedge e' \leq e \rightarrow \exists x'. x' \leq x \wedge P(e', x')$
e. Mapping to Events: $\mathrm{MAP\text{-}E}(P) =_{\mathrm{def}} \forall e \forall x \forall x'. P(e, x) \wedge x' \leq x \rightarrow \exists e'. e' \leq e \wedge P(e', x')$

Krifka (1998) takes drinking a glass of wine as an example. Summativity says two (distinct) events of drinking a glass of wine yield an event of drinking two glasses of wine. Uniqueness of objects states that an event is related to a specific object, that is, a drinking of a glass of wine is related through the theme role to a specific glass of wine, and to nothing else. Uniqueness of events says that only one event related to the object by the thematic relation exists; for example, for a specific glass of wine there can be only one drinking event. Mapping to objects says that every part of a drinking of a glass of wine corresponds to a part of the glass of wine, and mapping to events says that every part of the glass of wine being drunk corresponds to a part of the drinking event. These axioms ensure that there is a one-to-one mapping between events and objects, explaining the incrementality of durative event type verbs.

4.3.2 Ditransitive Verbs in the Dative Alternation

The punctual versus durative event type distinction is not restricted to transitive verbs of consumption and destruction we discussed in the previous section. It is also instantiated by ditransitive verbs of caused possession and motion. Meaning of ditransitive verbs has been much discussed with regard to the dative alternation, in which the goal or recipient argument appears either as the object of the preposition *to,* as in (25a), or as the direct object, as in (25b).

(25) a. Fido <u>gave</u> the bone <u>to</u> Spot.
b. Fido <u>gave</u> Spot the bone.

Is there any semantic difference between the two constructions? Goldberg (1992, 1995) and Harley (2002) assume that the direct object in the double object construction is a possessor, whereas the object of the preposition *to* in the prepositional construction is merely a location. Evidence comes from the animacy requirement in the double object construction. The explanation is that, since only animate entities can be a possessor, inanimate objects cannot appear in a double object construction, as (26b) shows.

(26) a. Fido sent the bone to <u>Spot/his house</u>.
b. Fido sent <u>Spot/*his house</u> the bone.

The "successful transfer inference," which is often associated with the double object construction, is taken as further evidence for their claim. For example, (27a) is said to imply that Spot has learned a new trick, while (27b) does not.

(27) a. Fido taught Spot a new trick.
b. Fido taught a new trick to Spot.

The problem of this analysis is that the double object construction often fails to trigger the successful transfer inference, and thus is not much different from its prepositional variant, as (28) illustrates. Denying the successful transfer inference does not result in contradiction in either the prepositional variant in (28b) or the double object variant in (28b).

(28) a. Fido taught a new trick to Spot for days, but he doesn't seem to have learned it.
b. Fido taught Spot a new trick for days, but he doesn't seem to have learned it.

Furthermore, a change of possession is entailed in both prepositional and double object constructions, as shown in (29). We cannot deny the change of possession without a contradiction in both variants.

(29) a. *Fido gave Spot the bone, but he never got it.
b. *Fido gave the bone to Spot, but he never got it.

These empirical facts strongly suggest that the successful transfer reading of the dative verb is not a function of different syntactic constructions.

Rappaport and Levin (2008) argue that the inference hinges on whether or not the verbs in question lexicalize an incremental or an instantaneous transition. Among the ditransitive verbs, *give*-type verbs listed in (30) denote instantaneous transition, invariably entailing a successful transfer, whereas *send*-type verbs in (31) refers to an incremental transition, without entailing a successful transfer.

(30) Ditransitive verbs having only caused possession meanings:
   a. Verbs that inherently signify acts of giving: *give, hand, lend, loan, pass, rent, sell, etc.*
   b. Verbs of future having: *allocate, allow, bequeath, grant, offer, owe, promise, etc.*
   c. Verbs of communication: *tell, show, ask, teach, read, write, quote, cite, etc.*

(31) Ditransitive verbs having caused location meanings:
   a. Verbs of sending: *forward, mail, send, ship, etc.*
   b. Verbs of instantaneous causation of ballistic motion: *fling, shoot, throw, toss, etc.*
   c. Verbs of causation of accompanied motion in a deictically specified direction: *bring, etc.*
   d. Verbs of instrument of communication: *e-mail, fax, radio, wire, telephone, etc.*

The core dative verbs, such as *give*, *lend*, *rent* and *sell*, are change of possession verbs that describe a non-incremental, instantaneous change. That is, the meaning of these verbs entails a simple transition from the recipient not having the theme to having it, rather than the theme incrementally crossing a path from the original possessor to the recipient. In this respect, these verbs pattern like traditional achievement verbs, such as *arrive*, *reach* or *die*. They are telic and only acceptable with *in* adverbials, as (32) shows. The sentences also do not entail that the described events were continuing for the time interval specified by the *in* adverbials, parallel to achievements.

(32) a. Fido <u>gave</u> Spot the bone/the bone to Spot <u>in/*for an hour</u>.
   b. I <u>sold</u> you the car/the car to you <u>in/*for an hour</u>.

Paths in transfer of possession events lack any internal structure since they are two-point paths from the original possessor to the recipient. Therefore, punctual event type verbs like *give* cannot take *to* phrases with modifiers further specifying the extent of the path, in contrast to durative event type verbs like *send*, as (33) illustrates.

(33) a. *Fido gave the bone halfway/all the way to Spot.
b. Fido sent the bone halfway/all the way to his house.

Unlike the durative event type verbs, the punctual event type verbs do not occur with *from*-marked source phrases, as (34a) shows. Assuming that a single predicate cannot have two sources, the subject of the punctual event type is the source of a possessional path, disallowing a separate source phrase.

(34) a. *Fido gave the bone from Bingo to Spot.
b. Fido sent the bone from Spot's house to his house.

The difference between the two types of verbs is whether the theme argument incrementally traverses the distance between the source and the goal or not, and whether the goal/recipient comes to have the theme object as a result of the event or not. For example, *I gave you a gift* entails that there was a change in possession of the gift from the speaker to the hearer. It entails that the hearer has the gift, so continuing the sentence with *but you never received it* is anomalous. *I sent you a gift*, on the other hand, entails that the gift traversed the distance between the speaker and the hearer and is now located with the hearer. It does not entail that the hearer has the gift, however, as evidenced by the fact that we can continue it with *but you never received it*.

Beavers (2011) proposes a more fine-grained distinction among punctual event type verbs. He compares *give*, *loan* and *hand*, and explains the difference in terms of increasing specifications of their results: *give* encodes just caused possession, *loan* encodes a stronger condition of transfer of possession, and *hand* encodes the strongest condition of both transfer and motion. Beavers (2012) also contends that some ditransitives encode both caused motion and caused possession simultaneously, suggesting that predicates of change can encode changes along two dimensions at once, contra some scalar models of change. To reflect this, he distinguishes two types of possession scales: those that do not also involve motion ("pure possession scales"), and those that do ("possession by motion scales").

Setting aside the issues of whether scales must involve a single dimension or not, we propose the following denotations for the ditransitive verbs, *give* and *send*, respectively, in (35). *Give* is a punctual (instantaneous) event description, whereas *send* is a durative (incremental) event description among the event type verbs.

(35) a. $[\![give]\!] = \lambda y \lambda z \lambda x \lambda e.\text{give}'(x, y, z, e)$ $\langle object, \langle object, \langle object, \langle punctual\text{-}event, t\rangle\rangle\rangle\rangle$
b. $[\![send]\!] = \lambda y \lambda z \lambda x \lambda e.\text{send}'(x, y, z, e)$ $\langle object, \langle object, \langle object, \langle durative\text{-}event, t\rangle\rangle\rangle\rangle$

Reflection

- Pick an incremental theme verb and describe its meaning in terms of the structure-preserving mapping. Does the description match your intuition about that verb?
- How does the assumption that the *give*-type verbs entail an instantaneous change of ownership, whereas the *send*-type verbs entail an incremental traverse and a change of location help refute the common presumption that different syntactic variants in the dative alternation are associated with these implications?
- Specific verbs in each type will trigger more specific entailments. For example, *allocat*e entails future possession, and *bring* entails a theme being at the speech location as a result. Can we use meaning postulates to express such meanings? What would they look like?

4.4 Bounded and Unbounded Durative Event Type Verbs

4.4.1 Variable Telicity and Degree Achievements

Lastly, durative event type verbs are further divided into two sub-types depending on whether the underlying multiple-point scale is bounded or unbounded. Verbs denoting changes on multiple-point scales, such as *cool* and *widen*, are traditionally called degree achievements or gradual change verbs. They describe incremental changes, but their result meaning component is controversial due to the variability in telicity (Dowty, 1979). When used in the past tense, they do not invariably trigger an entailment that the change lexicalized in the verb has happened. For example, (36) does not entail that the soup is cool. Instead, it is ambiguous between an atelic reading, i.e., the temperature of the soup was getting lower, and a telic reading, i.e., the temperature of the soup reached some implicit end state of being cool.

(36) The soup <u>cooled</u>.

In its atelic reading, it is compatible with a *for* adverbial, as (37a) shows, and only in its telic reading can it be modified by an *in* adverbial, as illustrated in (37b).

(37) a. The soup <u>cooled for</u> 10 minutes.
b. The soup <u>cooled in</u> 10 minutes.

Note that (38a) entails (38b) only in the atelic reading of *cool* (Kennedy and Levin, 2008). We have observed in Chapter 3 that the progressive form of activities, which are atelic, entails its past/perfective counterpart.

(38) a. The soup <u>is cooling</u>.
b. The soup <u>has cooled</u>.

Due to its atelic reading, the entailment in (39) is not valid, since there are multiple values between *cool* and *warm*, such as *lukewarm.*

(39) The soup did not cool. X⇒ The soup is (still) warm.

There have been various proposals to explain these puzzling facts about degree achievements. Assuming what counts as cool depends on context, Abusch (1986) represents *cool* as a function from contexts to properties of individuals. If the contextual argument *c* is the utterance context (c_u), as in (40a), it is true if an object is as cool as some contextual standard of coolness, entailing that it reached that standard (i.e., telic). If it is existentially quantified, as in (40b), it is true if an object increases in coolness, without entailing that a particular end-state is reached (i.e., atelic).

(40) a. $\lambda x \lambda e.\text{become}'(x, \text{cool}'(c_u), e)$
b. $\lambda x \lambda e \exists c.\text{become}'(x, \text{cool}'(c), e)$

This analysis predicts general ambiguity of degree achievements. Contrary to this expectation, some have a default telic reading, and others only have an atelic reading (Kennedy and Levin, 2008). (41) illustrates verbs like *darken*, *dry* and *empty* strongly implies that an endpoint has been reached, resisting a continuation denying such implication.

(41) a. *The sky <u>darkened</u> but it did not become dark.
b. *The shirt <u>dried</u> but it did not become dry.
c. *The sink <u>emptied</u> but it did not become empty.

On the other hand, (42) demonstrates that verbs like *widen* and *deepen* are only atelic, and thus are modified by *for* but not by *in* adverbials, and their progressive form entails their past tense form.

(42) a. The gap between the boats <u>widened</u> for/*in a few minutes.
b. The recession <u>deepened</u> for/*in several years.
c. *The gap <u>is widening</u>, but it hasn't widened.
d. *The recession <u>is deepening</u>, but it hasn't deepened.

4.4.2 The Degree Argument and a Standard of Comparison

Most degree achievements are deadjectival verbs derived from underlying gradable adjectives, e.g., *widen/wide*. We will explore adjective meaning and scale structures in greater detail and precision in Chapter 9 but let us briefly discuss gradable adjectives for our immediate purpose of explicating the meaning of their corresponding deadjectival verbs. Kennedy and Levin (2008) propose that gradable adjectives, even when there is no overt degree word, are associated with a null degree word that denotes the function ***pos*** (for "positive" degree), defined in (43a). Here, *G* is a variable for any gradable predicate, and ***stnd*** is a function from gradable predicate meanings to degrees that gives a standard of comparison for the predicate in the context of utterance. Applied to *wide* in (43b), it denotes a property true of an object just in case its width exceeds the given standard of width in the utterance context.

(43) a. $[\![pos]\!] = \lambda G \lambda x. G(x) \succcurlyeq stnd(G)$
b. $[\![pos]\!]([\![wide]\!]) = \lambda x.\text{wide}'(x) \succcurlyeq stnd(\text{wide}')$

The deadjectival verbs have adjectival roots that are either open- or closed-scale adjectives. Adjectives like *dark*, *dry*, *empty*, *ripe* and *straight* have a maximum value, e.g., something is straight if it is completely straight. Adjectives like *wide*, *deep* and *long*, on the other hand, do not have a maximum value on the relevant scales, e.g., there is no limit in width, depth or length of an object, so a limit (standard of width, etc.) must be provided contextually. A simple method of applying this analysis to deadjectival verbs would be to add a change of state component encoded by the predicate become′. Winter (2006) proposes (44a) as the meaning of a degree achievement. Applied to *straighten*, (44b) is true if and only if *pos*(straight′) is false of *x* at the beginning of an event *e* and true of *x* at the end of *e*, and *pos*(straight′) is true of *x* just in case *x* has the maximum straightness.

(44) a. $\lambda x \lambda e.\text{become}'(x, pos(G), e)$
b. $\lambda x \lambda e.\text{become}'(x, pos(\text{straight}'), e)$

This account predicts that *pos*(wide′) will denote the property of having a width that exceeds the contextually salient standard of comparison, so *widen* should have a meaning equivalent to *become wide* as in (45), which is telic. This is clearly not the case; *widen* lacks such entailment, as we observed in (42) above.

(45) $\lambda x \lambda e.\text{become}'(x, pos(\text{wide}'), e)$

Therefore, we need an additional semantic component beyond the change of state predicate become′. Hay et al. (1999) offer a solution by introducing *more*, which is a property that is true of *x* and *e* just in case *x* becomes more *G* at the end of *e* than at the beginning. This explains atelic readings of *widen* and *cool* but cannot explain why *straighten* and *darken* have default telic interpretations.

(46) $\lambda x \lambda e.\text{become}'(x, more(G), e)$

We face a real conundrum. The key point is that we cannot assume that degree achievements are ambiguous between the positive reading and the comparative reading since *widen*, etc. do not have both atelic and telic interpretations.

4.4.3 A Measure of Change Function

Kennedy and Levin (2008) offer a possible solution by introducing a **measure of change function** m_Δ. According to them, degree achievements take an individual and an event as arguments and map them onto a degree corresponding to the "difference" between the value of the individual on the measure function denoted by the base adjective at the beginning of the event and the value of the individual on the same measure function at the end of the event. For example, *darken* is represented as a measure of change function darken'_Δ in (47a). A null degree word *pos* introduces the standard value $stnd(\text{darken}'_\Delta)$ in (47b).

(47) a. $[\![darken]\!] = \lambda x \lambda e.\text{darken}'_\Delta(x, e)$
b. $[\![pos]\!]([\![darken]\!]) = \lambda x \lambda e.\text{darken}'_\Delta(x, e) \succcurlyeq stnd(\text{darken}'_\Delta)$

Crucially, they argue that $stnd(m_\Delta)$ can always be the lowest positive value on the measure of change scale, corresponding to the smallest change possible, which yields a comparative reading (*to darken* means *to become darker*). As a result, incremental change verbs derived from open scale adjectives only have atelic, comparative interpretations. If an upper limit to the amount of change possible in the property described by the base adjective is built-in in the verb meaning, $stnd(m_\Delta)$ can also be the upper endpoint on the measure of change scale. If this maximum standard is selected, the result is the positive, telic reading (*to empty* means *to become empty*). For the verbs like *cool*, which is ambiguous between telic and atelic readings despite the fact that the underlying scale is open, they argue that a conventionalized meaning "has a stabilized temperature" or "at room temperature" permits a telic reading.

Verbs like *darken*, *dry*, *empty*, *ripen*, *straighten*, etc. presuppose closed scales, whereas verbs like *widen*, *deepen*, *lengthen*, etc., involve open scales. Bounded incremental changes on closed scales can have the maximum standard since the lexical meaning of bounded event type verbs provides it. Unbounded incremental changes on open scales, on the other hand, have no fixed standard that can serve as the final point of the event, so such a standard must be externally provided by context. In this case, the default standard is the minimum degree. The denotations and semantic types of (intransitive) *widen* and *straighten* are given in (48).

(48) a. $[\![widen]\!] = \lambda x \lambda e.\text{widen}'(x, e)$ ⟨*object*, ⟨*unbounded-durative-event*, *t*⟩⟩
b. $[\![straighten]\!] = \lambda x \lambda e.\text{straighten}'(x, e)$ ⟨*object*, ⟨*bounded-durative-event*, *t*⟩⟩

Reflection

- McNally (2017) points out that the exceptional behavior of verbs like *cool* requiring some relevant non-minimal degree of the adjectival property is in fact much more widespread. Can you think of such a case? Can we predict when and how it becomes possible to conventionalize the endpoint of an event as non-minimal degree of the adjectival property, such as *cool*?
- Describe the relationship between gradable adjectives and their deadjectival verbs. Do you think it is necessary to introduce degrees as new primitives?
- Why do we need to postulate an implicit *pos* morpheme? Can semantics explain where the standard of comparison come from? If not, how do we know the standard?

4.5 Conclusion

In this chapter, we identified a set of important distinctions in the verb meaning in terms of the types of changes they describe. After enriching the domain of eventualities based on the logic of change, we discussed representative verbs, including process and event type verbs, punctual and durative event type verbs including ditransitive verbs of change of possession and location, and bounded and unbounded durative event type verbs including degree achievements. Inherent lexical meaning of the *give*-type verbs among ditransitive verbs gives rise to the changed possession entailment, rather than different syntactic frames. Variable telicity with degree achievements is explained in terms of a differential function. The verbs discussed in this chapter are by no means exhaustive. The goal of this chapter has been to inform the reader about semantic properties of each logical type of verbs and to instruct them on how to apply various linguistic tests and the logical tools to systematically analyze their meaning.

Points to Remember

- Verbs are divided into event type verbs that involve scalar changes and process type verbs that cannot be characterized as scalar changes on a single dimensional scale.
- When there is a scalar change, it can be an instantaneous change that happens on a two-point scale or an incremental change that occurs on a multi-point scale.
- Incremental changes may involve open or closed scales, in which case, the standard that makes the sentence true is the minimum degree but can also be the maximum degree for closed scales.

- Process and event complementarity is discerned in both change of state and motion verbs.
- Inherent lexical meaning of the *give*-type verbs gives rise to the changed possession entailment, rather than different syntactic frames.
- Variable telicity with degree achievements leads to the adoption of a measure of change function.

Technical Terms to Remember

1. **Scalar change:** A change on a scale, which is an ordered set of degrees (points or intervals measuring values).
2. **Strict ordering:** An ordering on which all values of a scale are connected and ordered with respect to one another on a single dimension representing a property of an argument of the verb.
3. **Transitive:** If one degree is at least as small as a second, and the second at least as small as a third, then the first is at least as small as the third.
4. **Antisymmetric:** Two degrees can be at least as small as each other only if they are identical
5. **Reflexive:** Every degree is at least as small as itself.
6. **Non-scalar change:** A change that cannot be simply described in terms of an ordered set of values on a single dimension.
7. **Two-point scales:** Scales consisting only of two values, describing a polar transition from not having to having a certain property.
8. **Multiple-point scales:** Scales that are associated with properties with many values.
9. **Closed scales:** Multi-point scales with bounds.
10. **Open scales:** Multi-point scales without bounds.
11. **Directed motion verbs:** Motion verbs that specify a direction of motion, but not the manner in which the motion is carried out.
12. **Manner of motion verbs:** Motion verbs that specify the manner in which the motion is carried out but is silent about the direction of motion.
13. **Mereology:** The theory of parthood.
14. **Divisive:** Whenever a property holds of something, it also holds of each of its proper parts.
15. **Quantized:** Whenever a property holds of something, it does not hold of any of its proper parts.
16. **Measuring out/incremental theme:** A one-to-one mapping between parts of the events and the parts of the theme arguments.
17. **Join operation:** An operation that adds individuals or events.

18. ***Pos:*** The null degree word which denotes the function for positive degree.
19. ***Stnd:*** A function from gradable predicate meanings to degrees that gives a standard of comparison for the predicate in the context of utterance.
20. ***More:*** A property that is true of x and e just in case x becomes more G (gradable predicate) at the end of e than at the beginning.
21. **Measure of change function:** A function that take an individual and an event as arguments and map them onto a degree corresponding to the difference between the value of the individual on the measure function denoted by the base adjective at the beginning of the event and the value of the individual on the same measure function at the end of the event.

Suggested Reading

Levin (1993) is an extensive work that describes a robust correlation between the semantics of verbs and their syntactic behaviors for a large number of English verbs (about 3,200) participating in 79 alternations. Beavers and Koontz-Garboden (2020) is a recent monograph length treatment of verb semantics using an event templatic approach. See Krifka (1998) and Champollion (2017) for the mereological event semantic model of motion and property change.

Practice

1. Classify the following verb pairs into their semantic types to show the crucial semantic contrast.

(a) *pour* vs. *fill*

process verb ⟨*object*, ⟨*object*, ⟨*process*, *t*⟩⟩⟩ vs. event verb ⟨*object*, ⟨*object*, ⟨*event*, *t*⟩⟩⟩

(b) *come* vs. *walk*
(c) *destroy* vs. *kill*
(d) *mail* vs. *hand*
(e) *deepen vs. darken*

2. Explain the contrast between a. and b. sentences. Based on the data below, what can you conclude about the meanings of *scrub* and *clear*?

(a) a. *All last night, I scrubbed.*
b. **All last night, I cleared.*

implicit object— *scrub*: yes, *clear*: no

(b) a. *I scrubbed the floor clean.*
b. **I cleared the floor empty.*

(c) a. *The broom cleared the floor.*
b. **The stiff brush scrubbed the sink.*

(d) a. **I scrubbed but didn't move a muscle.*
b. *I cleared the floor but didn't move a muscle.*

(e) a. *I scrubbed the brush over the sink.* ⇒ *I scrubbed the sink.*
b. *I cleared the bowl over the sink.* X⇒ *I cleared the sink.*

(f) a. *I scrubbed at the sink.*
b. **I cleared at the floor.*

(g) a. *The floor cleared.*
b. **The floor scrubbed.*

3. Provide the denotations and semantic types of the following verbs.

(a) *scrub*

⟦*scrub*⟧ = λ*y*λ*x*λ*e*.scrub′(*x*, *y*, *e*) ⟨*object*, ⟨*object*, ⟨*process*, *t*⟩⟩⟩

(b) *clear*
(c) *shovel*
(d) *empty*
(e) *stab*
(f) *kill*
(g) *smear*
(h) *cover*
(i) *pound*
(j) *flatten*

4. Explain the contrast between a. and b. sentences. Based on the data below, what can you conclude about the meanings of *walk* and *go*?

(a) a. *Fido walked for an hour/*in an hour.*
b. *Fido went in an hour/*for an hour.*

***Walk* can be modified by *for* adverbials but not *in* adverbials, whereas *go* shows the opposite pattern.**

(b) a. *Fido walked his paws sore.*
b. **Fido went his paws sore.*

(c) a. *Fido walked the stairs.*
b. **Fido went the stairs.*

5. Provide the denotations and semantic types of the following manner of motion and directed motion verbs.

(a) *arrive*

⟦*arrive*⟧ = λ*x*λ*e*.arrive′(*x*, *e*) ⟨*object*, ⟨*event*, *t*⟩⟩

(b) *walk*
(c) *leave*
(d) *swim*
(e) *come*
(f) *crawl*

(g) *go*
(h) *jump*
(i) *rise*
(j) *revolve*

6. Explain the contrast between a. and b. sentences. Based on the data below, what is the semantic difference between *hand* and *mail*?

(a) a. *I mailed the package from New York to Seoul.*
 b. **Fido handed the bone from Garfield to Spot.*

Source phrase— *mail*: yes, *hand*: no.

(b) a. **Where did you hand the ball?*
 b. *Where did you mail the package?*
(c) a. *I handed the package to my sister/*Seoul.*
 b. *I mailed the package to my sister/Seoul.*
(d) a. **Fido handed the bone all the way/halfway to Spot.*
 b. *I mailed the package halfway/all the way around the world to Seoul.*
(e) a. **Fido handed Spot the bone, but he never got it.*
 b. *I mailed the package to my sister, but she never got it.*

7. Provide the denotations and semantic types of the following ditransitive verbs of changed possession and location.

(a) *give*

⟦*give*⟧ = λ*y*λ*z*λ*x*λ*e*.give′(*x*, *y*, *z*, *e*) ⟨*object*, ⟨*object*, ⟨*object*, ⟨*punctual-event*, *t*⟩⟩⟩⟩

(b) *send*
(c) *lend*
(d) *ship*
(e) *rent*
(f) *bring*
(g) *sell*
(h) *fax*
(i) *show*
(j) *throw*

8. Explain the contrast between a. and b. sentences. Based on the data below, what is the semantic difference between *straighten* and *lengthen*?

(a) a. *I lengthened the rope, but it did not become long.*
 b. **I straightened the pole, but it did not become straight.*

Telicity implication— *straighten*: yes, *lengthen*: no.

(b) a. *The rope lengthened for/*in a few minutes.*
 b. *The pole straightened *for/in a few minutes.*
(c) a. **The rope is lengthening, but it hasn't lengthened.*
 b. *The pole is straightening, but it hasn't straightened.*

9. Provide the denotations and semantic types of the following degree achievements.

(a) *darken*

$[\![pos]\!]([\![darken]\!]) = \lambda x\lambda e.\mathbf{darken}'_{\Delta}(x, e) \succcurlyeq stnd(\mathbf{darken}'_{\Delta})$

$\langle object, \langle bounded\text{-}durative\text{-}event, t\rangle\rangle$

(b) *widen*
(c) *dry*
(d) *deepen*
(e) *empty*
(f) *lengthen*
(g) *ripen*
(h) *sweeten*
(i) *straighten*
(j) *flatten*

10. Describe the meaning of the following verb phrases using mereology.

(a) *read a book*

There is a one-to-one correspondence between the event of reading and the parts of a book.

a. **Summativity:** $\forall e\forall e'\forall x\forall x'.\mathbf{read}'(e, x) \wedge \mathbf{book}'(x) \wedge \mathbf{read}'(e', x') \wedge \mathbf{book}'(x) \rightarrow \mathbf{read}'(e \sqcup e', x \sqcup x')$

b. **Uniqueness of Objects:** $\forall x\forall x'.\mathbf{read}'(e, x) \wedge \mathbf{book}'(x) \wedge \mathbf{read}'(e, x') \wedge \mathbf{book}'(x') \rightarrow x = x'$

c. **Uniqueness of Events:** $\forall e\forall e'.\mathbf{read}'(e, x) \wedge \mathbf{read}'(e', x) \wedge \mathbf{book}'(x) \rightarrow e = e'$

d. **Mapping to Objects:** $\forall e\forall e'\forall x.\mathbf{read}'(e, x) \wedge \mathbf{book}'(x) \wedge e' \leq e \rightarrow \exists x'.x' \leq x \wedge \mathbf{book}'(x') \wedge \mathbf{read}'(e', x')$

e. **Mapping to Events:** $\forall e\forall x\forall x'.\mathbf{read}'(e, x) \wedge \mathbf{book}'(x) \wedge x' \leq x \rightarrow \exists e'.e' \leq e \wedge \mathbf{read}'(e', x')$

(b) *run a mile*
(c) *run a race*
(d) *eat an apple*
(e) *build a house*

Notes

1 Such subjects have been referred to as oblique subjects because certain prepositional phrases, particularly those expressing non-subcategorized arguments, are referred to as oblique phrases.

2 Sound verbs (*beep, buzz, creak, gurgle, jingle, ring, roar*, etc.) pattern together with manner of motion verbs (Levin and Rappaport, 1998, 2005).

3 This does not mean that directed motion verbs are inherently telic, e.g., *ascend, descend, rise, fall,* and *climb* are compatible with *for* adverbials. However, they still entail change in location in the lexically encoded direction, e.g., *ascend* entails upward movement as a function of time. We will discuss atelic (durative) event verbs, traditionally called degree achievements, in Section 4.4.

5 Polysemy and Coercion

5.1 Polysemy

5.1.1 Problems with Verbal Polysemy

Polysemy is a norm rather than an exception, that is, almost all words, especially those that are frequently used in everyday discourse, have multiple related meanings. Although polysemy is not restricted to verb meaning, it is particularly challenging to identify a basic set of meanings for polysemous verbs (Rumshisky and Batiukova, 2008).[1] The number of senses is too large, capable of reaching into hundreds in some cases (Brugman, 1988). A long list of meanings in the parentheses in (1), which is not even exhaustive, illustrates the difficulty involved in trying to determine how many senses a common verb like *fall* has. Such difficulty is attributed to the fact that verb meanings often depend on the arguments they take in semantic composition rather than their inherent meanings alone. We can see, however, that the basic meaning component of motion gets transformed in different meanings of *fall* in (1). The physical senses of *fall* in "physically drop" or "downward extension" and its metaphoric extensions of "decrease," "loss," "placement," etc. are not unrelated.

(1)
a. The boy fell. (physical drop)
b. Her hair falls down to her waist. (extending downward)
c. Prices fell. (decrease)
d. Roman Empire fell. (lose power or suffer a defeat)
e. Night fell. (for a state to commence)
f. This case falls into this category. (be categorized)
g. Her birthday falls on Sunday. (get assigned to a person, location or time)
h. The stress falls on the last syllable. (stress or emphasis placed on)
i. The responsibility falls on me. (responsibility, luck, suspicion placed on a person)

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How do we navigate the maze of polysemy and eventually reach the goal of the intended meaning? Syntactic structures can sometimes help, as (2) illustrates. *Deny* in the "refuse to give" meaning selects two arguments, as in (2a), whereas the same verb in the "proclaim false" meaning selects only one, as in (2b).

(2) a. The authorities <u>denied</u> the visa to the prime minister (= refuse to give)
b. The authorities <u>denied</u> the attack (= proclaim false)

More often, however, semantics of arguments is the only clues, as (3) and (4) exemplify.

(3) a. The general <u>fired</u> four rounds (= shoot)
b. The general <u>fired</u> four lieutenant colonels (= dismiss)
(4) a. The customer will <u>absorb</u> this tax (= pay)
b. The customer will <u>absorb</u> this information (= learn)

The related senses cannot be seen as different aspects of one and the same event. (5) shows that the literal meaning of *expire*, i.e., ceases to be legally effective, and its metaphoric extension, i.e., to become dead, are distinct and thus require a separate predication. This phenomenon is called **zeugma effect**, where a polysemous word bans a copredication of different senses. This means that these meanings are distinct, albeit related, and thus cannot be accessed simultaneously in the same sentence.

(5) *The old man and his driver's license <u>expired</u> yesterday.

The relative independence of senses of a polysemous verb is reflected on its syntactic behaviors, as well. We have observed that process type verbs, unlike event type verbs, are compatible with the conative construction. Things are more complicated when different senses are involved; *cut* typically allows the conative alternation, as in (6a), but when it is not used in the physical sense the sentence becomes infelicitous, as shown in (6b) (Falkum, 2011).

(6) a. I <u>cut/cut at</u> the rope.
b. The bank <u>cut/*cut at</u> its interest rates.

5.1.2 The Sense Enumerative Lexical Model

As briefly mentioned in Chapter 1, a conventional model of lexical meaning, called the Sense Enumerative Lexical (SEL) model, in the tradition of Katz (1972), lists each sense of the verb separately as a relation with its appropriate argument types. Consider the polysemy of *kill* in (8).

(8) a. Fido killed the mouse. (= cause-to-die)
b. You killed the conversation. (= terminate)
c. I killed the day surfing the internet. (= waste)

In this model, *kill* would have three distinct lexical entries as in (9). For each sense, the verb can act on its arguments completely compositionally as cases of three distinct function applications.

(9) a. $[\![kill_1]\!] = \lambda y \lambda x \lambda e.\text{cause-to-die}'(x, y, e)$
b. $[\![kill_2]\!] = \lambda y \lambda x \lambda e.\text{terminate}'(x, y, e)$
c. $[\![kill_3]\!] = \lambda y \lambda z \lambda x \lambda e.\text{waste-doing}'(x, y, z, e)$

What is left unexplained in the SEL model is any logical relation between the senses, which is a major drawback. Furthermore, experimental research such as Frisson (2009), Klepousniotou et al. (2012) and MacGregor et al. (2015) show reading time differences as well as the involvement of different brain regions between homonymy and polysemy, which is not expected under this theory. These studies reveal that in cases of homonyms the reader settles on a specific reading immediately, with a clear bias toward the dominant and more frequent meaning. Moreover, due to the competition among homonymous senses, unselected meaning quickly decays. By contrast, polysemy lacks all these biases and competition effects; rather, polysemous words are recognized faster due to priming effects between senses. Moreover, their common activation persists, indicating that the reader does not immediately commit to a particular meaning. This suggests that homonymous meanings are represented and stored separately, as the SEL model predicts, whereas polysemous meanings have a single representation and storage, which makes the SEL model inappropriate.

5.1.3 Co-compositionality

A crucial linguistic difference between different senses of a polysemous word and those of genuine ambiguity/homonyms is that only the occurrence of the former is predictable. If a word is genuinely ambiguous, a sentence containing it will also always be ambiguous. For example, (10) has three separate readings such that I hate the Pope's male bovine, decree or empty talk, due to the lexical ambiguity of the word *bull*. Only extralinguistic context can assist in disambiguating, so *bull* needs to be treated as homonyms of three separate words/lexemes.

(10) I hate the Pope's bull.

In case of logical polysemy, by contrast, different senses are a function of meaning composition within the sentence, so extralinguistic context is not always necessary to identify the intended meaning. For example, *kill* means "causing to die" when it takes an animate complement, "terminate" when it takes an event-denoting complement, and "waste" when it takes a time-denoting complement. Taking another example, in the context of particular objects, the verbs *bake* and *carve* are interpreted as a creation verb, as in (11b) and (12b), while with other objects, it maintains the underlying manner meaning, as in (11a) and (12a). Treating them as ambiguous between manner and creation verbs will not explain the fact that they are interpreted as creation verbs only when they take an artifact argument.

(11) a. I baked <u>the potato</u>.
b. I baked <u>the cake</u>.

(12) a. You carved <u>the stick</u>.
b. You carved <u>the statue</u>.

Since the different senses of a polysemous word are systematic and predictable, they must be accounted for in terms of a general principle. Although the SEL model, by treating homonymy and polysemy alike, is not a good model, it does preserve the principle of compositionality in a strict sense. The principle of compositionality is a fundamental guiding principle that explains the infinite productivity of language. As we have seen, compositional rules are basically function applications. Type-restricted application with many-sorted types provides an account for why composition fails when there is a type mismatch. However, it does not answer why such a type mismatch is sometimes permitted, or why more-fine grained type distinctions in the argument result in different interpretations of the predicate. Ubiquitous polysemy forces us to introduce the new concept co-compositionality, in which some sort of "fine-tuning" or "augmenting" occurs when predicates take arguments. As Pustejovsky (2012) argues, it is often the case that the argument introduces new information over and above what it contributes as an argument to the function within the sentence when they combine with predicates, and predicates provide a meaning general and flexible enough to accommodate different kinds of arguments with rich conceptual structures.

Reflection

- Why is it particularly difficult to analyze verbal polysemy? Pick and compare a polysemous verb and a polysemous noun. Was it more difficult to determine the multiple meanings of the verb than the noun?
- What are the problems with the SEL model? If we reject this model, how can we abide by the principle of compositionality?
- What is co-compositionality? Why do we need this concept? How can we substantiate this principle?

5.2 Theoretical Approaches to Polysemy

Vincente (2018) groups different views on polysemy into three different main theories, summarized in (13).

(13) a. **Literalism**: Each polysemous word has a literal, denotational, meaning. The rest of senses it has is generated through linguistic rules, coercion, or pragmatic inferences.
b. **Over-specification** or rich account: The meaning of a polysemous word includes all of its different senses that are stored in a single representation. Senses are selections of the total meaning of the word.
c. **Under-specification** or core meaning account: The meaning of a polysemous word is an underspecified, abstract, and summary representation that encompasses its different senses.

5.2.1 Literalist Approach

The first view in (13a), the literalist approach, is to postulate a basic or literal meaning of a word and derive other extended or non-literal senses by shifting the original meaning when the literal sense does not produce an appropriate interpretation. This approach presupposes a hierarchy among senses: one of them is "the" meaning of a word and the rest is derived from this basic or core meaning. It seems reasonable to take the literal meaning as the basic from which other senses are derived. This theory also explains why copredication is not allowed; the original meaning and derived meanings are substantially different and cannot be used in the same sentence because the latter has to be generated by a special rule. In this approach, extended senses are treated as atypical, so they are expected to engender an additional processing cost, involving an extra step of first activating a literal meaning and then searching for an extended meaning only when it fails. For example, we can define *kill* as *cause to die*, restricting its theme argument to animate objects. When the argument given to it does not meet this requirement, a type-shift from the underlying sense of *cause to die* to *terminate* or *waste* occurs to rescue the composition.

Asher (2011) endorses the literalist view as he tries to explain a large number of meaning variations in terms of coercion. Copestake and Briscoe's (1995) account of some regular polysemy also takes a literalist standpoint. From a different theoretical perspective, this theory is also advocated by some followers of relevance theory, such as Falkum (2011, 2015). Cognitive linguists in general hypothesize that metaphor-based polysemy consists of meaning-chains in which a prototypical, usually embodied, meaning of a word is extended in various ways.

Like the prototype theory, however, these approaches lead to the problem of identifying the basic sense, which is not always easy for many polysemous words, since any of their multiple senses may or may not be basic or literal. Moreover, no uncontroversial empirical evidence for extra processing time or cost for derived meaning exists. Klein and Murphy (2001) is the first experimental work that supports additional processing cost and separate storage for different senses of polysemous words. Pylkkänen et al. (2006) is more recent work using magnetoencephalography (MEG). Frazier and Rayner (1990), however, found no extra processing cost in their eye tracking experiments and argue for a single underspecified storage for them. Frisson (2009) is a more recent survey for this position. While we have the feeling that the "terminate" or "waste" sense of *kill* is metaphorical extensions of literal *kill*, these senses are highly conventionalized, and thus interpreting (8b) and (8c) is as immediate as interpreting (8a). That is, even if we concede that metaphor-based polysemy has originally derived from a literal meaning, existing studies show that, once they have been established, i.e., once a word has become polysemous, there is no extra recalculation process of accessing a representation of the literal meaning to construe a metaphoric sense.

5.2.2 Over-Specification Approach

The over-specification approach argues that the observed meaning of a word is just a part or a selection of the total meaning of the word. It presupposes that it is in principle possible to list every sense of a word, equating the meaning of the word with the "totality" of the senses. The difference between the literalism and over-specification is that the former holds that the extended meanings are not obtained by a process of "selection," but rather strictly "derived" through semantic or pragmatic rules. On the other hand, over-specification's tenet is that the observed meaning is a proper part of the meaning of the word. The problem with this approach is that the number of senses of a polysemous verb is too large, reaching sometimes hundreds (Brugman, 1988). As previously observed, verbal polysemy (e.g., *expire*) does not allows copredication, indicating that their senses are independent, making it impossible to view them as different aspects of one and the same event.

Pustejovsky (1995) is the best-known over-specification approach to polysemy. His Generative Lexicon theory is designed to explain inherent (nominal) polysemy and coercion, in which different aspects or facets of the total conceptual meaning of the words are differently highlighted. We will discuss his model in more detail in the next chapter.

5.2.3 Under-Specification Approach

The third method in (13c), the under-specification, thin approach, is to make the verb meaning general enough to be compatible with different senses. Verbal polysemy is often based on metaphoric extensions, so an abstract representation that applies to all different senses is not only possible but desirable. More often than not, we can reasonably postulate a summary or abstract meaning representation consisting of a number of entailments that form part of all the metaphorical senses to explain the connection. The observed co-priming is explained as the activation of these features spread simultaneously to all the senses that include such features. Therefore, we will assume that under-specification, not over-specification, approaches provide the best account for verbal polysemy. For example, the lexical meaning of *cut* can be very abstract so that it can cover both uses of *cut* in *cut the grass* and *cut the interest rates*. The common core of the different senses of the verb *cut* can be defined as a change of state in which an entity which exemplifies some kind of connectedness undergoes a process of controlled disconnection (Spalek, 2015). If we accept this approach, co-compositionality manifests in the process in which verbs, whose meaning is rather schematic and abstract, obtain their more concrete meanings by taking the rich meaning of its arguments. In the process, inferences are drawn on the basis of our general knowledge about kind-concepts and event structures.

Based on the discussion in the previous section, let us adopt a variant of under-specification analyses of verbal polysemy. We observed in (11), repeated in (14), that the creation sense of *bake* emerges only when it combines with an artifact noun like *cake*. We infer from (14b) that by baking, which is a typical manner of creating cakes, the speaker made it.

(14) a. I baked <u>the potato</u>.
b. I baked <u>the cake</u>.

Let us assume that the basic meaning of *bake* as predicates over events only. The intransitive base can be shifted to a transitive version with an artifact restriction, engendering the creation meaning, as in (15a). When the object is restricted to a natural kind, it has a process reading, as in (15b). For our immediate purpose, we will make a type distinction between artifact type and natural kind type within the object type. We will explore the noun meaning in the following chapters.

(15) a. $[\![\textit{bake}]\!] \Rightarrow [\![\textit{bake}\ \_\__{\textit{artifact}}]\!]$
$\lambda e.\text{bake}'(e) \qquad \lambda x_{\textit{artifact}}\lambda e.\text{make-by-baking}'(e) \wedge \textit{theme}(e) = x_{\textit{artifact}}$
$\langle \textit{eventuality}, t\rangle \qquad \langle \textit{artifacts}, \langle \textit{event}, t\rangle\rangle$
b. $[\![\textit{bake}]\!] \Rightarrow [\![\textit{bake}\ \_\__{\textit{natural-kind}}]\!]$
$\lambda e.\text{bake}'(e) \qquad \lambda x\lambda e.\text{bake}'(e) \wedge \textit{theme}(e) = x_{\textit{natural-kind}}$
$\langle \textit{eventuality}, t\rangle \qquad \langle \textit{natural-kind}, \langle \textit{process}, t\rangle\rangle$

Let us apply this approach to other polysemous verbs. We can offer a comparable treatment to the polysemy of *kill* we observed in (8) above, repeated in (16).

(16) a. I <u>killed</u> the spider.
b. You <u>killed</u> the conversation.

Kill is a punctual result verb that changes its meaning depending on the object it takes. To capture this, we will introduce further type distinctions between animate and inanimate objects. Because we do not restrictively define *kill* as referring only to the "cause-to-die" event selecting animate themes, no type-mismatch actually occurs.

(17) a. $[\![kill]\!] \Rightarrow [\![kill \,\_\__{animate}]\!]$
$\lambda e.\mathrm{kill}'(e)$ $\quad \lambda x_{animate}\lambda e.\text{cause-to-die}'(e) \wedge theme(e) = x_{animate}$
$\langle punctual\text{-}event, t\rangle$ $\quad \langle animate, \langle punctual\text{-}event, t\rangle\rangle$
b. $[\![kill]\!] \Rightarrow [\![kill \,\_\__{inanimate}]\!]$
$\lambda e.\mathrm{kill}'(e)$ $\quad \lambda x_{inanimate}\lambda e.\mathrm{terminate}'(e) \wedge theme(e) = x_{inanimate}$
$\langle punctual\text{-}event, t\rangle$ $\quad \langle inanimate, \langle punctual\text{-}event, t\rangle\rangle$

Additionally, let us use a meaning postulate for the purpose of representing the abstract statement that encompasses its different senses. In the result state, the theme argument ceases to exist, as (18) expresses. Regardless of whether *kill* selects an animate argument, denoting an event of taking its life, as in (16a), or an inanimate argument, as in (16b), the verb triggers the same entailment that the theme no longer exists as the result of the action.

(18) $\forall x \forall y \forall e.\mathrm{kill}'(x, y, e) \rightarrow \mathrm{cause}'(x, \mathrm{become}'(\neg \mathrm{exist}'(y)))$

The sense extension, or polysemy in general, is the result of abstract knowledge about event schemas and their entailment patterns, encompassing the speaker's lexical and pragmatic competence. Now that we have rejected literalist theories of polysemy, this means that we need a different account for type coercion, which is the "go-to" repair strategy for literalists. In the following subsections, we will discuss a variety of phenomena, including aspectual coercion, variable arguments and certain stative verbs, which have been under the umbrella of general coercion phenomena.

Reflections

- What are the literalist and the over-specification approaches to polysemy? What are strengths and weaknesses of these theories? How are they different?
- What is the under-specification approach to polysemy? Why is this theory most suitable for verbal polysemy?

- We treated the verb as a predicate over event only and changed its interpretation when it takes an argument. We also used meaning postulates to represent its abstract meaning. Can you think of other ways to deal with verbal polysemy?

5.3 Coercion

5.3.1 Complement Coercion

Complement coercion involves aspectual verbs like *start*, *continue* and *finish*, and psych-verbs like *enjoy*, *prefer* and *endure*, which are assumed to require event complements. This input type requirement is satisfied with a gerund complement in (19a) or an event-denoting nominal in (19b).

(19) a. I began/enjoyed <u>reading the book</u>.
b. You began/enjoyed <u>the fight</u>.

When the complement is object-denoting, as in (20), however, there is an apparent type-mismatch, but for some reason, it does not result in an anomaly.

(20) a. I began <u>the book</u>.
b. I enjoyed <u>the cake</u>.

A common analysis for resolving this conflict proposed by literalists is utilizing a type-shift or coercion of the argument (Asher, 2011; Pustejovsky, 1995). That is, these verbs are said to "coerce" the entity-denoting complement into an event-denoting type, which is made possible by the fact that artifact nouns such as *book* has their purposes, e.g., reading, as part of their lexical meanings or as a result of an application of some kind of type-shifting rule.[2] Natural kind nouns, on the other hand, are more difficult to be coerced since they are not associated with a typical, unique function/purpose. Some very specific extralinguistic or discourse context is required to possibly interpret (21).

(21) *I began <u>the dog/the tree</u>.

If we follow the coercion analysis, *the book* in (20a) will be given the denotation in (22) using a type-shifting function *telic*, which maps an artifact object to its typical function or purpose, shifting *the book* from an object type to an eventuality type. We assume that *x* is a free variable for the reader.

(22) $telic(\text{b}) = \lambda e.\text{read}'(x, \text{b}, e) \quad \langle eventuality, t\rangle$

To accommodate the shifted denotation, the aspectual verb *begin* will have to be a **higher-order predicate**, a function from properties (of events) from a function from entities to properties, as in (23), despite the fact that it is a simple transitive verb.

(23) $[\![begin]\!] = \lambda P \lambda x \lambda e \exists e'.\text{begin}'(x, e, e') \wedge P(e')$ $\langle\langle eventuality, t\rangle, \langle entity, \langle punctual\text{-}event, t\rangle\rangle$

Predicates that take properties as arguments, like quantified NPs, are called a higher order predicate. In contrast, predicates that take only individuals (constant or variable) as their arguments are called a **first order predicate**. In Chapter 2, we introduced the logical translations of quantified sentences, repeated in (24). At that time, we did not separate the meaning of quantified subjects and the predicates.

(24) a. $\forall x.\text{dog}'(x) \rightarrow \text{bark}'(x)$ "All dogs bark."
b. $\exists x.\text{dog}'(x) \wedge \text{bark}'(x)$ "Some dogs bark."

It would be ideal, however, if we could give a separate denotation to the quantified NPs themselves, rather than the whole sentences. After all, we are interested in how the sentence meaning is compositionally obtained by putting together the words and phrases occurring within it, observing the principle of compositionality. We can utilize the λ-operator to accomplish this. In (25), the predicate is abstracted, so any VP can combine with quantified NPs to yield the desired truth condition of the whole sentences. Quantified NPs are of type $\langle\langle e, t\rangle, t\rangle$ because they take a property $\langle e, t\rangle$ (the verb denotation) as an argument to yield a truth value.

(25) a. $[\![every\ dog]\!] = \lambda P \forall x.\text{dog}'(x) \rightarrow P(x)$ $\langle\langle object, t\rangle, t\rangle$
b. $[\![some\ dog]\!] = \lambda P \exists x.\text{dog}'(x) \wedge P(x)$ $\langle\langle object, t\rangle, t\rangle$

(26) show how these quantified NPs combine with the predicate *bark*. As we can see, when a VP combines with a quantified NP, it becomes an argument of the subject NP. Note that this is the opposite of what we observe with proper names. Proper names, which denote individuals, are arguments of the VPs, which denote a set of individuals. Quantified NPs, by contrast, are not individuals and do not refer to a particular object; instead, they are functions that take the VP as an argument. The end results are basically the same as the predicate logical formulas in (24a) above, but using the lambda operator, the outcome is derived compositionally, respecting the subject-predicate sentence structure.

(26) a. $[\![every\ dog]\!] = \lambda P \forall x.\text{dog}'(x) \rightarrow P(x)$ $\langle\langle object, t\rangle, t\rangle$
b. $[\![barks]\!] = \lambda y.\text{bark}'(y)$ $\langle object, t\rangle$
c. $[\![every\ dog]\!]([\![barks]\!]) = [\lambda P \forall x.\text{dog}'(x) \rightarrow P(x)](\lambda y.\text{bark}'(y))$
$= [\forall x.\text{dog}'(x) \rightarrow \lambda y.\text{bark}'(y)](x) = \forall x.\text{dog}'(x) \rightarrow \text{bark}'(x)$ t

If we treat aspectual verbs like *begin* as higher-order predicates as in (23), (20a) can be translated in (27) (s is the speaker).

(27) a. $[\![began]\!] = \lambda P \lambda x \lambda e \exists e'.\text{began}'(x, e, e') \wedge P(e')$ $\langle\langle eventuality, t\rangle, \langle object, \langle punctual\text{-}event, t\rangle\rangle$
b. $[\![the\ book]\!] = telic(\text{b}) = \lambda e.\text{read}'(x, \text{b}, e)$ $\langle eventuality, t\rangle$
c. $[\![began]\!](telic(\text{b})) = [\lambda P \lambda x \lambda e \exists e'.\text{began}'(x, e, e') \wedge P(e')](\lambda e.\text{read}'(x, \text{b}, e))$
$= [\lambda x \lambda e \exists e'.\text{began}'(x, e, e') \wedge \lambda e.\text{read}'(x, \text{b}, e))](e')$
$= \lambda x \lambda e \exists e'.\text{began}'(x, e, e') \wedge \text{read}'(x, \text{b}, e')$ $\langle object, \langle punctual\text{-}event, t\rangle\rangle$
d. $[\![began\ the\ book]\!]([\![I]\!]) = [\lambda x \lambda e \exists e'.\text{began}'(x, e, e') \wedge \text{read}'(x, \text{b}, e')](\text{s})$
$= \lambda e \exists e'.\text{began}'(\text{s}, e, e') \wedge \text{read}'(\text{s}, \text{b}, e')$ $\langle punctual\text{-}event, t\rangle$

In addition to the theoretical problem of justifying the *telic* function and making the meaning of aspectual verbs more complex, Piñango and Deo (2016) point out an empirical problem with the coercion analysis; aspectual verbs do not invariably take an event-denoting complement. For instance, (28) lacks an event interpretation of reading the book where the chapter on global warming is the agent.

(28) The chapter on global warming began the book.

Utt et al. (2013) found a clear difference between aspectual verbs and psych-verbs. The former occurred much more frequently with event-denoting nominals than the latter in their corpus study, casting doubt to the claim that both types of verbs lexically select event-denoting complements. Processing studies such as Katsika et al. (2012) show that only the former incur additional processing cost. These results give misgivings to adopting coercion and type-shifting as a general repair strategy for a limited set of transitive verbs, such as psych- and aspectual verbs.

Like *kill*, *begin* appears to be a verb that takes both objects and eventualities. Piñango and Deo (2016) propose **structured individuals** to be complements of aspectual verbs. Events have beginning, continuation and ending, so naturally gradable, which is the reason why aspectual verbs prefer event-denoting arguments. However, some artifact objects can also turn into gradable predicates by linearly ordering their constituent parts. An entity can be mapped onto a totally ordered scale with respect to certain dimensions (material, spatial, temporal, abstract, etc.). For example, a book can be mapped onto a linear structure either along the physical dimension (pages as adjacent parts that are totally ordered) or the information dimension (chapters as adjacent parts that are totally ordered). Adopting their insight, we will treat aspectual verbs as simple transitive verbs taking a structured or scalar/incremental entity as an internal argument, as in (29).

(29) $[\![begin]\!] = \lambda y_{scalar}\lambda x\lambda e.\text{begin}'(x, y_{scalar}, e)$ $\langle entity_{scalar}, \langle entity, \langle punctual\text{-}event, t\rangle\rangle\rangle$

For all gradable or incremental individual x, there is a homomorphism function h described in (30), where $\leq$ is a part-of relation. The homomorphism function applies to a gradable individual to yield a scale where there is a one-to-one mapping from the parts of the object to the parts of the scale.

(30) a. h: $h(x) = e$
b. $\forall x \forall x' \forall x''.x', x'' \leq x \wedge x' \leq x'' \rightarrow h(x') \leq h(x'')$

If we adopt the denotation in (29), the composition can proceed without a coercion operator or a higher-order predicate, as in (31).

(31) a. $[\![began]\!] = \lambda y_{scalar}\lambda x\lambda e.\text{began}'(x, y_{scalar}, e)$ $\langle entity_{scalar}, \langle entity, \langle punctual\text{-}event, t\rangle\rangle\rangle$
b. $[\![the\ book]\!] = \text{b}$ $object_{scalar}$
c. $[\![began]\!]([\![the\ book]\!]) = [\lambda y_{scalar}\lambda x\lambda e.\text{began}'(x, y_{scalar}, e)](\text{b})$
$= \lambda x\lambda e.\text{began}'(x, \text{b}, e)$ $\langle entity, \langle punctual\text{-}event, t\rangle\rangle$
d. $[\![began\ the\ book]\!]([\![I]\!]) = [\lambda x\lambda e.\text{began}'(x, \text{b}, e)](\text{s}) = \lambda e.\text{began}'(\text{s}, \text{b}, e)$ $\langle punctual\text{-}event, t\rangle$

The identity of the scale is determined by context. For example, depending on discourse context, *the book* can be mapped onto its constituent parts (e.g., pages, chapters) or onto an event in which the book is the theme (e.g., reading, writing). Such one-to-one mapping between events and object is already familiar to us from the discussion in Chapter 4 on Krifka's (1992, 1998) homomorphism function, where the thematic relation mediates between events and objects, preserving the part–whole structure. In this case, parts of the event of reading (or writing) can be mapped to parts of the book.

Adopting this analysis free us from having to worry about a type mismatch or stipulating a type-shifting operation. Instead, aspectual verbs can be treated on a par with other transitive verbs. We can also maintain a uniform semantics for aspectual verbs across their different uses in (20a) and (28). Then why is there extra processing cost for aspectual verbs complemented with nouns? Note that their complete interpretation hinges on picking out the salient dimension along which the complement can be understood as a structured individual. Lai et al. (2017) argue that the additional processing cost observed with aspectual verbs is not due to an extra type coercion step but instead is attributed to the ambiguity of dimensions. An entity can be mapped onto multiple dimensions, and determining which dimension is relevant depends on context and requires additional processing cost.

5.3.2 Aspectual Coercion

Numerous researchers, including Verkuyl (1972, 1993), de Swart (1998), Dowty (1979), Jackendoff (1991), Krifka (1989, 1992), Moens and Steedman (1988) and Pustejovsky (1991), investigate the phenomenon of **aspectual coercion**, which is the shift of lexical aspect (Aktionsart) under the influence of adverbs, direct object and grammatical tense and aspect. As we have observed in Chapter 3, the progressive is only supposed to be compatible with dynamic event descriptions, but some state verbs are compatible with it, as (32) illustrates.

(32) a. I am liking this play a great deal.
b. I am believing in ghosts these days.
c. You are being silly.

Goldberg (1995) and Jackendoff (2002) discuss a similar phenomenon of indeterminacy of telicity by examining the occurrence of process verbs with a resultative phrase or a goal PP to generate a telic reading, as (33) demonstrates.

(33) a. I wiped the counter clean.
b. You blew the tissue off the table.
c. Fido walked to the garden.
d. Fido ran the race.

Construction Grammar (Goldberg, 1995) argues that not only words but constructions themselves have their own meaning because they are also abstract form–meaning pairing. In this theory, a construction can contextually coerce the meanings of words occurring in it. For example, in (34), the verb *help*, which does not entail motion, is coerced to have a motion interpretation because the sentence instantiates a specific construction called "caused-motion construction," which means "*x* causes *y* to move and be at *z*."

(34) I helped her into the car.

de Swart (1998) proposes that coercion operators are eventuality description modifiers which map a set of eventualities onto another set of eventualities. She represents the input and output type as indices on her coercion operator *C*. For example, C_{sd} maps stative (*s*) onto dynamic (*d*) eventualities. (35) shows that C_{sd} is inserted before the progressive applies, satisfying its input requirement, to derive (32a) above.

(35) [Pres [Prog [C_{sd} [*I like this play*]]]

If hidden coercion operators can be activated anytime there is a type mismatch to make these sentences acceptable, no explanation can be offered as to why they are subject to such severe lexical restrictions. While *like* or *believe* can take progressive, *know* cannot, for example. There is no principled reason why a coercion operator cannot be used for the verb *know*, so we need further stipulations.

Pickering et al. (2006) provide empirical evidence for under-specification analysis for cases like (33c) and (33d). Based on evidence from eye-tracking experiments, they argue that the reader needs not make an immediate decision about telicity of a verb until they access the direct complement or adjunct that can give more clues. We know that process verbs can become telic when there is a quantizable complement or goal adjunct (Krifka, 1989). Let us represent the basic meaning of the process verb *run* as predicates over events only. This intransitive base can then become a transitive version by adding an event-denoting theme like *the race*, fixing the type of the verb to bounded durative event type, as in (36).

(36)

$[\![run]\!]$	$\Rightarrow$	$[\![run \;\_\__{quantizable}]\!]$
$\lambda e.\mathrm{run}'(e)$		$\lambda x_{quantizable}\lambda e.\mathrm{run}'(e) \wedge theme(e) = x_{quantizable}$
$\langle eventuality, t\rangle$		$\langle eventuality, \langle bounded\text{-}durative\text{-}event, t\rangle\rangle$

We will discuss the stative verbs in the progressive form in (32) above in the next section.

Reflections

- Why do you think some predicates appear to coerce their arguments to fit their input type requirements? Do you expect to observe similar phenomena in other languages?
- What are complement and aspectual coercions? What are existing analyses of them? Which one do you find most plausible?
- Some process verbs have telic readings in certain contexts. What are those contexts? Is it necessary to assume that their meaning changes in these cases? If not, what are some possible analyses?

5.4 Event-like Behaviors of Stative Verbs

5.4.1 Manner Modification

Stative verbs, such as *appear, belong, concern, consist, depend, imagine, know, like, need, own, perceive, prefer, recognize, remember, resemble and want*, normally reject a modification by manner adverbs, as (37) shows (Jackendoff, 1972).

(37) a. *Fido resembled his father <u>slowly</u>.
b. *Fido desired a bone <u>enthusiastically</u>.
c. *Fido hates Garfield <u>revoltingly</u>.

They also cannot occur in the progressive form, as evidenced by (38a), and lack a habitual reading in the present form, as in (38b).

(38) a. *Fido is <u>resembling</u> his father.
b. Fido <u>resembles</u> his father.

These are often taken to be features of stative verbs that distinguish them from eventive verbs (Vendler, 1967; Dowty, 1979). The incompatibility is explained in terms of a difference in argument structure between stative and eventive verbs; the latter have an extra event argument that stative verbs lack (Katz, 2003; Maienborn, 2005).

There are, however, a number of cases in which manner modifiers appear with stative verbs, as shown in (39). Some can even occur in the progressive form, as in (39g) and (32) above.

(39) a. Fido sleeps <u>soundly</u>.
b. Fido holds his bone <u>tightly</u>.
c. Garfield lies <u>quietly</u> on the floor.
d. Fido knew Garfield <u>well</u>.
e. Fido <u>firmly</u> believed that Garfield stole his bone.
f. Garfield loves Fido <u>passionately</u>.
g. Fido is thinking <u>worriedly</u> about his master.

Are stative verbs coerced to be event verbs in these cases? Scholars like Parsons (1990, 2000) and Landman (2000) answer negatively to this question, instead claiming that stative verbs must, like event verbs, have an event argument. Under such analysis, the state sentence (39f) would be given the logical translation in (40).

(40) $\exists e.\text{love}'(\text{g}, \text{f}, e) \wedge \text{passionate}'(e)$

In addition to the manner modification in (39), there are other evidence for parallel behaviors of eventive and stative verbs. For example, Landman (2000) points out that state sentences allow the same kind of entailment as event sentences.

(41) a. I knew her well by face from television.
b. I knew her well.
c. I knew her by face.
d. I knew her from television.
e. I knew her.

(42) a. Fido hit Garfield hard on the head with his paw.
b. Fido hit Garfield hard.
c. Fido hit Garfield on the head.
d. Fido hit Garfield with his paw.
e. Fido hit Garfield.

The uniform treatment of eventive and stative verbs, however, raises some questions. First, the entailment pattern in (41) and (42) appear to be different. It is controversial whether (41c) and (41d) entail (41b) or (41e). If I know someone only by face from television, can I say that I know her (well)? By contrast, (42b), (42c) and (42d) clearly entail (42e). Second, in many cases in (39) above the adverbs modifying states are not manner adverbs but rather interpreted as degree adverbs. For example, in (43a), *well* indicates the quality of speaking, but in (43b), *well* characterizes a degree of knowledge, rather than the quality of knowledge. It is puzzling why so many adverbs that are interpreted as manner modifiers when they combine with eventive verbs (e.g., *firmly*, *well*) should be reinterpreted as degree modifiers when they are combined with stative verbs.

(43) a. I speak Korean well.
b. I know Korean well.

Third, a manner adverbial modification of stative verbs is also highly lexically restricted. The adverbs *passionately* and *well*, for example, combine with practically any agentive eventive predicate, but can only combine with a small number of stative predicates (*hate*, *want*, *desire*). A high degree of love is normally expressed as in (44a), whereas a high degree of knowledge is typically expressed as in (44b).

(44) a. Fido loves Garfield deeply/*well.
b. Fido knows that *deeply/well.

It is awkward to say *know passionately*, *depend on passionately* or *love well*. It is hard to explain this selectivity solely on the basis of semantics of stative verbs.

5.4.2 Analyses Without Coercion

Let us hypothesize instead that eventive verbs like *speak* have an event argument, while stative verbs like *know* have a degree argument. Then, the contrast in the interpretation of *well* in (43) above can be explained. Chapter 3 noted that, like adjectives, verbs can be classified as gradable (scalar) and non-gradable (non-scalar) predicates. Gradable verbs as well as stative verbs can combine felicitously with the adverbial phrase *very much*, as in (45), and can be used in the comparative, as in (46).

(45) a. Fido <u>loves</u> Garfield <u>very much</u>.
b. I <u>cooled</u> the soup <u>very much</u>.

(46) a. Fido <u>loves</u> Garfield <u>more</u> than Kitty.
b. The soup is <u>cooler than</u> ice cream.

Note that stereotypical stative verbs such as *love*, *know*, *want*, *desire*, *believe*, *depend*, *appreciate* and *resemble* are all gradable. Only a small class of stative verbs, like *own*, *contain*, *belong* and *consist of*, is non-gradable, which is expected to reject the modification by *very much*.

(47) a. *Fido <u>owns</u> a bone <u>very much</u>.
b. *Fido <u>belongs to</u> me <u>very much</u>.

As previously discussed, Kennedy (2001) analyzes gradable adjectives as a relation between individuals and degrees on a scale. Perhaps we can give a similar treatment to state verbs. To do so, we need to answer the following questions. Is there a maximal degree of liking? Are the standards for knowing contextual or absolute? Morzycki (2015) suggests tests such as the cooccurrence with the adverb *completely* and the entailments associated with the comparative to answer these questions. As we see in (48), *depend (on)*, which occurs naturally with *completely*, seems to be associated with a closed scale, while *like*, which does not, appears to be associated with an open scale.

(48) a. Fido <u>depends on</u> Spot <u>completely</u>.
b. *Fido <u>likes</u> Spot <u>completely</u>.

The verb *like* seems to require a contextually specified standard, contrasting with the verbs *love* and *hate*, which seem to require only minimal standards. This follows from the entailments in the comparative; (39a) can be true even if Fido does not like either Garfield or Spot, while (49b) can only be true if Fido hates both of them.

(49) a. Fido <u>likes</u> Spot more than Garfield.
b. Fido <u>hates</u> Garfield more than Spot.

Katz (2003) treats stative verbs as a vague predicate, as (50) represents, where $\preccurlyeq$ is an ordering relation on the scale. In this analysis, *Fido knows Garfield* is true if and only if there is an eventuality of Fido knowing Garfield to a degree that surpasses the contextually given standard of comparison of knowing someone (indicated by d_c in (50)). Postulating an extra degree argument for stative verbs obviates the need to assume that manner adverbials coerce stative verbs to become event verbs.

(50) $\exists d.\text{know}'(\text{f}, \text{g}, d) \wedge d_c \preccurlyeq d$

To be consistent with our practices so far, we will treat stative verbs uniformly as transitive verbs that only differ in their semantic types, as represented in (51). *Own* in (51a) is a punctual stative verb that describes an instantaneous transition in ownership; *depend on* in (51b) is a bounded durative stative verb that has a maximum degree of depending on something/someone; *hate* in (51c) is an unbounded durative stative verb that only requires a minimum degree of hating.

(51) a. $[\![own]\!] = \lambda y \lambda x \lambda e.\text{own}'(x, y, e)$ $\langle e, \langle animate, \langle punctual, t\rangle\rangle\rangle$
b. $[\![depend\ on]\!] = \lambda y \lambda x \lambda e.\text{depend-on}'(x, y, e)$ $\langle e, \langle animate, \langle bounded\text{-}durative, t\rangle\rangle\rangle$
c. $[\![hate]\!] = \lambda y \lambda x \lambda e.\text{hate}'(x, y, e)$ $\langle e, \langle animate, \langle unbounded\text{-}durative, t\rangle\rangle\rangle$

Reflection

- What are the semantic differences between stative verbs that are and are not compatible with manner adverbs?
- Why is it desirable to avoid coercion analyses for stative verbs? What are the advantages of treating stative verbs uniformly that differ only in their semantic types?
- We have seen so far not only eventive verbs, but also stative verbs rely on the notion of scales. We have also observed that some entities (e.g., books) are structured and gradable. Why do you think the notion of scale is important in lexical semantics?

5.5 Conclusion

This chapter investigated logical polysemy and type coercion. Polysemy and coercion reveal that the semantic composition is much more complex and richer than has traditionally been assumed. A mechanical function application between arguments and functions does not work when the predicate selects only particular aspects of its argument, or the argument introduces new information beyond what it contributes as an argument to the function within the phrase. We put forward the concept of the co-compositionality, in which some sort of fine-tuning occurs when predicates take arguments. We applied this treatment to complement and aspectual coercion, event interpretations of stative verbs, as well as general verbal polysemy.

Points to Remember

- Most words are polysemous whose meanings are logically related. The SEL model ignores any logical relations between the senses and thus is undesirable.
- There are different approaches to polysemy. Literalism postulates the core/literal meaning of a word and uses type shifting operators to derive other meanings. Over-specification approaches argue for an exhaustive listing of all meanings and selection whereas under-specification approaches propose an abstract, summary representation that encompasses its different senses. Verbal polysemy seems to be best captured by under-specification analyses.
- The phenomena of coercion include complement coercion, where object argument is coerced to denote an event, and aspectual coercion, which is the shift of lexical aspect under the influence of adverbs, direct object, and grammatical tense and aspect. Instead of complicating the denotation of a restricted set of verbs or introducing extraneous type shifting operators, we maintain our type-restricted application with many-sorted types, while dealing with these by invoking structured individuals.
- Stative verbs can be modified by manner adverbs, raising the question whether stative verbs are coerced to eventive verbs. It is possible to analyze them without coercion by treating them as vague.

Technical Terms to Remember

1. **Zeugma effect:** A polysemous word bans copredication in different senses.
2. **Co-compositionality:** Some sort of “fine-tuning” or “augmenting” occurs when predicates take arguments.
3. **Literalism:** Each polysemous word has a literal, denotational meaning and the rest of senses is generated through linguistic rules, coercion, or pragmatic inferences.

4. **Over-specification**: The meaning of a polysemous word includes all of its different senses that are stored in a single representation and senses are selections of the total meaning of the word.
5. **Under-specification**: The meaning of a polysemous word is an underspecified, abstract and summary representation that encompasses its different senses.
6. **Complement coercion:** Aspectual verbs and psych-verbs coerce the entity-denoting complement into an event-denoting type, which is made possible by the fact that artifact nouns such as *book* has its purpose, e.g., reading., as part of its lexical meaning or as a result of an application of some kind of type-shifting rule.
7. **Higher order predicate:** Predicates that take properties as arguments, like quantified NPs.
8. **First order predicate:** Predicates that take only individuals (constant or variable) as their arguments.
9. **Structured individual:** An entity that can be mapped onto a totally ordered scale with respect to certain dimensions (material, spatial, temporal, abstract, etc.).
10. **Aspectual coercion:** The shift of lexical aspect (Aktionsart) under the influence of adverbs, direct object and grammatical tense and aspect.

Suggested Reading

See Pustejovsky (2012) for the concept of co-compositionality. See Vincente (2018) for different theoretical approaches to polysemy. See Piñango and Deo (2016) for a more rigorous analysis of complement coercion. There is rich literature on aspectual coercion. See the cited works in this chapter. See Katz (2003) for more details of stative verbs as vague predicates.

Practice

1. List at least two distinct but related senses of the following polysemous verbs and provide examples in which each sense becomes salient.

(a) *kill*

Cause to die*: I killed the bug.*
Terminate: *You killed the mood.*
Waste*: I killed the day watching TV.*

(b) *open*
(c) *fire*
(d) *bake*
(e) *carve*
(f) *drive*

(g) *fall*
(h) *declare*
(i) *admit*
(j) *deny*

2. Analyze the verbs in 1 using the SEL model.
(a) *kill*
a. $[\![kill_1]\!] = \lambda y \lambda x \lambda e.\textbf{cause-to-die}'(x, y, e)$
b. $[\![kill_2]\!] = \lambda y \lambda x \lambda e.\textbf{terminate}'(x, y, e)$
c. $[\![kill_3]\!] = \lambda y \lambda z \lambda x \lambda e.\textbf{waste-doing}'(x, y, z, e)$

3. Provide co-compositional under-specification analyses of the examples in 1.
(a) *kill*

a.	$[\![kill]\!]$	$\Rightarrow$	$[\![kill\ \_\_\__{animate}]\!]$
	$\lambda e.\textbf{kill}'(e)$		$\lambda x_{animate} \lambda e.\ \textbf{cause-to-die}'(e) \wedge theme(e) = x_{animate}$
	$\langle punctual\text{-}event, t\rangle$		$\langle animate, \langle punctual\text{-}event, t\rangle\rangle$
b.	$[\![kill]\!]$	$\Rightarrow$	$[\![kill\ \_\_\__{inanimate}]\!]$
	$\lambda e.\textbf{kill}'(e)$		$\lambda x_{inanimate} \lambda e.\ \textbf{terminate}'(e) \wedge theme(e) = x_{inanimate}$
	$\langle punctual\text{-}event, t\rangle$		$\langle inanimate, \langle punctual\text{-}event, t\rangle\rangle$
c.	$[\![kill]\!]$	$\Rightarrow$	$[\![kill\ \_\_\__{time}]\!]$
	$\lambda e.\textbf{kill}'(e)$		$\lambda x_{time} \lambda e.\textbf{waste}'(e) \wedge theme(e) = x_{time}$
	$\langle punctual\text{-}event, t\rangle$		$\langle time, \langle punctual\text{-}event, t\rangle\rangle$

4. Based on the multiple senses of the following verbs, come up with an abstract summary meaning that pertains to all senses and represent it using meaning postulates.
(a) *drive* (operate, provide power, force, motivate)
$\forall x \forall y \forall e.\textbf{drive}'(x, y, e) \rightarrow \textbf{cause}'(x, \textbf{move}'(y))$

(b) *acquire* (buy, learn, take on a property)
(c) *absorb* (learn, soak up, pay)
(d) *fire* (shoot, dismiss, provide energy)
(e) *expire* (become invalid, die)

5. Which ones are examples of complement coercion and which ones are examples of aspectual coercion?
(a) *Fido finished the bone.*
complement coercion

(b) *Fido ran to the house.*
(c) *Fido enjoyed the bone.*
(d) *Fido is loving the bone.*
(e) *Fido endured the race.*
(f) *Fido hopped for two minutes.*
(g) *The train arrived late for two weeks.*
(h) *I started dinner.*
(i) *I suddenly knew the answer.*
(j) *I continued the movie.*

6. Provide compositional analyses of the sentences containing aspectual verbs with and without coercion.

(a) *I finished the novel.*

$\llbracket \textit{finished} \rrbracket = \lambda P \lambda x \lambda e \exists e'.\text{finished}'(x, e, e') \wedge P(e')$ $\quad \langle\langle \textit{eventuality}, t\rangle, \langle \textit{entity}, \langle \textit{punctual-event}, t\rangle\rangle$

$\textit{telic}(\text{n}) = \lambda e.\text{read}'(x, \text{n}, e)$ $\quad \langle \textit{eventuality}, t\rangle$

$\llbracket \textit{finished} \rrbracket(\textit{telic}(\llbracket \textit{the novel} \rrbracket)) = [\lambda P \lambda x \lambda e \exists e'.\text{finished}'(x, e, e') \wedge P(e')](\lambda e.\text{read}'(x, \text{n}, e))$

$= [\lambda x \lambda e \exists e'.\text{finished}'(x, e, e') \wedge \lambda e.\text{read}'(x, \text{n}, e))](e')$

$= \lambda x \lambda e \exists e'.\text{finished}'(x, e, e') \wedge \text{read}'(x, \text{n}, e')$ $\quad \langle \textit{entity}, \langle \textit{punctual-event}, t\rangle\rangle$

$\llbracket \textit{finished the bone} \rrbracket(\llbracket I \rrbracket) = [\lambda x \lambda e \exists e'.\text{finished}'(x, e, e') \wedge \text{read}'(x, \text{n}, e')](\text{s})$

$= \lambda e \exists e'.\text{finished}'(\text{s}, e, e') \wedge \text{read}'(\text{f}, \text{n}, e')$ $\quad \langle \textit{punctual-event}, t\rangle$

OR

$\llbracket \textit{finished} \rrbracket = \lambda y_{scalar} \lambda x \lambda e.\text{finished}'(x, y_{scalar}, e)$ $\quad \langle \textit{entity}_{scalar}, \langle \textit{entity}, \langle \textit{punctual-event}, t\rangle\rangle\rangle$

$\llbracket \textit{the novel} \rrbracket = \text{n}$ $\quad \textit{object}_{scalar}$

$\llbracket \textit{finished} \rrbracket(\llbracket \textit{the novel} \rrbracket) = [\lambda y_{scalar} \lambda x \lambda e.\text{finished}'(x, y_{scalar}, e)](\text{n})$

$= \lambda x \lambda e.\text{finished}'(x, \text{n}, e)$ $\quad \langle \textit{object}, \langle \textit{punctual-event}, t\rangle\rangle$

$\llbracket \textit{finished the novel} \rrbracket(\llbracket I \rrbracket) = [\lambda x \lambda e.\text{finished}'(x, \text{n}, e)](\text{s})$

$= \lambda e.\text{finished}'(\text{s}, \text{n}, e)$ $\quad \langle \textit{punctual-event}, t\rangle$

(b) *I started dinner.*

(c) *I continued the movie.*

7. Provide compositional analyses of the following sentences using higher-order predicates.

(a) *Every dog runs.*

a. $\llbracket \textit{every dog} \rrbracket = \lambda P \forall x.\text{dog}(x) \rightarrow P(x)$ $\quad \langle\langle \textit{animate}, t\rangle, t\rangle$

b. $\llbracket \textit{runs} \rrbracket = \lambda y.\text{run}(y)$ $\quad \langle \textit{animate}, t\rangle$

c. $\llbracket \textit{every dog} \rrbracket(\llbracket \textit{runs} \rrbracket) = [\lambda P \forall x.\text{dog}(x) \rightarrow P(x)](\lambda y.\text{run}(y)) = [\forall x.\text{dog}(x) \rightarrow \lambda y.\text{run}(y)](x) = \forall x.\text{dog}(x) \rightarrow \text{run}(x)$ $\quad t$

(b) *Some dog runs.*

(c) *Two dogs run.*

8. Provide co-compositional under-specification analyses of the following verb phrases.

(a) *run the race*

$\llbracket \textit{run} \rrbracket$	$\Rightarrow \llbracket \textit{run} \_\_\__{quantizable} \rrbracket$	$\Rightarrow$	$\llbracket \textit{run the race} \rrbracket$
$\lambda e.\text{run}'(e)$	$\lambda x_{quantizable} \lambda e.\text{run}'(e) \wedge \textit{theme}(e) = x_v$		$\lambda e.\text{run}'(e) \wedge \textit{theme}(e) = \text{r}$
$\langle \textit{process}, t\rangle$	$\langle \textit{quantizable}, \langle \textit{bounded-durative-event}, t\rangle\rangle$		$\langle \textit{bounded-durative-event}, t\rangle$

(b) *run to the park*
(c) *run for two hours*
(d) *climb the mountain*
(e) climb to the top

9. Explain why the following sentences are ungrammatical.
(a) **This book contains valuable information very much.*
***Contain* is not gradable and cannot be modified by degree adverbs.**

(b) **I like this book completely.*
(c) **I own this book very much.*
(d) **I love this book well.*
(e) **This book belongs to me very much.*

10. Provide the denotations and types for the following stative verbs.
(a) *love*
$[\![\textit{love}]\!] = \lambda y \lambda x \lambda e.\mathbf{love}'(x, y, e) \quad \langle \textit{entity}, \langle \textit{animate}, \langle \textit{unbounded-durative}, t \rangle\rangle\rangle$

(b) *depend on*
(c) *know*
(d) *like*
(e) *appreciate*

Notes

1 We will discuss nominal polysemy in Chapter 8 when we analyze metonymy and metaphor.
2 We will discuss the functional/telic role of artifact nouns in more detail in Chapter 6.

Part III

Nouns

6 Theories of Nouns

6.1 Names

6.1.1 Criteria of Identity

We commonly think of nouns as referring expressions that we use to pick out something in the world to talk about. However, this simple and seemingly unproblematic idea raises many questions. For one thing, in order to "pick out" something, we should know what constitutes a "thing," something's identity, and how we know whether two things are the same or different. In this and the next two chapters, we will explore the semantics of nouns, answering these questions and others.

We already know that nouns do not always denote particular individuals. Only proper names like *Fido* and *Florence* pick out specific entities in the world, the actual flesh-and-blood dog Fido and the actual province Florence in Italy, respectively. Common nouns like *dog* and *cat*, on the other hand, do not refer to a specific entity in the world. In (1a), *cat* cannot be referring to any individual cat. Instead, it draws our attention to all those things that are actually cats, i.e., the set of all cats. (1a) simply tells us that that set of all cats that *cat* refers to does not include Fido as its member, as represented in (1b).

(1) a. Fido is not a cat.
 b. Fido $\notin [\![cat]\!]$

Accordingly, common nouns refer to properties of individuals, rather than individuals themselves. Their semantic type is $\langle e, t\rangle$, the set of all individuals that satisfy the property.

Because common nouns, intransitive verbs and adjectives are uniformly property-denoting (i.e., general type $\langle e, t\rangle$), they are not fundamentally different from one another when it comes to criteria of application. Just like knowing the meaning of *Italian* and *run* helps identify the entities that are Italian and those who run, respectively, knowing the meaning of *dog* allows us to identify which things are dogs. (2a) describes a function that maps an entity x in D to 1 (true) if and only if x is a dog, yielding a set of all dogs

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in the world. Note that a verb in (2b) and an adjective in (2c) describe the same kind of function, generating a set of all runners and a set of red things, respectively.[1]

(2) a. $[\![dog]\!] = \lambda x.\text{dog}'(x)$
b. $[\![run]\!] = \lambda x.\text{run}'(x)$
c. $[\![red]\!] = \lambda x.\text{red}'(x)$

If nouns are not fundamentally different from verbs and adjectives in terms of criteria of application, then what distinguishes nouns from the other categories? Gupta (1980), based on Geach (1962), uses **criteria of identity** that provide standards of sameness to distinguish nouns from other lexical categories. Different nouns come with different criteria of identity. He cites (3) as an example; despite the truth of (3a), the inference from (3b) to (3c) is invalid because the same person can be counted for different passengers.

(3) a. Every passenger is a person.
b. National Airlines served at least 2 million <u>passengers</u> in 1975.
c. National Airlines served at least 2 million <u>persons</u> in 1975.

To indicate the sameness of identity, linguists utilize a **referential index system** that places the same numerical subscript on the nouns that denote the same entity, as (4) illustrates. These examples also show that nouns can be the **antecedents** to pronouns and reflexives. Pronouns (*she/her, he/him, it*) and reflexives (*himself, herself, itself*) need full nominal antecedents (e.g., *Fido, every cat*) to fix their denotations. The anaphoric dependency is marked by the same subscript index 1 in (4).

(4) a. <u>Fido</u>$_1$ adores <u>his</u>$_1$ master.
b. <u>Every cat</u>$_1$ admires <u>itself</u>$_1$.

Verbs and adjectives, by contrast, lack these abilities; Baker (2004) cites (5) to show that the genitive NP can bind a reflexive pronoun, whereas the adjective whose meaning is almost the same as the NP cannot.

(5) <u>Albania's/*The Albanian</u> destruction of itself grieved the expatriate community.

Due to the criteria of identity specific to them, nouns can name things and appear in canonical argument positions as subjects and objects, while adjectives and verbs cannot (Baker, 2004), as in (6).

(6) a. A mistake in <u>judgment/*proud/*brag</u> led his downfall.
b. I admire a good <u>joke/*sincere/*sing</u>.

To investigate the nominal semantics, we need to identify the broader aspects of noun meaning grammar is sensitive to, which will help determine their semantic types. Just like verbs, nouns belong to grammatically significant categories, such as mass, count, natural kind, artifact, eventuality and abstract nouns. Next, we aim to discover the principles that relate them to the grammar, explaining (in)compatibility of function composition due to type (mis)match. In particular, how different aspects of a noun can be accessed by different predicates and modifiers, and how the selective composition can be semantically analyzed are important questions that need a careful study. We will explore the noun meaning in this and the next two chapters, starting with the semantics of proper names.

6.1.2 Names as Rigid Designators

The question of whether **proper names** are directly referential or have descriptive contents is an issue raised since the birth of formal semantics. Contrary to the common assumption at the time that names are purely referential, whose sole function is to pick out a referent, Frege, to account for the contrast between (7a), which is not informative, and (7b), which is, argued that names are descriptions, e.g., "the bright star that is seen in the morning/evening." If names were directly referential, both names denote the same entity, namely, the planet Venus, and (1a) and (1b) would have the same semantic content, leaving it unexplained why (1a) is a tautology but (1b) describes an important astronomical discovery.

(7) a. Hesperus is Hesperus.
    b. Hesperus is Phosphorus.

The position that names are directly referential expressions, however, found strong advocates later in Marcus (1961), Kripke (1980) and Kaplan (1978), and has been a standard account of proper names. Evidence comes from semantic differences between proper names and definite descriptions. Proper names refer to the same individual in all possible worlds, whereas definite descriptions can pick out different individuals in different possible worlds. For example, *Joe Biden* refers to the actual person Joe Biden under any circumstances, whereas *the president* denotes different people in different times and worlds. As previously discussed, Frege (1892) has established the variable meanings that hinge on different scenarios to be "sense," distinguishing it from actual reference. This gives us a logical tool to differentiate the meaning of proper names and definite descriptions: Although their references coincide under certain circumstances, their senses differ. Proper names lack any descriptive content but instead their sole function is to pick out particular referents. For this reason, Kripke (1980) and Putnam (1975) call them **rigid designators**. A rigid designator designates the same object in all possible worlds in which that object exists and never designates anything else. As a result, proper names are not affected by a logical operator like a quantifier or an attitude verb. Consider Maier's (2009) examples in (8). (8a) means that the actual Mary is mistakenly thought by some people as bearing a different name, *Martha*. The name *Mary* here is interpreted in the actual world and does not vary in one possible world to another, which represent different people's belief states. Therefore, they are purely referential expressions, rigidly designating a particular (known) individual in the context. If the name is replaced with the definite description, as in (8b), the sentence is no longer felicitous because it attributes a contradictory belief to some people.

(8) a. Some people think that <u>Mary</u> is called Martha.
b. #Some people think that <u>the person called Mary</u> is called Martha.

One way to salvage (8b) is to assign a wide scope to the definite description, allowing it to escape the scope of the attitude verb. However, Maier (2009) points out that such a move will not suffice to explain the difference between the contingent (9a) and the tautological (9b) because in this case there is no scope relation involved.

(9) a. Mary is called Mary.
b. The person called Mary is called Mary.

If a name is devoid of any descriptive sense, then there has to be a different way to explain the relation between names and the thing it names. According to Kripke (1980), the link is created through the original naming action by those who had direct contact/acquaintance with the named thing, which then passed down to other people who borrowed the ability to use the name. Evans (1982), on the other hand, emphasizes the role of community, arguing that names derive from conventional patterns in society. That is, a name refers to a thing if it is common knowledge within the community that people use the name to refer to its referent, which does not require the direct acquaintance or a causal chain connecting to those who had direct acquaintance. When hearing a name people typically assume that there is a thing that the name refers to, forming a "vicarious" link between them (Maier, 2016).

6.1.3 Fictional Names

If names are rigid designators, fictional names are problematic because they do not refer to anything in the actual world. For example, it is controversial whether (10) is a proposition that can be determined as true or false.

(10) <u>Sherlock Holmes</u> smokes a pipe.

Russell (1905) thought that fictional names were not genuine names. Instead, he considered them to be definite descriptions combining all the properties attributed to a specific character in the story by the author. Under this analysis, if anyone is the unique intelligent English detective who lives at 221B Baker Street, smokes the pipe, etc., then that person is Sherlock Holmes. Such view, called "**descriptivism**," has some problems pointed out by Kripke (1980). If there actually was someone who satisfied all the properties of Sherlock Holmes, then we have to conclude that he existed according to the descriptivism. This clearly was not Conan Doyle's intention. It should not matter whether there actually existed someone who satisfies all the description of Sherlock Holmes or not because that person still cannot be Sherlock Holmes in Doyle's story. Furthermore, if fictional names are simply descriptions, then it would be impossible to imagine alternative circumstances or worlds in which those descriptions are not true. But it is easy to imagine a situation where Holmes is not a pipe smoker. Lastly, it is possible to disagree on a character's properties. In (11), A and B seem to have a genuine disagreement about whether Gregor Samsa turned into a cockroach or a beetle when he woke up in the beginning of Franz Kafka's novel *Metamorphosis*. Obviously, disputes can happen only when we have different attitudes toward one and the same object.

(11) A: Gregor Samsa was transformed into a cockroach.
B: No, he was not. Gregor was transformed into a beetle.

On the other side of the debate is what is called **direct referentialism**. Direct referential theories hold that fictional names have no truth-conditional content. Evans (1982) and Walton (1990) argue that the author pretends to use fictional names as if they refer but since nothing is actually asserted, sentences containing fictional names are false. If this is correct, we cannot distinguish (10) from (12) since both sentences are false. This is unintuitive.

(12) Sherlock Holmes lives at 221B Baker Street.

Moreover, both (13a) and (13b) will be equally false because neither Holmes nor Watson is a member of the set of smokers. Yet, ordinary people who read *A Study in Scarlet* or know about it would immediately accept (13a) as true and (13b) as false.

(13) a. Holmes smokes.
b. Watson smokes.

Since neither descriptivism nor referentialism of fictional names is entirely satisfactory, we need to find a compromise.

Note that fictional characters actually exist in the actual world as abstract artifacts that have the same ontological category as novels and plots (Braun, 2005; Salmon, 1998; Thomasson, 1999). In (14), *Sherlock Holmes* refers to the character.

(14) Sherlock Holmes is a character in Conan Doyle's novels.

Braun (2005) argues that the author's intention disambiguates between a singular proposition containing names referring to a character and a non-referring gappy proposition. According to him, unfilled ("gappy") propositional structures like <__, smokes> can be asserted and believed. Similarly, Sales (2013) proposes that if the author intends to use a name to refer to a character she created, it is referential, and if she lacks such intention, the proposition containing the name is an open, gappy one. The author's intention can also change over time or even indeterminate. This is similar to hybrid accounts that employ a direct reference theory for names outside of fiction (as referring to characters) and a descriptive theory for names within fiction (Currie, 1990). However, these ambiguity accounts are less parsimonious. It would be better if we could provide a unified account for both actual names and fictional names.

Stokke (2021) offers such a unified account. He argues that fictional names are individual concepts, functions from possible worlds to individuals. However, the function is also mediated by roles, constituted by sets of properties. So, there is some component of descriptivism, as well. A fictional character is not an individual but a role that can be filled by an individual. For example, the fictional name *Sherlock Holmes* denotes the function from a possible world *w* to the unique individual *x* in *w*, if he exists, such that *x* in *w* has all the properties constituting the role of Sherlock Holmes. Only the role exists in the actual world, and it can be filled by different individuals in different possible worlds. In this account, used non-fictionally, (12) and (13a) are neither true nor false, but used in the novel, they are true.

Reflection

- What are features common to nouns, verbs and adjectives? What are distinctive features of nouns that differentiate them from other lexical categories?
- Why are names called rigid designators? How do they differ from definite descriptions?
- Does the existence of fictional names undermine referential semantics? How would you treat fictional names in intensional semantics?

6.2 Reference to Kind

6.2.1 Interpretation of Bare Nouns

Carlson (1977) draws our attention to multiple interpretations of bare common nouns, as illustrated in (15), which can only occur in the plural form in English.

(15) a. Horses are rare. (as a group/species)
b. Horses are mammals. (all)
c. Horses have tails. (almost all)
d. Horses give birth to their foals in the spring. (many of the females)
e. Horses are running. (some)

It is highly unlikely that the bare plural noun itself is multiply ambiguous. Perhaps we can postulate a null determiner that is the plural form of indefinite *a/an* is responsible for the existential reading in (15e). This assumption runs into trouble because bare plurals and indefinites behave differently in the scope of an intensional verb, as shown in (16). While (16a) is ambiguous between Fido wanting to meet any cat or a particular cat, say, Garfield, (16b) does not mean that Fido wants to meet a particular set of cats.

(16) a. Fido wants to meet a cat.
b. Fido wants to meet cats.

Due to the ambiguity of indefinites, (17a) has contradictory and non-contradictory readings, whereas (17b) is not contradictory.

(17) a. A dog is in the backyard and a dog is not in the backyard.
b. Dogs are in the backyard and dogs are not in the backyard.

Likewise, (18a) and (19a) are ambiguous between specific versus non-specific indefinite readings, but (18b) and (19b) are not, having only a non-specific reading.

(18) a. Every dog met a cat.
b. Every dog met cats.

(19) a. Fido didn't eat a bone.
b. Fido didn't eat bones.

Furthermore, if bare nouns were ambiguous, any sentences containing them would be multiply ambiguous, which is not the case. In (20), the same bare noun is predicated with a generic and an existential predicate conjoined, further demonstrating that bare nouns cannot be ambiguous between *some* and *most* readings (Schubert and Pelletier, 1987).

(20) <u>Dogs</u> are noisy animals and are barking outside right now.

6.2.2 Object, Kind and Stage

To explain the puzzling behavior of bare plurals, Carlson (1977) suggests a distinction between the species of horse, an abstract entity called **kind**, and the ordinary object horses. In addition to kinds and objects, he further postulates spatiotemporal slices of individual horses called **stages**. Stages are defined in terms of individuals. (21) is read "the set of all things x such that x bears the relation R to Fido," where R is a realization relation that says, "have a stage of."

(21) $\lambda x.R(x, \mathrm{f})$

Carlson (1977) make a distinction between **individual-level** and **stage-level predicates** among stative predicates. The former describes a more permanent property, whereas the latter expresses a temporary property. Individual-level predicates like *is smart* are directly predicated of the individual Fido, as in (22a), whereas stage-level predicates like *is hungry* are predicated of one of his realizations, as in (22b).[2]

(22) a. $[\![\textit{Fido is smart}]\!] = [\lambda x.\mathrm{smart}'(x)](\mathrm{f}) = \mathrm{smart}'(\mathrm{f})$
b. $[\![\textit{Fido is hungry}]\!] = [\lambda y \exists x.R(x, y) \wedge \mathrm{hungry}'(x)](\mathrm{f}) = \exists x.R(x, \mathrm{f}) \wedge \mathrm{hungry}'(x)$

The bare plural *horses* invariably refer to the kind, and its different interpretations in (15) come from the predicates, which can be kind-, object- or stage-level. *Be rare* in (15a) is a kind-level predicate because only kinds can be rare. Hence, it can directly combine with *horses* to express the proposition that the kind horse is rare.

(23) $[\![\textit{horses are rare}]\!] = [\lambda x.\mathrm{rare}'(x)](\mathrm{h}) = \mathrm{rare}'(\mathrm{h})$

Have tails in (15b) is an object-level predicate which describes a more or less permanent property but allow for exceptions. Such sentences are called characterizing or **generic sentences**. By contrast, universally quantified sentences do not allow exceptions. (24a) is true if an occasional potato lacks vitamin C, but (24b) will be false in that situation.

(24) a. Potatoes contain vitamin C.
b. Every potato contains vitamin C.

To make the composition work, the **generic operator GEN** is called for. As shown in (25), GEN is a two-place operator that relates the set of bare noun denotations to the set of predicate denotations, engendering "almost all" reading (Carlson, 1989). (15d) will receive a similar treatment with a more restricted domain of female horses.

(25) $[\![\textit{horses have tails}]\!] = \textsc{gen}\,x.\text{horses}'(x)(\text{have-tails}'(x))$

Finally, *are running* in (15e) is a stage-level predicate that denotes a temporary property. The sentence can be logically translated in (26) in terms of the *R* operation in (21) above.

(26) $[\![\textit{horses are running}]\!] = \exists x.R(x, \text{h}) \wedge \text{run}'(x)$

Therefore, no noun is inherently kind-denoting but ambiguous between kind-denoting and object-denoting (Carlson and Pelletier, 1995; Krifka, 2003). Their interpretation as kind-denoting largely depends on the predicate, e.g., *rare* or *is extinct* selects for kind-denoting noun.

6.2.3 Nominalization and Predicativization

The denotation of mass nouns is also claimed to be names of a kind, rather than a set of individuals (Carlson, 1977; Chierchia, 1998; Krifka, 2003; Krifka et al. 1995; Lasersohn, 2011). *Nylon* in (26) do not denote any specific nylon but the kind nylon.

(27) Nylon was invented in 1935.

However, if we assume that mass nouns exclusively refer to names of kinds, we will lose a uniform treatment of mass and count nouns; the former will be of individual type *e*, and the latter will have the property type $\langle e, t\rangle$. We also cannot explain how mass nouns can combine with (quantificational) determiners, as in (28a), and occur as predicates, as in (28b). To explain (28), mass nouns must be able to not only denote names but also properties.

(28) a. This water is clean.
b. This is clean water.

Those who claim that common nouns denote names of kinds postulate some operation that turns kinds to set of individuals to solve this problem. For example, Chierchia (1998) uses the up ($^{\cup}$) and down ($^{\cap}$) operators to connect properties to kinds and vice versa. Assuming that each property has an individual counterpart, he views kinds as "**nominalization**" of common nouns, as in (29a), and common nouns as "**predicativization**" of kinds, as in (29b).

(29) a. $^{\cap}$dog = d
b. $^{\cup}$d = dog

Semantically, then, kind is identified with the totality of its referents. For example, the dog-kind is a function from worlds to the sum of all instances of the kind, captured by the **iota (ι) operator** in (30) (Chierchia, 1998).

(30) For any property P and world w, $^{\cap}P = \lambda w.\iota P_w$ is in the set of kinds where P_w is the extension of P in w.

Type-shifting is in fact pervasive in nominal domain (Partee, 1987). In addition to nominalization and predicativization, names (e) should be able to be lifted to quantifiers ($\langle\langle e, t\rangle, t\rangle$) when they are conjoined with the latter, as in *Fido and every cat*. Definite descriptions like *the dog* are commonly treated as quantifiers ($\langle\langle e, t\rangle, t\rangle$), but are lowered to (unique) individuals satisfying the description (e). Common nouns like *dog* are properties ($\langle e, t\rangle$), which become quantifiers ($\langle\langle e, t\rangle, t\rangle$) when preceded by determiners like *the* and *a*. Quantifiers ($\langle\langle e, t\rangle, t\rangle$) in the predicate position, as in *Fido is the dog*, denote properties ($\langle e, t\rangle$). Bare plurals like *dogs* and mass nouns like *water* are names of kinds (e), which can be shifted to properties of plural individuals ($\langle e, t\rangle$) via predicativization (up) operation. The opposite direction of shifting happens with nominalization (down) operation (Chierchia, 1998). Figure 6.1 show various type-shifting operators mapping between individuals, properties and quantifiers in English, from Partee (1987, p. 362).

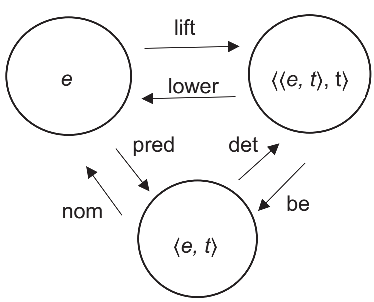

Figure 6.1 Type-shifting operators.

Reflection

- What are the motivations for claiming that bare nouns refer to names of kinds? If we do not accept the distinction between kinds, objects and stages, how can we explain the multiple interpretations of bare nouns?
- Chierchia (1998) and Krifka (1995) argue that Chinese nouns uniformly denote kinds because the language lacks the mass and count distinction, and all nouns are mass. Do you find this hypothesis plausible? What would be some consequences of such a claim?
- Why do you think type shifting is common in nominal domain? Do you think type shifting principles are universal? In English, nominalization and predicativization are covert, while determiners and *be* are overt type-shifters connecting properties and quantifiers. Do you think the same holds in other languages? What about articleless languages like Chinese and Korean?

6.3 Qualia Structure

Now that we have grasped the general behavior of nouns as a unit in a sentence, let us focus on their internal semantic structures. Since Aristotle first suggested that noun meanings are based on a structure of qualia roles, this idea has been employed by many linguists, Jackendoff (2002), Paradis (1995), Pustejovsky (1995), to name a few. Pustejovsky's (1995) Generative Lexicon (GL) is an influential theory incorporating the qualia structure. His configurational template of nouns consists of four qualia roles: the formal, the constitutive, the telic and the agentive roles, defined in (31). They encode information about certain properties of a noun, such as its constituent parts, its place in a larger structure, and activities associated with it (function and mode of creation). As briefly mentioned in the previous chapter, the qualia structure of nouns in GL can be seen as over-specification of all their aspects and facets, establishing basically a part–whole schema where one part of the schema is highlighted for each qualia role.

(31) a. **Constitutive qualia** role: the relation between an object and its constituent parts.
b. **Formal qualia** role: that which distinguishes it within a larger domain.
c. **Telic qualia** role: its purpose or function.
d. **Agentive qualia** role: factors involved in its origin or in bringing it about.

$$\begin{bmatrix} \text{house} & \\ \text{QUALIA} = & \begin{bmatrix} \text{F = building} \\ \text{C = \{door, rooms…\}} \\ \text{T = live-in} \\ \text{A = build} \end{bmatrix} \end{bmatrix}$$

Figure 6.2 Qualia structure of *house*.

Formal quale provides taxonomic information about the lexical item (the *is-a* relation). Constitutive quale gives information on the parts and constitution of an object (the *part-of* or *made-of* relation). Telic quale concerns information on purpose and function (the *used-for* or *functions-as* relation). Finally, agentive quale gives information about the origin of the object (the *created-by* relation). Examples in (32) highlight each qualia role of *house*.

(32) a. He owns a two-story house. (formal: house as artifact)
b. Lock your house when you leave. (constitutive: part of house, door)
c. We bought a comfortable house. (telic: purpose of house)
d. The house is finally finished. (agentive: origin of house)

Figure 6.2 shows a concrete example of lexical entry with qualia role specifications. GL theory maintains that all aspects of nouns such as *house* must be considered part of the meaning of the entry *house* in the lexicon.

6.3.1 Formal and Constitutive Qualia

Formal quale establishes a relation between the entity denoted by a word and the category it belongs to, answering the question "What kind of entity is it?" This relation enables us to grasp the nature of an entity by distinguishing it among other kinds. For example, a rock is a natural kind, a table is an artifact, water is substance, a dog is animate being, and so on. Traditional hyponymy relations hold between a kind and its sub-kinds, and sub-kinds inherit all the properties of their hypernymy kind. For example, *animal* is a hypernym of *dog*. Sometimes, more classifications are possible for the same type of object; a knife can be a weapon or a kitchenware. Moreover, classifications at different levels of generalization are available for reference; water can be seen as a liquid (its immediate superordinate), a fluid such as water or air (a higher superordinate) or a substance such as fluid and sand (the highest superordinate). Lexical meaning often provides default values for the different formal factors or attributes. We might assume, for instance, that the size value associated with the noun *ant* is small, when evaluated relative to the superordinate class for the noun *insect*. Default values, however, may be updated from discourse context in composition; context updates the value of the size factor from small (default) to large (for an ant) in *large ant*. Comparison classes of adjectives are suggested by specific information from the formal role, which will be discussed more extensively in Chapter 10.

We also have general knowledge about how an entity is made up, its constitutive role, e.g., a table has a top and leg(s), and a tree has a trunk, root, branches and leaves. There is a fundamental distinction between inherently individuated things, such as humans, dogs and trees, and inherently undifferentiated stuff, such as water, air and sand. This distinction, which is encoded grammatically as a mass/count distinction, is a result of how the formal role interacts with the constitutive role for a lexical item. The formal and constitutive roles are distinct for count nouns, whereas they are the same for mass nouns. For example, the formal role of the mass noun *water* is liquid, and its parts are also liquid. The count noun *car* denotes a vehicle (its formal role value), but is made of many different parts, e.g., chassis, engine, seats and so on, none of which is a vehicle by itself. We will discuss the mass/count distinction more in detail in the next chapter. The parts and constitution of an object denoted by nouns like *car* can be selectively predicated, as illustrated in (33).

(33) a. I forgot to lock the car. (door)
b. I started the car. (engine)
c. The car skidded on the icy road. (wheels)

Regarding the question as to which parts need to be formally encoded, the distribution of the noun in context helps identify lexically specified (viz., default) values. The "legitimate" parts of an object are available in discourse as individual units, make a functional contribution to the entity, and they are cognitively salient. In the context of *paint* in (34a), for example, *room* is used to reference the part represented by the wall, while in the context of *sweep* in (34b) it refers to the floor. Because of this evidence, we might consider *wall* and *floor* as default values of the constitutive quale for the noun *room*.

(34) a. I was going to paint my room.
b. I have swept the room.

Although the qualia structure has been applied to concrete entities, it can apply to other types of nouns, such as event-denoting deverbal nouns. Paradis (2005) contends, for example, the constitutional quale of a *walk* tells us that it is a type of moving along a path with a particular manner and speed, corresponding to the argument structure of its cognate verb.

6.3.2 Telic and Agentive Qualia

Telic quale regards information on purpose and function, and agentive quale provides information about the origin of an object. For example, cars can be used for driving and are put together by people in a factory. Nouns denoting natural kinds typically do not have telic or agentive qualia values, but only artifact nouns have them. Grimm and Levin (2017) point out that while natural kinds may be defined by their essences or natural properties, denotations for artifacts are typically determined in terms of an event associated with their functional meaning. Reflecting this fundamental difference, the modifier in the natural kind compound *leopard lizard* describes the skin pattern of a lizard, while the modifier in artifact compound *butter knife* designates the function of a knife (Levin et al., 2019). Further linguistic evidence exists to confirm that artifact nouns encode their telic roles. As previously discussed in terms of complement coercion, aspectual verbs like *begin* select for the telic role of the artifact noun they take as complements, as in (35a). Natural kind denoting nouns, by contrast, are more difficult to be coerced out of context, as in (35b). The GL theory argues that there is a hidden event in the lexical representation of nouns denoting objects that are made for a particular purpose.

(35) a. I began <u>a new book</u>.
b. *You began <u>the cat</u>.

The same adjective makes a reference to different events related to the artifact nouns that it modifies.

(36) a. comfortable <u>chair</u> (to sit on)
b. comfortable <u>shoes</u> (to wear, to walk in)
c. dinner <u>dress</u> (wearing)
d. dinner <u>table</u> (eating at)

As illustrated in (37), the event described by denominal verbs in noun-to-verb conversion denotes the telic function of the base nouns. For example, from the noun *shelf*, whose telic role is holding books and other similar objects, the verb *shelve* is licensed because its direct object corresponds to the argument referred to in the noun's telic value.

(37) a. I <u>shelved</u> the books.
b. I <u>faxed</u> the letter.
c. I <u>bottled</u> the wine.

The flexibility of light verbs such as *make*, *take* and *have* provides further evidence for the telic role. Specific information in the qualia structure of the complement is exploited in the overall interpretation of the construction. In (38), *take* is interpreted as *ingest* in the context of *tablet* and as *use to travel* in the context of *train*.

(38) a. I took a tablet (ingest)
b. I took a train (travel with)

Qualia pairs, a combination in which the predicate expresses one of the qualia values of the noun, are uninformative in a typical discourse context. A short passive in (39a) is infelicitous because the predicate *was painted* describe the telic role of the subject *picture*.

(39) a. *This picture was painted.
b. This picture was painted in 1604.

A middle construction in (40a) is bad precisely because it sounds redundant as it only expresses the obvious telic role of the subject *book*, i.e., reading.

(40) a. *This book reads.
b. This book reads easily.

An adjectival use of past participles in (41a) is also uninformative when they only describe the telic role of the modified noun *house*, in this case, building.

(41) a. *a built house
b. a recently built house

Agentive roles can also be made salient, as in (42).

(42) a. I completed my Ph.D. thesis in 2000. (write)
b. You wouldn't let me finish my sentence. (speak)
c. Woody Allen has started a new movie. (direct, film)
d. I began a large oil painting yesterday. (paint)

(43) shows that only the artifact noun *coffee* makes a reference to its agentive qualia role, but natural kind noun *water* does not, even when modified by the same adjective.

(43) a. fresh coffee (agentive quale = brew)
b. fresh water (in contrast to salt water)

Despite the intuitive appeal of GL's qualia structure, Asher (2011) points out problems inherent to including qualia information in the lexicon. For example, (44a) is predicted to imply that there was a reading of the book and that that event was incomplete or unfinished, contrary to fact. (44b) shows that the implicit telic event, which is assumed to be part of lexical meaning of *book*, cannot be referenced by the use of a pronoun.

(44) a. I began <u>the book</u>, but never finished <u>it</u>.
b. I began <u>the book</u>. *<u>It</u> will take three days.

GL's qualia structure does not address the generative nature of a semantic composition process. As we have discussed with regard to polysemy and coercion, over-specification approaches like GL simply select components of previously established contents in the lexical entries.

Reflection

- What are qualia structures? What are the utilities for assuming complex qualia structures for nouns? What are their problems?
- What are the differences between objects and substances, on the one hand, and artifacts and natural kinds, on the other? Explain in terms of their qualia structures.
- Should we treat the qualia structure strictly as parts of lexical meanings of nouns, as is done in Pustejovsky's (1995) Generative Lexicon theory?

6.4 Complex Types

6.4.1 Dot Objects

When defining the meaning of words, an important step has been to determine their semantic types not only to understand their nature but also to explain their composition behaviors. At first sight, deciding a semantic type for a noun seems straightforward. *Dog* and *tree* are natural kinds, *chair* and *room* are artifacts, etc. Numerous nouns, however, have more complex structures and cannot be easily classified to belong to one type or another. For example, *book* has physical copy and information aspects that cannot be separated. One of the key properties of such complex types is that they allow copredication, in which two distinct senses of a lexical item are simultaneously accessed by applying two apparent incompatible types of predicates to a single type of object. In (45a), *boring* brings out the information type of *book*, while *thick* selectively predicates its physical object type. Similarly, *speech* is an event and information at the same time, each of which is predicated in the same sentence (45b); *long* predicates the event type of *speech*, whereas *interesting* picks out the content/information type.

(45) a. The book is thick and boring.
b. The speech was long but interesting.

Predication in general involves the attribution of a property to an object considered under a certain conceptualization. To consider a book as a physical object is to think of it under a certain aspect; to consider the book as an informational object is to think of it under another aspect. The copredication of these two senses indicates that the referent of *book* remains the same and is not ambiguous. As previously observed, ambiguity/homonymy triggers a zeugma effect, rejecting copredication, as exemplified in (46). The two references of *bank*, namely, the edge of a river and a financial institution, are distinct and separate.

(46) *The bank is overflowing and specializes in IPO. (Asher, 2011)

How can we deal with the complex types? The existing theories must postulate multiple ambiguities of numerous nouns, making the system less parsimonious. To avoid multiple ambiguity, Asher (2011) and Pustejovsky (1995) evoked the concept of **dot object**. Dot objects or complex types have a symmetric internal structure consisting of two types put together by the type construction • ("dot"), which reifies the two elements into a new type. The constituents of a dot type pick up different and even incompatible aspects of the object. For instance, *lunch* is of a complex type event•food, whose two types are ontologically clearly different. When an expression is typed as a dot object, it is disambiguated in context by the selecting predicative phrase. Additional examples of nouns referring to dot objects are given below together with the predicates that select one aspect or the other.

(47) *house* (phys•location)
a. phys: *built, buy, sell, rent, own, demolish, renovate, burn down, erect, destroy, etc.*
b. location: *leave, enter, occupy, visit, inhabit, reach, approach, evacuate, inspect, etc.*

(48) *exit* (event•location)
a. event: *make, facilitate, follow, force, hasten, register, etc.*
b. location: *block, bar, take, find, mark, indicate, reach, choose, locate, etc.*

(49) *BMW* (producer•product)
a. producer: *design, build, produce, create, assemble, accept, invest, hate, etc.*
b. product: *stand, spin out of control, go on sale, etc.*

(50) *door* (phys•aperture)
  a. phys: *slam, push, pull, bang, kick, knock at, smash, hold, paint, hit, remove, damage*, etc.
  b. aperture: *pass, enter, block*, etc.

6.4.2 Product Types and the Object Elaboration

A simple analysis of a • type would be treating it as an intersective or conjunctive type. This analysis, which treats the dot type as sets of objects, does not yield the correct result because the intersection is sometimes an empty set, or does not give the right object. For example, the intersection of the type "object" and "aperture" for *door* is empty, which cannot be slammed or entered. This is not a parthood relation over the object itself, either, for we need not consider the object to be the sum of all its aspects or tropes. For example, *lunch* is wholly an event under one aspect and wholly food under another aspect not the sum of the two. Asher (2011) model complex types via a pair of types or a product, treating objects of • type are inhabitants of such a collection of pairs consisting of a component of each constituent type. The **product type** yields a constituent in a specific context, as shown in (51).

(51) a. *carrying the book*: P X I → P
  b. *reading the book*: P X I → I
  (where P is physical type and I is information type)

One aspect of the complexity of a dot type is exploited by way of predicating over that aspect only. Asher and Pustejovsky (2006) and Asher (2011) call such predications an "**object elaboration**." Copredication in (52a) is translated in (52b), in which a function selecting a constituent out of a product type operates on the noun, "elaborating" on the sort of object it is.

(52) a. <u>The book</u> weighs five pounds and is an interesting story.
  b. $\exists!x.\text{book}'(x) \wedge \text{weight-five-pounds}'(\text{f}_1(x)) \wedge \text{interesting-story}'(\text{f}_2(x))$

Reflection

- What are complex types and what are their semantic properties? How are they different from simple types? Is the boundary between simple and complex objects clear-cut?
- What does the existence of complex types imply about the semantics of nominals? Do other lexical categories behave similarly?
- How do you semantically represent complex types? Do you find Asher's product type plausible? What exactly does his shifting function do? What is the "object elaboration"?

6.5 Conclusion

This chapter began exploring the semantics of the noun by examining existing theories about them. We first discussed the semantics of (fictional) names. We explored the semantics of bare nouns in terms of the notion of kind and type-shifting principles. Common nouns were characterized by their qualia structure, consisting of formal, constitutional, telic and agentive qualia roles. Finally, we examined complex types and ways to formally represent them.

Points to Remember

- Proper names rigidly designate specific individuals whose referents do not vary from one world to another. In this way, they are distinguished from definite descriptions whose denotations are variable.
- A debate exists regarding whether common nouns denote properties or kinds. Most approaches assume the correspondence between the two domains via type-shifting.
- Common nouns carry information about their formal (*kind-of*), constitutive (*has-a*), telic (*made-for*) and agentive (*made-by*) qualia. Pustejovsky's (1995) Generative Lexicon theory treats the qualia structure as parts of lexical meanings of nouns.
- Nouns such as *book* and *lunch* have two different aspects or tropes of meaning. Asher (2011) treats them as product types whose components can be selectively predicated via the process of object elaborations.

Technical Terms to Remember

1. **Criteria of identity:** Criteria that provide standards of sameness.
2. **Referential index system:** A system that places the same numerical subscript on the nouns that denote the same entity.
3. **Antecedents:** Full noun phrases that provide referents to pronouns and reflexives.
4. **Proper names:** Nouns that lack any descriptive content but instead whose sole function is to pick out particular referents.
5. **Definite descriptions:** NPs that pick out references by virtue of their description, that is, their meaning is variable, letting it to refer to different entities given different states of affairs.
6. **Rigid designators:** Expressions that designate the same object in all possible worlds in which that object exists and never designate anything else.

7. **Descriptivism:** Fictional names are not genuine names but definite descriptions combining all the properties attributed to a specific character in the story by the author.
8. **Direct referentialism:** Real and fictional names denote individuals without any connotations associated with them.
9. **Kind:** An abstract entity obtained from the totality of ordinary objects in each possible world.
10. **Stages:** Spatiotemporal slices of individual entities.
11. **Individual-level predicates:** Predicates that describe a more permanent property.
12. **Stage-level predicates:** Predicates that express a temporary property.
13. **Generic sentences:** Sentences that describe a more or less permanent property but allow for exceptions.
14. **Generic operator GEN:** A two-place operator that relates the set of bare noun denotations to the set of predicate denotations, engendering "almost all" reading.
15. **Nominalization:** Down ($^{\cap}$) operator which connects properties to kinds by generating the totality of its referents.
16. **Predicativization:** Up ($^{\cup}$) operator which turns kinds to their individual specimens.
17. **Iota (ι) operator:** The operator that maps properties to a unique (sum of all) individuals that have the property.
18. **Constitutive qualia:** The relation between an object and its constituent parts.
19. **Formal qualia:** Taxonomic information about the lexical item (the *is-a* relation).
20. **Telic qualia:** Information on purpose and function (the *used-for* or *functions-as* relation).
21. **Agentive qualia:** Information about the origin of the object (the *created-by* relation).
22. **Dot object/complex types:** Types that have a symmetric internal structure consisting of two types put together by the type construction • (dot), which reifies the two elements into a new type.
23. **Product type:** A pair of types or a product that treats objects of • type as inhabitants of a collection of pairs consisting of a component of each constituent type.
24. **Object elaboration:** The process of predicating only over an aspect of a complex type.

Suggested Reading

Kripke (1980) is a classic reading for proper names. See Soams (2002) for cognitive significance of names. See Carlson (1977) and Carlson and Pelletier (1995) for kinds and generics, and Pustejovsky (1995) for qualia structure and complex types.

Practice

1. Explain why the inference from a-b to c is invalid.
   a. We served five hundred customers this week.
   b. Customers are persons.
   c. We served five hundred people this week.

2. Provide logical translations of the following sentences.
   (a) *Every cat$_1$ admires itself$_1$.*
   $\boldsymbol{\forall x.\mathbf{cat}'(x) \rightarrow \mathbf{admire}'(x, x)}$

   (b) *Some dogs$_1$ chased their$_1$ tails.*

3. What kind of functions do the following nominal expressions denote?
   (a) *Fido*
   The constant function from all possible worlds to Fido if he exists.

   (b) *the dog*
   (c) *the richest man in the world*
   (d) *Frodo*
   (e) *house*

4. Identify the type-shifting rules that are involved in the following expressions.
   (a) *some dog and Garfield*
   The name *Garfield* is lifted to a quantifier ($\langle\langle e, t\rangle, t\rangle$) to conjoin with *some dog*.

   (b) *is the dog*
   (c) *drink water*

5. Provide logical translations of the following sentences using Carson's theory.
   (a) *Tigers are striped.*
   $\boldsymbol{[\![\textit{tigers are striped}]\!] = \textsc{gen}x.\mathbf{tigers}'(x)(\mathbf{striped}'(x))}$

   (b) *Tigers are on the front lawn.*
   (c) *Tigers are widespread.*

6. What are the semantic types of the following nominal expressions? If they can have multiple types, list them and describe the type shifts.
   (a) *every cat*
   $\boldsymbol{\langle\langle e, t\rangle, t\rangle}$

(b) *the dog*
(c) *cat*
(d) *dogs*
(e) *air*

7. Make up sentences that highlight each qualia role of the following nouns.
(a) *house*
a. He owns a two-story house. (formal)
b. Lock your house when you leave. (constitutive)
c. We bought a comfortable house. (telic)
d. The house is finally finished. (agentive)

(b) *car*
(c) *book*

8. Explain why the following sentences are ungrammatical.
(a) **I began Fido.*
no telic role of Fido

(b) **This house was built.*
(c) **This book reads.*
(d) **I have a painted picture.*
(e) **I finished the tree.*

9. Identify the parts and constitution of the object denoted by the following nouns that are selectively predicated in the sentences.
(a) *Lock the house!*
door

(b) *Sweep the room!*
(c) *Your shoes are untied.*
(d) *The window is shattered.*
(e) *I started the car.*

10. Based on the examples provide the dot semantic types of the underlined nouns and logical translations of the examples.
(a) *I put <u>the book</u> back on the shelf because I could not understand it.*
phys•information
$\exists! x$.book′(x) ∧ put-back-on-the-shelf′(s, $f_1(x)$) ∧ ¬understand′(s, $f_2(x)$)

(b) *I picked up <u>the bottle</u> and drank the whole thing.*
(c) *I like <u>Hyundai</u> and it will be on sale this week.*
(d) *I used to work at <u>the newspaper</u> you are reading.*
(e) *<u>The speech</u> was long and full of mistakes.*

Notes

1 We are simplifying the verb denotation and not using event semantics in this chapter in order to focus on the semantics of nouns.
2 Examples of individual level predicates: *is tall, is intelligent, is altruistic, knows Korean, is a dog, is female, is a singer, loves Fido.* Examples of stage level predicates: *is drunk, is barking, is available, is speaking Korean, is sober, is sick, is in the room.*

7 Types of Nouns

7.1 Object and Substance Type Nouns

7.1.1 Many-Sorted Types in the Domain of Things

This chapter will make a more fine-grained type distinction within the domain of things. The sub-domains of D_{thing} form a hierarchical structure, described in terms of subset (⊆) and set union (∪) relations in (1) and graphically in Figure 7.1 with some representative examples. The domain of things is first partitioned into the domain of atomic objects (D_{object}) and the domain of non-atomic substances ($D_{substance}$). This division is comparable to the division between processes and events in the domain of eventualities. Like events, atomic objects have heterogeneous parts. Similar to processes, non-atomic substances have homogeneous parts. The domain of objects is further divided into the domain of natural kinds ($D_{natural\text{-}kind}$) and the domain of artifacts ($D_{artifact}$). As we will see in this chapter, the former is characterized by their natural properties, whereas the latter is associated with their function. While artifacts are inherently inanimate, natural kinds comprise of animate and inanimate objects. Animacy plays some role in semantic composition, so we will assign separate sub-domains for animate ($D_{animate}$) and inanimate natural kinds ($D_{inanimate}$). While living organisms can act voluntarily/ intentionally and are sentient, non-living things cannot and are not. The domain of substances also contains natural kinds (e.g., *water*) and artifacts (e.g., *juice*), but we will explore the distinction only in terms of objects in this chapter. The properties can easily carry over to natural kind substances and artifact substances. Nouns can also refer to events, physical states or abstract states (e.g., *jog, death, hunger, joy*). Their denotations will come from the domain of eventualities, $\mathrm{D}_{eventuality}$, in this case.

(1) a. $D_{object} \cup D_{susbstance} \subseteq D_{thing}$
b. $D_{natural\text{-}kind} \cup D_{artifact} \subseteq D_{object}$
c. $D_{animate} \cup D_{inanimate} \subseteq D_{natural\text{-}kind}$

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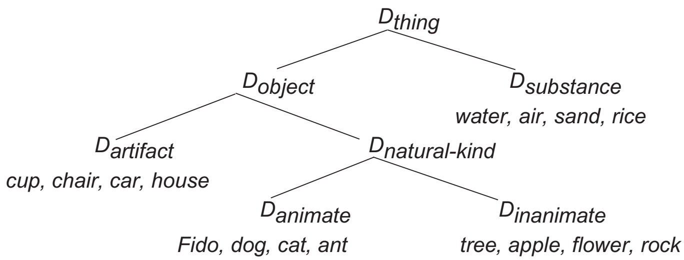

Figure 7.1 The hierarchy of many-sorted types in D_{thing}.

These categories are mapped to semantic types of nouns that the grammar is sensitive to, enabling us to grasp the nature or essence of an entity that distinguishes it from other kinds.

7.1.2 The Count Versus Mass Distinction

Things are made of inherently individuated objects, such as cats and cups, and inherently undifferentiated stuff, such as water and air. Intuitively, **objects** are entities with a clear boundary and internal integrity, whereas **substances** are unbounded stuff. Such distinction is cognitively salient and may be innate as evidenced by the fact that pre-linguistic infants can distinguish substances from objects (Soja et al., 1991). One of the defining characteristics of substance is that smaller parts of the material are still that material. For example, part of water is also water, and part of sand is also sand. This is not the case for objects. For example, a tree has many parts, such as a trunk, branches, leaves and roots, none of which is a tree by itself. Objects are things that consist of heterogeneous parts, all of which cannot be the whole object, and substances are things that consist of homogeneous parts. Krifka (1992) and Link (1983) use mereology to explain such ontological distinction. We have already discussed mereology, the study of parthood, in Chapter 4, when we logically differentiated process verbs from event verbs. The same distinction obtains in the domain of things. The axioms of mereology are given in (2). (2a) says if x is part of y and y is part of z, then x is part of z (**transitivity**). (2b) says two distinct things cannot be part of each other (**antisymmetry**). (2c) says everything is part of itself (**reflexivity**).

(2) a. $\forall x \forall y \forall z. x \leq y \land y \leq z \rightarrow x \leq z$
b. $\forall x \forall y. x \leq y \land y \leq x \rightarrow x = y$
c. $\forall x. x \leq x$

Substances are divisive, whereas objects are quantized, as defined in (3a) and (3b), where $<$is a proper part relation. A predicate P is divisive if and only if whenever it holds of something, it also holds of each of its proper parts. A predicate P is quantized if and only if whenever it holds of something, it does not hold of any of its proper parts.

(3) a. Divisive reference: $\mathrm{DIV}(P) =_{\mathrm{def}} \forall x.P(x) \rightarrow \forall y.y < x \rightarrow P(y)$
b. Quantized reference: $\mathrm{QUA}(P) =_{\mathrm{def}} \forall x.P(x) \rightarrow \forall y.y < x \rightarrow \neg P(y)$

The assumption that substances are divisive raises the question of minimal parts. For example, a hydrogen atom as part of water is not water. Therefore, we have to add **granularity parameter** that sets limits on the parts of a certain threshold (Champollion, 2017).

The ontological distinction between objects and substances is encoded as the mass/count distinction in the grammar. First, count nouns can be pluralized, whereas mass nouns cannot, as (4) shows.

(4) a. *dogs, books, tables, moments, stories*
b. **waters, *oxygens, *muds, *informations, *advices*

Second, count nouns can be preceded by numerals, whereas mass nouns cannot, as in (5).

(5) a. *two dogs, two books, two tables, two moments, two stories*
b. **two waters, *two oxygens, *two muds, *two informations, *two advices*

Third, although determiners like *some, no, the, any, a lot, more* and *less* are compatible with both count and mass nouns, determiners like *a*, *each* and *every* can only occur with count nouns, as shown in (6).

(6) a. *every dog, a book, each table, every moment, a story*
b. **every water, *an oxygen, *each mud, *every information, *an advice*

Some determiners have two forms, one for count and one for mass nouns, as (7) demonstrates.

(7) a. *many/few dogs, many/few books, many/few tables, many/few moments, many/few stories*
b. *much/little water, much/little oxygen, much/little mud, much/little information, much/little advice*

Count nouns do not occur with classifiers; only mass nouns can, as in (8).

(8) a. **three pieces of dogs/books/tables/moments/stories*
b. *three cups of water, three gallons of mud, three pieces of information/advice*

Only mass nouns (and plurals) can be modified by *all, enough* and *more*.

(9) a. We have enough water.
b. *We have enough book.

Only mass nouns can occur in an argument position by themselves.

(10) a. *I have dog/book/table/moment/story.
b. I have water/oxygen/mud/information/advice.

Only count nouns can be referred back to by using pronouns *one* and *another*.

(11) a. I ate an apple in the morning and ate another after lunch.
b. I ate an apple, and you ate one, too.

(12) a. *I drank water in the morning and had another after lunch.
b. *I drank water, and you drank one, too.

Their different syntactic behaviors justify the assignment of different semantic types to count and mass nouns in (13). Count nouns such as *apple* are of type $\langle object, t\rangle$, a function from the domain of objects to truth values, and mass nouns like *water* are of type $\langle substance, t\rangle$, a function from the domain of substances to truth values.

(13) a. $[\![apple]\!] = \lambda x.\text{apple}'(x)$ $\langle object, t\rangle$
b. $[\![water]\!] = \lambda x.\text{water}'(x)$ $\langle substance, t\rangle$

A type mismatch makes (14a) anomalous because *drink* requires substance type as its argument, but *the apple* is of object type. *Water*, which belongs to the substance type, meets the type requirement, and felicitously occur in (14b).

(14) a. *Fido drank <u>the apple</u>.
b. Fido drank <u>the water</u>.

(15) is the compositional analysis of the verb phrase in (14b).

(15) a. $[\![drink]\!] = \lambda x\lambda y.\text{drink}'(y, x)$ $\langle substance, \langle animate, t\rangle\rangle$
b. $[\![the\ water]\!] = \text{w}$ *substance*
c. $[\![drink]\!]([\![the\ water]\!]) = [\lambda x\lambda y.\text{drink}'(y, x)](\text{w}) = \lambda y.\text{drink}'(y, \text{w})$
$\langle animate, t\rangle$

The composition fails in (14a) due to a type mismatch, as (16) shows.

(16) a. ⟦*drink*⟧ = $\lambda x \lambda y.\text{drink}'(y, x)$ ⟨*substance*, ⟨*animate*, *t*⟩⟩
b. ⟦*the apple*⟧ = a *object*
c. *⟦*drink*⟧(⟦*the apple*⟧) = *$[\lambda x \lambda y.\text{drink}'(y, x)](\text{a})$ (type mismatch; $D_{object} \cap D_{substance} = \emptyset$)

Similarly, the verb *break* requires an object type as its input, which is satisfied by the object complement *table* in (17a). (17b) exemplifies a failure of function application due to a type mismatch because the type of *the mud* is substance.

(17) a. Fido broke <u>the table</u>.
b. *Fido broke <u>the mud</u>.

We leave the compositional analyses of (17) to the reader.

7.1.3 Lattice-Theoretic Analyses of Mass Nouns

While count nouns denote sets of individuals, it is hard to determine the kind of set mass nouns refer to. For example, does *water* denote a set of all water in the world? Such description does not make sense because water is not atomic. An influential semantic analysis of the mass term is mereology-based. Link (1983) treats mass and plural entities as a different sort within the entity type. Plurals and mass terms refer to a (atomic) **join-semilattice**, where either **sum** (+) or **fusion** (⊕) operation join objects or bits of stuff to form plural individuals. Plural individuals are obtained by adding singular individuals. For example, assuming that there are only three dogs, Fido, Spot and Bingo, in our domain, the singular NP *dog* will denote a set containing these three dogs, as in (18a). To form a set of plural individuals out of this set, Link (1983) introduces an operator * that works on one-place predicate *P* and generates all the individual sums of members of the extension of *P*. That is, ⟦**P*⟧, the denotation of **P*, would include both singular and plural individuals like (18b).

(18) a. ⟦*dog*⟧ = {Fido, Spot, Bingo}
b. ⟦**dog*⟧ = {Fido, Spot, Bingo, Fido + Spot, Spot + Bingo, Fido + Bingo, Fido + Spot + Bingo}

(18b) generates an ordering between its members in terms of parthood, which is visualized in Figure 7.2. We can see that Fido is part of the sum of Fido and Spot, and the sum of Fido and Spot is part of the sum of Fido, Spot and Bingo, etc. (Fido ≤ Fido + Spot ≤ Fido + Spot + Bingo).

The plural NP *dogs* denotes a set containing only plural individuals, i.e., the set in (18b) minus the set of singular dogs in (18a), i.e., ⟦**P*⟧ – ⟦*P*⟧. (19) shows such a set of plural individuals.

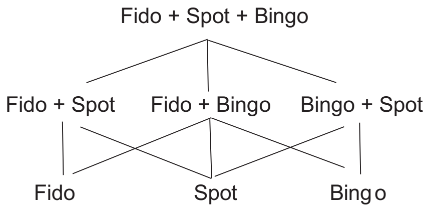

Figure 7.2 Part-of relation.

(19) $[\![*dog]\!] - [\![dog]\!]$ = {Fido + Spot, Spot + Bingo, Fido + Bingo, Fido + Spot + Bingo}

Importantly, mass terms are like plurals except that a fusion (⊕) operation, instead of a sum (+) operation, joins bits of stuff to form plural individuals. Unlike atomic domains, since there is no difference between singular and plural stuff, *water* includes both individual and fused bits of water, yielding (20) as the denotation of *water*.

(20) $[\![*water]\!] = \{w, w', w'', w \oplus w', w' \oplus w'', w \oplus w'', w \oplus w' \oplus w''\}$

In this analysis, the only difference between count and mass nouns (and hence the object and substance domains in *D*) is whether their denotations include both singular and plural individuals (mass, due to the lack of minimal parts) or only singular individuals (count).[1]

7.1.4 Relationship to the Ontology

We have so far assumed that the mass vs. count distinction is clear-cut based on the different ontological domains their referents come from. It is a simplification, however, that physical constitution of things can invariably determine the count/mass distinction. A transparent mapping between objects and count nouns, on the one hand, and substances and mass nouns, on the other, does not always obtain. For example, *rice* is mass, but *lentil(s)* is count, and *fruit* is mass while *vegetable(s)* is count, although there is no discernable perceptual difference between the two in each pair. Many nouns, *line, paper, chocolate, plane, rope, stone, wall, fence, hair*, etc., which can be used as both count and mass nouns, are homogeneous (part of line is also line). Some count nouns, such as *cloud, puddle, ripple, mountain, valley* and *wave*, do not seem to have heterogeneous parts. *Furniture* and *silverware,* which are mass nouns, are not homogeneous (furniture contains different objects). There are count and mass noun pairs which refer to the same thing, e.g., *coins/change, letters/mail, suitcases/luggage, clothes/ clothing, shoes/footwear*. Abstract nouns such as *virtue, prejudice, theory, joy, pleasure, belief and suggestion* are count, and *information, knowledge, advice, fun, wisdom* and *curiosity* are mass. It is difficult to explain the contrast in terms of divisive and quantized references; it does not make much sense to say that virtue has heterogeneous parts while information has homogeneous parts. Group nouns, such as *team, family, committee, faculty, staff* and *class*, sometimes behave like singular nouns referring to a group (*the team has a lot of supporters*), and sometimes behave like plural nouns referring to the members of a group (*the family can't stand each other*). These facts suggest that the mass/count distinction might be a purely grammatical (formal) one that does not reflect the natural ontology (Cheirchia, 1998).

The mismatch, however, seems to be restricted to certain types of things. Nouns denoting aggregates show a larger degree of "arbitrariness" in terms of the mass/count distinction than those typically denoting objects or substance. While typical objects (e.g., dog, chair) tend to be lexicalized into count nouns, and typical substances (e.g., water, air, gas) are more or less consistently denoted using mass terms in English and in other languages, it is often difficult to determine whether individual members of an aggregate should be treated as objects or not. The puzzling cases, e.g., *rice* vs. *lentil(s), fruit* vs. *vegetable(s), furniture, kitchenware, change, mail, luggage*, are mostly **aggregate terms**, nouns denoting either collective artifacts (e.g., *furniture*) or granulars (e.g., *lentil*). Whether an aggregate is linguistically encoded using a mass noun or a count noun depends on context, and various accounts explain their behaviors (Chierchia, 2010; Landman, 2011; Rothstein, 2010; Sutton and Filip, 2016). Rothstein (2010) discusses how nouns like *line, paper, rope, stone, wall, fence, hair*, etc. can be used as both count and mass nouns but homogeneous. For example, fencing enclosing a square field can count as four fences in one context and one fence in another. Let us assume that the denotation of *fence* is the upward closure of the four panels of the fence $\{f_1, f_2, f_3, f_4\}$, and there are two contexts $k_1 = \{f_1, f_2, f_3, f_4\}$ and $k_2 = \{f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4\}$. Context $k1$ indexes each panel to be counted as one, while the context $k2$ indexes the entire fence by joining the four panels. These different contexts apply to *fence* to produce the following sets of ordered pairs shown in (21). There will be four fences in context k_1 and one fence in context k_2.

(21) a. $[\![fence]\!]_{k1} = \{\langle f_1, k_1\rangle, \langle f_2, k_1\rangle, \langle f_3, k_1\rangle, \langle f_4, k_1\rangle\}$
b. $[\![fence]\!]_{k2} = \{f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4, k_2\}$

Landman (2011) and Sutton and Filip (2016) provide an account of artifactual aggregates or collective artifact nouns like *furniture, kitchenware*, etc. It is puzzling why there is a wide cross-linguistic variation in terms of count/mass distinction (these nouns can be plural in other languages), and why these nouns resist coercion, unlike prototypical mass nouns like *water*, as shown in (22).

(22) a. Please bring me three waters.
b. ??Can you bring three furnitures to our office?

Sutton and Filip (2016) use a function ***ind*** which maps number neutral predicates (of type $\langle e, t\rangle$) to entities that count as "one" for that predicate. To encode the context-sensitivity of counting criteria, *ind* has a counting context argument (of type $\langle\langle e, t\rangle, \langle c, \langle e, t\rangle\rangle\rangle$). When the speech context does not provide a counting context (i.e., the null counting context), *ind* sets include everything that could count as one for that predicate. Prototypical count nouns like *cup* and *chair*, at the null counting context, yield the set of individual cups and chairs, which is a disjoint set, making counting possible. They are of type $\langle c, \langle e, t\rangle\rangle$, but the utterance context immediately saturates the context argument c, turning them to type $\langle e, t\rangle$. The null counting context for substance nouns like *water* and *mud*, by contrast, returns the number neutral predicates (of type $\langle e, t\rangle$). Since it is not disjoint, counting is impossible. For artifactual aggregates, the entities that count as one vary from one context to another. In some, sums count as one, but in others, proper parts of sums each count as one. This means that the *ind* set evaluated at the null counting context is not disjoint but overlapping, causing a problem with counting. If the overlap is resolved, as in the case of *fence* (seen in (21) above), it can be counted. If not, it remains mass, as in the case of *furniture*. They propose that coercion is nothing but the result of evaluating the counting base at the utterance counting context. Unless an implicit classifier is used, the null counting context cannot be replaced with the utterance context for artifactual aggregates, rendering counting impossible.

7.1.5 Universal Packager and Universal Grinder

The ontological boundaries between objects and substances are not rigid, and it is not difficult to shift count nouns to mass nouns and vice versa. These processes are colorfully called **universal packager** and **universal grinder**, respectively (Bach, 1986; Pelletier, 1975). The former turns mass nouns to count nouns, as illustrated in (22a), interpreting two beers as two servings or two kinds of beer. The latter shifts count nouns to mass nouns, as exemplified in (22b), which is interpreted as portions of an apple.

(22) a. I had two beers.
b. You put apple in the salad.

Does this mean that there is no inherent distinction between the domain of objects and the domain of substance? Moving away from Link's classic dual domain theory, some have proposed to treat root meaning of count nouns as mass or unspecified in number, and to allow a counting operator pick out atomic individuals that are formed out of the base stuff (Borer, 2005; Krifka, 1989; Pelletier, 1975). Such a uniform domain treatment, while economical, has some empirical problems; there are many prototypical count and mass nouns that have robust associations with object and substance domains, respectively, and grinding and packaging operations are not entirely free. Packaging relies on preexisting conventionalized units of packaging (Landman, 2011). For example, (22a) above means two bottles (or cans) or kinds of beer, rather than two liters of beer. The grinder is also restricted. Artifacts nouns, especially complex ones, are less acceptable to grind than natural kind nouns, as we see in the contrast in (23) (Chierchia, 2010).

(23) a. There was <u>dog</u> all over the highway.
b. ?There was <u>bicycle</u> all over the floor.

To maintain the sub-domains of objects and substance, we need to postulate some kind of semantic operations that shift a member from one domain to another. Landman (1991) proposes a grinding operation that maps an individual in the count domain onto a mass domain consisting of its parts, and a packager that maps substance onto a plurality of contextually determined atomic individuals.[2]

Reflection

- What are the differences between objects and substance? How much does the grammatical mass and count distinction reflect this ontological division? Should we postulate separate semantic domains or a single domain for count and mass nouns?
- How do we represent the meaning of mass nouns? What are some problems with using the regular set theory?
- What are special properties of aggregate nouns? Why are some of them mass nouns despite the fact that they include heterogeneous members (e.g., *furniture*)? Do you think Sutton and Filip (2016) succeeded in explaining the lack of plurals?

7.2 Natural Kind and Artifact Object Type Nouns

7.2.1 Philosophical Debates

Artifacts are man-made objects for a particular purpose or function, such as tools, documents, instruments, machines, buildings, arts, etc. They contrast with **natural kinds**, such as animals, plants, rivers and mountains. Philosophers have debated whether artifacts and natural kinds have the same ontological status. Schwartz (1978) distinguishes between real and nominal kinds, arguing that artifacts lack a common "hidden nature" and have only nominal essence, which allows an analytic specification in terms of the form and function that characterize their membership of a nominal kind. They are more easily defined by their abilities and capacities rather than by what they are made of or what they look like (Miller and Johnson-Laird, 1976). For example, what makes a clock is its function of telling time, regardless of its shape or material. The name *key* applies to widely different objects that are used to open locks (e.g., a metal key that physically opens a deadbolt, a card key with a magnetic stripe, or a remote-control key) (Malt, 2010). Therefore, an artifactual primary kind entails its proper function, defined as a purpose or use intended by a producer. Many artifact nouns (e.g., *scraper, polisher, remover, cleaner*) simply name their proper function. It has been suggested that natural kind and artifact nouns even refer differently (Schwartz, 1978). The modifier in the natural kind compound *leopard lizard* describes the skin pattern of a lizard, while the modifier in artifact compound *butter knife* designates the function of a knife (Downing, 1977; Levin et al., 2019; Wisniewski and Love, 1998). Children are sensitive to the producer's intention when extending the names of artifacts to novel objects (Gelman and Bloom, 2000). Natural kind terms are directly referential, in line with Putnam's causal theory of reference, whereas artifact kind terms determine their referent by a description, e.g., a clock is any timekeeping device.

On the other side of the debate is the position that advocates a strong ontological status to artifacts (Baker, 2004) or a uniform treatment of natural kind and artifact terms. We succeed in referring to something using a name not because we know a description that uniquely picks out the referent, and this holds true not just for natural kind terms but also artifact terms (Kornblith, 2007). Although functions are important for artifact nouns, the names for them are commonly extended to other objects based on form as well as function. For example, *brush* refers to objects with handles and bristles/hairs regardless of its function, e.g., for smoothing hair, applying paint to a surface, pushing snow off a windshield, scrubbing dirt off a surface, producing soft sounds on a drum, etc. There are different terms for objects with different shape or material but with the same function, e.g., *box, basket, bin, crate* and *carton*, which are all containers. Function alone cannot distinguish between *key* and *can opener* (they both open something) or between *blanket* and *plastic wrap* (they both cover). *Chair, bench, stool* and *sofa* share the same function (sitting on), but the particular forms distinguish between objects called by each name (Malt, 2010).

7.2.2 Artifact Nouns and Telic Qualia

As observed in the previous chapter, nouns denoting natural kinds typically do not have telic or agentive qualia values which artifact nouns have (Pustejovsky, 1995). This is reflected in grammar in such a way that their associated telic event can be selected in an appropriate linguistic context. To recapitulate, aspectual and psych-verbs select for the telic role of the noun they take as complements, as in (24a), attributive adjectives modify the telic role, as in (24b), light verbs take specific interpretations depending on the telic role of the object complement, as in (24c), denominal verbs name the telic role of their base nouns, as in (24d), and short passives in which the predicate only expresses the telic role of the subject as in (24e) is uninformative and thus unacceptable, among others.

(24) a. I enjoyed/finished the <u>book</u>.
b. fast <u>car</u> (to drive)
c. taking a <u>tablet</u> vs. taking a <u>train</u>
d. fax a <u>document</u> (= send)
e. This <u>picture</u> was painted *(in 1604).

Highlighting the importance of function for artifact nouns, Grimm and Levin (2017) and Levin et al. (2019) analyze these nouns as relational properties that contain only the predicate describing associated functional events. For example, *cup* refers to the set of things that people can drink out of in an event of drinking, translated as (25).[3] In (25), *x* is a free variable whose denotation is fixed by context.

(25) $[\![cup]\!] = \lambda y \exists w.\text{drinks-out-of}'_w(x, y, e)$

They further make a distinction between functional artifact nouns and stage-level artifact nouns.[4] Whereas the associated event for the former is an intended function that entities must have the potential to carry out (e.g., *cup*), the associated event for the latter describes a temporary property that characterizes an entity. This class includes countable nouns like *delivery*, *tip*, *gift* and *present* and non- countable nouns like *mail*, *change* and *laundry*. Unlike functional artifact nouns, which stand in a potential relationship to their associated event, stage-level artifact nouns describe entities that stand in an actual relationship. For example, a letter is called *mail* only when it is in the postal system. (26) contains the translations of some stage-level artifact nouns.

(26) a. $[\![tip]\!] = \lambda y.\text{remunerates-for-good-service-with}'(x, y, e)$
b. $[\![laundry]\!] = \lambda y.\text{launders}'(x, y, e)$

They argue that the existence of stage-level artifact nouns further distinguishes artifact nouns from natural kind nouns; object belonging to a natural kind, like *dog*, remains in that kind throughout its existence. Grimm and Levin (2017) attempt to explain why collective nouns such as *furniture* cannot be pluralized, whereas other similar count nouns like *vehicle* can. The count noun *car* is a sub-type of *vehicle* since they share the same associated event of providing transportation. The common associated functional event verifies

$[\![car]\!] \subseteq [\![vehicle]\!]$, allowing *vehicle* to have a taxonomic plural, as represented in (27a) and (27b).

(27) a. $[\![vehicle]\!] = \lambda x \exists w.\text{used-to-transport}'_w(x, e)$
b. $[\![car]\!] = \lambda x \exists w.\text{used-to-transport}'_w(x, e) \wedge \text{has-four-wheels}'(x)$

An artifactual aggregate and its constituent entities, by contrast, have different associated functional events. For example, *furniture* furnishes, but a *chair* is for sitting, as (28a) and (28b) represent. Artifactual aggregate nouns thus cannot stand in a taxonomic super/sub-element relation, lacking a taxonomic plural.

(28) a. $[\![furniture]\!] = \lambda x \exists w.\text{used-to-furnish}'_w(x, e)$
b. $[\![chair]\!] = \lambda x \exists w.\text{used-to-sit}'_w(x, e)$

It seems problematic, however, to define artifact nouns exclusively in terms of their functions. The definition in (29), for example, makes any objects that we can drink out of *cup*, so bowls and glasses will be included in the denotation of *cup*. Empirical facts also point to an equal importance of form and function for artifact nouns, as discussed in the previous section. Therefore, instead of encoding telic roles in the lexical translations of artifact nouns, we will represent such knowledge using a meaning postulate. The denotation of an artifact noun *cup* is given in (29a). It is a function from the set of artifacts to truth values. A meaning postulate in (29b) describe that artifact nouns like *cup* are associated with their intended functions. Since a cup needs not be constantly used to drink in the actual world to qualify as a cup, we include an existentially quantified world argument, indicating that a possibility to be used to drink suffices.

(29) a. $[\![cup]\!] = \lambda x.\text{cup}'(x)$ $\langle artifact, t\rangle$
b. $\forall x.\text{cup}'(x) \rightarrow \exists W \exists e.\text{used-to-drink}'_w(x, e)$

Reflection

- What are some fundamental differences between natural kinds and artifacts? Is qualia structure sufficient to distinguish between the two types?
- If you weigh in on the philosophical debate regarding the ontological status of artifact nouns, what would be your position, and why?
- Why do artifact nouns allow predicates that select a particular event that is associated with them? How can we formally represent this? Is it necessary to assume that there is a hidden event argument only for artifact nouns?

7.3 Animate and Inanimate Natural Kind Object Type Nouns

7.3.1 The Animacy Hierarchy and Grammatical Effects

Animacy is another fundamental ontological distinction in the natural kind noun meaning. Dahl (2008, p. 145) suggests that "the capacity for perceiving and acting upon the environment" is the defining criterion for animacy. Only living organisms can act voluntarily/intentionally and are sentient. Our conception about animacy, however, does not always align with biology which clearly distinguishes between living vs. non-living entities. We seem to view animacy as a gradable notion depending on whether a living organism has all the capacities of a typical animate being. For instance, plants and cells are living entities, but they are not sentient and do not act voluntarily. We therefore tend to assume that animals are more animate than insects and insects are more animate than plants or sells. In interacting with inanimate artifacts, such as computers and cars, we sometimes personify them as if these entities are animate (Bayanati and Toivonen, 2019). To reflect a degree of animacy, traditional accounts appeal to the **animacy hierarchy** and its interaction with definiteness, individuation and degrees of referentiality (Aissen, 2003; Silverstein, 1976).

(30) Animacy hierarchy: human < animal < inanimate

Such hierarchy is employed to explain a wide range of linguistic phenomena which are affected by animacy cross-linguistically. Numerous empirical studies support the grammatical reflex of animacy. Animate nouns are three times more likely to appear as subject arguments than inanimate nouns while the reverse holds for the object; direct objects are more likely to be case-marked if they have a high degree of animacy; animate nouns are more likely to be marked with number and gender; animates, especially humans, are more likely to be a discourse topic, and therefore more likely to be definite; English passives are much more common when they promote animate noun phrases to the subject position (Aissen, 2003; Clark, 1965; Dahl, 2008; Harris, 1978; Snider and Zaenen, 2006). The animate-first bias in production is due to the fact that animate entities are in general more salient, predictable, or accessible than inanimate entities (Bock et al., 1992). Cognitive effects (Radanovic et al. 2016) and language acquisition (Gelman and Opfer, 2002) also support the difference between animate and inanimate entities. Nine-month-olds distinguish between and react differently to animate and inanimate objects using featural and dynamic cues.

English makes animacy distinction in pronouns (*she/he* vs. *it*), question words (*who* vs. *what*), and quantifiers (*everyone* vs. *everything*). As observed in Chapter 4, an animacy requirement is placed on the double object ditransitive construction. Double object constructions with *send*-type verbs are anomalous when the indirect object is inanimate and direct object is animate, as in (31a), in which case the prepositional alternation must be used instead, as in (31b).

(31) a. *The president sent Korea the ambassador.
b. The president sent the ambassador to Korea.

Rosenbach (2002) notes that animacy also affects the genitive construction. In the genitive phrase in (32), the *of* construction is less felicitous if the possessor is animate, as in (32a). By contrast, inanimate possessors tend to occur with the *of*-genitive more frequently, as in (32b).

(32) a. his wife > the wife of his
b. the roof of the house > the house's roof

She also shows that human dependents are more likely to occur in the genitive, as in (33a), while inanimate dependents are more likely to be marked with noun modifiers, as in (33b). This is expected given that English genitives encode primarily prototypical possessive relations, like kinship relations (*John's wife*), body parts (*John's face*) or relations expressing legal ownership (*John's car*).[5]

(33) a. Mary's dinner party > the Mary dinner party
b. the hotel lobby > the hotel's lobby

Folli and Harley (2007) observe that animate subjects can have both inalienable objects, such as their body parts, and alienable ones, but inanimate subjects may only have their inalienable subparts, as evidenced by (34).

(34) a. John has a car.
b. John has a broken arm.
c. The oak tree has many branches.
d. ??The oak tree has a family of birds.
e. The oak tree has a family of birds in it.

They propose **teleological capacity**, rather than intention or volition, as a defining feature of animacy in English. Teleological capacity is defined as "the inherent abilities of the entity to participate in the event" (p. 190). Assuming this is true, even inanimate objects can be an agent as long as they are teleologically able to generate the action described by the verb. As observed by Levin and Rappaport (1991), although trains are inanimate, they possess some inherent and internal properties for typical whistlers, making (35a) felicitous. When the subject of sound emission verbs like *whistle* or *squeak* is not teleologically capable of producing the noise, a goal of motion phrase is required, as in (35b), turning the verbs into those describing the manner of motion of the subject.

(35) a. The train whistled.
b. The bullet whistled *(into/out of the room).

Similarly, unergative verbs such as *cough, shiver* and *blush* require their subjects to be animate, but the required animacy is a necessary property of their subjects which makes them teleologically capable of producing the described actions, rather than intentionality.

7.3.2 Shifting Animacy

Once animacy is integrated into the linguistic system, it tends to become a formal feature controlling the output of the grammar, rather than semantically interpretable (Bayanati and Toivonen, 2019). Some have thus proposed syntactic accounts for animacy effect (Folli and Harley, 2007). de Swart and de Hoop (2018) offer a semantic account, arguing that while conceptual animacy may be gradient, linguistic animacy is binary and discrete. They discuss how these types can shift overtly or covertly. Their examples come from Dutch, which shows an intriguing alternation in contact verbs; verbs like *hit* and *bite* take animate objects directly but require a preposition for an inanimate object. They argue that the prepositions like *in* and *against* are inserted to form complex verbs, changing their original ⟨*animate*, ⟨*animate*, *t*⟩⟩ type to ⟨*inanimate*, ⟨*animate*, *t*⟩⟩ type.

Zwarts (2017) points out problems with such an analysis. He argues that while the type distinction between animate and inanimate entities is sufficiently clear, type-shifting requires a more structured domain consisting of complex types. Such richly structured domain allows various type shifts between properties and kinds and mass and count (Chierchia, 1998; Link, 1983; Partee, 1987). Simply dividing the domain of entities *D* into subdomains will call for functions from animates to inanimates and vice versa (he calls them "statue" and "wand," respectively) to explain a systematic connection between the two domains. This causes a problem because there is no one-to-one correspondence between animates and their inanimate counterparts and vice versa (e.g., not all statues of men correspond to living men), which is unexpected if we assume that animacy shifts occur at the entity type level. He argues for a shift at the property level. For example, animate category men (type ⟨*animate*, *t*⟩) is shifted to the inanimate category of statues or bodies of men (type ⟨*inanimate*, *t*⟩) (Kamp and Partee, 1995). Rather than viewing the type shift as a repair strategy at the noun phrase level to coerce it to fit the argument position of the verb, a shift at the noun level explains better our intuitions about the flexibility of animate and inanimate categories (rather than entities).

Animacy may be an inherent feature of an argument, but the sentential or discourse context can enforce a conceptual shift in situation-specific or conventional cases. Such shifts occur in both directions—from inanimate to animate as in (36a) and from animate to inanimate as in (36b) and (36c).

(36) a. <u>The ham sandwich</u> wants to pay.
b. She read <u>Shakespeare</u>.
c. He looked at the <u>stone lion</u>.

Personifications of inanimate objects, as in (37a), involves metaphoric extensions. Names of countries can denote their people, metonymically extending their reference, as in (37b). Collective inanimate nouns (e.g., *family, institution, company, association*) can refer to their members, as in (37c), allowing an animate interpretation.[6]

(37) a. <u>Nature</u> is generous.
b. <u>Korea</u> is rejoicing after the World Cup victory.
c. The <u>family</u> are happy.

Animate versus inanimate distinction is an important one for nouns referring to natural kinds, as we have observed so far, so we will specify such sortal information in their semantic type specifications, as in (38).

(38) a. $[\![dog]\!] = \lambda x.\text{dog}'(x)$ $\langle animate, t\rangle$
b. $[\![rock]\!] = \lambda x.\text{rock}'(x)$ $\langle inanimate, t\rangle$

The animate versus inanimate distinction plays a role in restricting the predication types for natural kind nouns, as (39) illustrates. The input type required by *happy* is satisfied by the type of the argument given to it, *the dog*, in (39b), and the composition proceeds naturally. The composition fails in (39a) above due to a type mismatch.

(39) a. *The rock is happy.
b. The dog is happy.

Reflection

- What is the animacy hierarchy? Describe its effect on grammar. Why is it more appropriate to treat animacy as gradient notion?
- Why is teleological capacity, rather than volition or intention, more suitable for animacy in English? Do you expect there will be a

language requiring volition and intention for animacy? If so, what does it say about cross-linguistic variation in animacy?

- Do you think animate versus inanimate distinction is part of syntax/ semantics or part of our encyclopedic knowledge? Shifts between the two domains can be easily observed. What is the implication for the animacy in grammar?

7.4 Eventuality Type Nouns

7.4.1 Deverbal Nouns

Many nouns denote **eventualities** (a cover term for events, processes and states, Bach, 1986) rather than things. The domain of eventualities is partitioned largely into the domain of events, processes and states. Events involve a change of state and have quantized reference. They consist of heterogeneous sub-events, each of which are distinct from one another, and cannot by itself be the whole event. For example, an event of building (a house) consists of various sub-events, such as laying down the foundation, raising up walls, putting on a roof, doing electrical and plumbing works, etc., all of which are not identical with one another and are not equal the whole building a house event. Processes lack a natural endpoint and have divisive reference. Processes, such as exercising, have homogeneous sub-events. A part of a process is also the same process, e.g., exercising for 10 minutes and exercising for an hour are both exercising. *Death* is a result-denoting noun and is incompatible with a *for* adverbial, as (40a) shows. *Exercise*, on the other hand, is a process-denoting noun, and can be modified by a *for* adverbial, as in (40b).

(40) a. *His <u>death</u> lasted for an hour.
     b. His <u>exercise</u> lasted for an hour.

Most nouns referring to events are derived from verbs by means of nominalizers. Note a close connection between the verb *build* in (41a) and the deverbal noun *building* in (41b-d), the latter of which are derived from the former by attaching the nominalizer -*ing*. Borer (2003), Chomsky (1970) and Grimshaw (1990) observe that a deverbal noun can be a complex event nominal in (41b), a simple event nominal in (41c), or a result noun in (41d). According to Grimshaw (1990), complex event nominals have obligatory arguments, as indicated by the asterisk in front of the parenthesis in (41b).

(41) a. The Normans built the castle.
     b. the <u>building</u> *(of the castle) by the Normans
     c. the <u>building</u> of the castle
     d. the stone <u>building</u>

Smith (1972) observes that zero-derived deverbal nouns like *drop* are sometimes agentless, as in (42a), whereas Latin-nominalizing ones like *consumption* have a full argument structure of their cognate verbs, as in (42b).[7]

(42) a. ?Fido's drop of the bowl
b. Fido's consumption of food

This observation led Chomsky (1970), Harley and Noyer (2000) and Marantz (1997) to an influential hypothesis that the base roots of deverbal nouns lack external agent arguments in their lexical entry, and the agent role is assigned in a verbal projection in syntax.

Lexicalists, such as Fabregas and Martin (2012), Grimshaw (1990), Rappaport (1983) and Wechsler (2008), on the other hand, argue that deverbal nouns carry over the argument structure of their cognate verbs. Fabregas and Martin (2012) support this claim with the evidence that the nominalizers merely change the category label of the base verb, inheriting its lexical aspectual information. For example, the telic deverbal noun *destruction* is compatible with *take place*, as (43a) shows, whereas the state deverbal noun *preoccupation* is not, as in (44a). (43b) has a habitual reading, whereas (44b) has a continuous reading. As shown in the contrast between (43c) and (44c), only dynamic deverbal nouns allow a manner adverbial modification.

(43) a. The <u>destruction</u> of the city took place during the Second World War.
b. the constant <u>destruction</u> of cities
c. the fast <u>destruction</u> of the city

(44) a. *My <u>preoccupation</u> with the climate change took place last summer.
b. my constant <u>preoccupation</u> with the climate change
c. *the fast <u>preoccupation</u> of me

Assuming that deverbal nouns are event-denoting, we adopt the neo-Davisonian event semantic notation to represent that the conjoined arguments with relevant semantic roles can be filled out by arguments for deverbal nouns. The deverbal noun *destruction* in (43) denotes a bounded result event type, as translated in (45a). The deverbal noun *preoccupation* in (44) calls for a state variable *s*. We also postulate a state type *s* to be mapped to the domain of states, which is a sub-domain of the set of eventualities, as in (45b).

(45) a. $[\![\textit{destruction of the city by the enemy}]\!]$
$= \lambda e.\text{destruction}'(e) \wedge \textit{agent}(e) = \text{e} \wedge \textit{theme}(e) = \text{c}$
$\langle \textit{bounded-durative-event}, t\rangle$
b. $[\![\textit{my preoccupation with the climate change}]\!]$
$= \lambda e.\text{preoccupation}'(e) \wedge \textit{experiencer}(e) = \text{s} \wedge \textit{theme}(e) = \text{c}\ \langle \textit{state}, t\rangle$

7.4.2 Abstract Nouns

Nouns describing bodily, cognitive or emotional states and behavioral properties do not refer to concrete things or eventualities, but rather to more abstract entities, which are outside both space and time. They are much less concrete than physical things or even eventualities, as they cannot be directly observed but only indirectly grasped through our personal and social experiences. Despite this abstractness, their existence is undeniable, and languages have a large number of abstract nouns.

Experimental studies reveal modality-specificity of abstract concepts, such as motor information (Glenberg and Kaschak, 2002; Richardson et al. 2003) but also attested processing difficulty without context, such as delay in lexical access, comprehension and memory (Schwanenflugel and Shoben, 1983; Wattenmaker and Shoben, 1987). This is because immediately picturing a situation in which an abstract concept is relevant is often difficult (Schwanenflugel, 1991). For example, a court trial might be related to the concept of truth, but there are also many other situations where the truth concept can occur, generating competition and interference (Galbraith and Underwood, 1973). Barsalou and Wiemer-Hastings (2005), however, found that when relevant situations are made salient, abstract words are found to be processed equally well. They argue that our interaction and experience with abstract concepts is often as direct as those of concrete objects. Abstract and concrete concepts share common situational content, differing only in their focus within background situations, with concrete concepts focusing on objects, and abstract concepts on events and introspections. The different foci make the representation of abstract concepts more complex, explaining the experimental results. If abstract concepts are grounded in situations, their modality-specific behaviors are expected.

Most abstract nouns derive from a verb or an adjective, denoting a state or its causal event. Following the general trend of thing-event interchangeability, a reasonable flexibility exists between abstract states and their associated events (Bach, 1986; Jackendoff, 1991; Krifka, 1989). The fact that abstract nouns, just like concrete ones, can be counted further reveals their efficacy. Process and state predicates have mass denotation, as shown in (46).

(46) a. She hates liars. ⇔ There is *a <u>hating/hate</u> by her of liars.
b. She dominates her husband. ⇔ There is *a <u>dominating/domination</u> by her of her husband.

Brinton (1998) explicitly argues that mass nouns are derived from state and process verbs, whereas count nouns are derived from telic verbs, citing examples like (47). She further argues that zero-derived nouns are mostly count, attributing zero-derivation to the addition of telicity feature.[8]

(47) a. *live → a quantity of/*one living*
b. *run → much/*a running*
c. *perform → *a good deal of/one performance*
d. *arrive → *much/an arrival*

Payne and Huddleston (2002), on the other hand, maintain that there is unpredictable patterns such that some abstract nouns have a mass interpretation and others have a countable interpretation, exemplified by the contrast between (48) and (49), and (50) and (51).

(48) a. Considerable injustice was revealed during the enquiry.
b. Two fundamental injustices were revealed during the enquiry.

(49) a. Serious harm was done to the project's prospects.
b. *Two serious harms were done to the project's prospects.

(50) a. Full discussion of the land in question is vital.
b. Two discussions of the land in question took place.

(51) a. Permission is required.
b. ?Two separate permissions are required.

At the same time, they also acknowledge that abstract nouns which can have a result sense tend to be more countable, as in (52).

(52) a. Necessity is the mother of invention. [abstract, non-count]
b. ?There were two separate inventions of the light bulb. [event, count]
c. Edison was honored for three separate inventions. [result, count]

Similarly, Grimm (2013) argues that abstract nouns are non-countable when designating a state or a property but are countable in other contexts. Bodily and mental states, such as *sleep*, *hunger*, *excitement*, *alertness*, *fatigue*, *rage*, *drunkeness*, etc., are primarily interpreted as states having mass denotation, but when they refer to many sleeping events of the same individual, it can be countable and plural. Likewise, nouns describing mental properties such as *intelligence* or *creativity* have a countable use when they refer to intelligence or creativity of different individuals, as (53) illustrate.

(53) Please, let's not insult both our intelligences by pretending this is open to question.

Nouns describing behavioral properties such as *kindness* have a countable use if they are event-oriented, foregrounding the occasions where the properties are displayed, as in (54).

(54) Still, with a motorcycle she could leave the city on weekends, get away from the often overbearing <u>kindnesses</u> of her boarding family.

Lastly, nouns that denote stimulus (e.g., *irritant*), although rare, are invariably countable, whereas those designating the experiencer-state are typically uncountable. Most psych-nouns, such as *annoyance*, *despair*, *fear*, *sorrow*, *pride*, etc., are polysemous between "experiencer-state" and "stimulus," and it depends on context whether polysemous psych-nouns are non-countable or countable. For instance, *much annoyance* refers to an experiencer-state and thus uncountable, whereas *several annoyances* denote the stimulus and countable.

There have been various proposals to formalize the meaning of abstract nouns (Anderson and Morzycki, 2015; Grimm, 2013; Hinterwimmer, 2020; Moltmann, 2004). Nouns describing mental properties permit participant-anchoring, such as *intelligences* which designates intelligence with respect to different individuals. Grimm (2013), following Koontz-Garboden and Francez (2010), take property concepts to denote **primitive properties** (individuals of type p, a subtype of e). Instantiations of the primitive property are defined as ${}^{\cup}p$, which is equivalent to $\lambda x.\pi(x, p)$, the set of entities which possess p (where π represents the possession relationship). When nouns designate property concepts directly, pluralization fails since the referent of the property concept, the primitive property, is unique. Instantiations of properties, by contrast, yield potentially countable sets—but what types of instantiations are permitted is restricted by the lexical semantics of the noun. For *intelligence* and other inalienably possessed properties, ${}^{\cup}p$ realizes the set of participants which possess the property, i.e. $\lambda x(\pi(x, p))$ ranges over human individuals. Behavioral properties instead require events which possess the property, i.e., ${}^{\cup}$*kindness* "acts of kindness," i.e. $\lambda x.\ \pi(\mathrm{x}, p)$ ranges over events.

Hinterwimmer (2020) discusses abstract mass nouns' additional dimension for measurement and identification, which is the intensity with which the property is instantiated in an individual. When modified by *a lot*, abstract nouns trigger an ambiguity between a quantity/cardinality reading and an intensity reading. In case of the latter, abstract nouns map the entities to values on a scale of equivalence classes of the property instantiations. This contrast with concrete nouns modified by *a lot*, which allow only the quantity/cardinality reading. (55a) is ambiguous between the reading that the intensity of the generosity/understanding exceeds some standard or expectations, and the reading that the number of occasions on which the speaker experienced generosity/understanding exceeds some standard. (55b) is similarly ambiguous; it could mean that the villages are not very beautiful (degree reading) or that the speaker found fewer of the villages that she visited beautiful than she had expected (cardinal reading).

(55) a. During my stay in France, I experienced a lot of generosity/ understanding for my problems.
b. I found little beauty in the villages that I visited during my holidays in Bavaria.

Anderson and Morzycki (2015) provide semantics of abstract evaluative adjectives using Davidsonian states conceived as temporally and spatially located particulars, as in (56), where ***loc*(*w*, *s*)** means that *w* contains *s*.

(56) a. $[\![\textit{generous}]\!] = \lambda x \lambda s \lambda w.\text{generous}'(\text{s, x}) \wedge \textit{loc}(w, s)$
b. $[\![\text{beautiful}]\!] = \lambda \text{x} \lambda \text{s} \lambda \text{w}.\text{beautiful}'(\text{s, x}) \wedge \textit{loc}(w, s)$

Hinterwimmer (2020) proposes to turn the adjective denotations in (56) into the corresponding noun denotations by existentially quantifying the individual arguments, as shown in (57).

(57) a. $[\![\textit{generosity}]\!] = \lambda s \lambda w \exists x.\text{generous}'(s, x) \wedge \textit{loc}(w, s)$
b. $[\![\textit{beauty}]\!] = \lambda s \lambda w \exists x.\text{beautiful}'(s, x) \wedge \textit{loc}(w, s)$

Reflection

- What are the properties of deverbal and deadjectival nouns? What do they denote? How can we deal with their argument structure?
- What are some problems involved in semantically representing abstract nouns? Do all abstract nouns behave the same? If not, explain why. What are the similarities and differences between the different formal theories of abstract nouns?
- How are the ontological domains between physical things, eventualities, and abstract states connected to one another? Is there a case where multiple meanings of a noun come from these different domains?

7.5 Conclusion

This chapter introduced a more fine-grained ontology for noun meaning, structuring the domain of things accordingly. We provided semantic analysis to various types of nouns, including count, mass, natural kind, artifact, animate, inanimate, deverbal and deadjectival nouns denoting eventualities and abstract states.

Points to Remember

- The domain of things is divided into atomic objects and non-atomic substances. The domain of objects are in turn composed of the domains of natural kinds and artifacts. The domain of natural kinds is further partitioned into the domain of animate and inanimate natural kinds.

- Major theories of mass denotation are names of kind analysis and mereology-based account.
- Telic roles of artifact nouns affect their composition.
- The animacy hierarchy (human < animal < inanimate) explains certain grammatical phenomena. There is a shift from animate to inanimate and vice versa.
- Some deverbal nouns carry over the argument structure of their cognate verbs.
- Abstract state-denoting nouns describe bodily, cognitive and emotional states and behavioral properties. Various analyses have been proposed, such as primitive properties, which all assume some kind of instantiation relation.

Technical Terms to Remember

1. **Objects:** Entities with a clear boundary and internal integrity consisting of heterogeneous parts, all of which cannot be the whole object.
2. **Substances:** Unbounded stuff whose smaller parts of are still that material (consist of homogeneous parts).
3. **Granularity parameter:** Parameter that sets limits on the parts of a certain threshold to resolve the question of minimal parts.
4. **Join-semilattice:** A hierarchical structure with part–whole relations where plural individuals are obtained by adding singular individuals.
5. **Sum** (+): The operation that joins objects to form plural individuals in the count domain.
6. **Fusion** ($\oplus$): The operation that joins bits of stuff to form the mass domain.
7. **Aggregate terms:** Nouns denoting either collective artifacts or granulars.
8. ***Ind*:** A function which maps number neutral predicates to the entities that count as one for that predicate.
9. **Universal packager:** A shifting operator that turns mass nouns to count nouns, relying on preexisting conventionalized units of packaging.
10. **Universal grinder:** A shifting operator that turns count nouns to mass nouns.
11. **Artifacts:** Man-made objects for a particular purpose or function.
12. **Natural kinds:** Natural objects, which are not man-made, defined by their inherent properties and directly referential.

13. **Animacy:** The property of living organisms, which can act voluntarily/intentionally and are sentient.
14. **Animacy hierarchy:** A degree of animacy in the order of human, animal and inanimate, which interacts with definiteness, individuation and degree of referentiality.
15. **Teleological capacity:** The inherent abilities of an entity to participate in an event.
16. **Abstract nouns:** Nouns derived from a verb or an adjective denoting a state or its causal event, and which describe bodily, cognitive or emotional states and behavioral properties.
17. **Primitive properties:** Property concepts that denote Instantiations of the properties and are equivalent to the set of entities which possess the properties.

Suggested Reading

The literature on nominal semantics is massive but scattered. Unlike other lexical categories there is no monograph on formal nominal semantics. Link (1983) is a classic reading for count and mass domains. See Chierchia (1998, 2010) for an alternative proposal. Artifact nouns and their telic roles are most extensively discussed in Pustejovsky (1995). See Aissen (2003) for animacy in grammar and Grimshaw (1990) for deverbal nouns and grammar. We refer the reader to the works cited in this chapter for recent developments on semantics of abstract nouns.

Practice

1. Explain the following data.

(a) a. *dogs*
b. **waters*

Count nouns can be pluralized but mass nouns cannot.

(b) a. *two chairs*
b. **two muds*

(c) a. *many tables/few table*
b. *much blood/little blood*

(d) a. *three pieces of furniture*
b. **three pieces of chair*

(e) a. *I ate an apple in the morning and ate another after lunch.*
b. **I drank water in the morning and had another after lunch.*

2. Provide the denotations and semantic types of the following mass and count nouns.
(a) *apple*
$[\![apple]\!] = \lambda x.\mathbf{apple}'(x)\ \langle object, t\rangle$

(b) *water*
(c) *chair*
(e) *woman*
(f) *air*

3. Provide the denotations of the bare plural and mass nouns in join semi-lattice. Assume that there are only three entities denoted by the nouns.
(a) *dogs*
$[\![{}^*dog]\!] - [\![dog]\!] = \{\mathbf{d} + \mathbf{d}', \mathbf{d}' + \mathbf{d}'', \mathbf{d} + \mathbf{d}'', \mathbf{d} + \mathbf{d}' + \mathbf{d}''\}$

(b) *rice*
(c) *pears*
(d) *air*
(e) *sand*

4. Discuss semantics of the following artifactual aggregates. Provide the denotations of them. If they allow both mass and count interpretation, provide both.
(a) *fence*
$[\![fence]\!]_{k1} = \{\langle f_1, k_1\rangle, \langle f_2, k_1\rangle, \langle f_3, k_1\rangle, \langle f_4, k_1\rangle\}$
$[\![fence]\!]_{k2} = \{f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4, k_2\}$

(b) *furniture*
(c) *stone*
(d) *silverware*
(e) *line*

5. Mass and count nouns can be shifted to each other. Indicate the direction of the shift, and the intended interpretations.
(a) *I had two beers.*
Shift from mass to count; refers to two servings or kinds of beer.

(b) *You put apple in the salad.*
(c) *There was dog all over the highway.*
(d) *I bought a wine.*
(e) *I had lamb for dinner.*

6. Provide the denotations and semantic types for the following object-type nouns. For artifact nouns, provide their telic roles using meaning postulates.
(a) *cup*
$[\![cup]\!] = \lambda x.\mathbf{cup}'(x)\ \langle artifact, t\rangle$
$\forall x.\mathbf{cup}'(x) \rightarrow \exists w \exists e.\mathbf{used\text{-}to\text{-}drink}'_w(x, e)$

(b) *mud*
(c) *vehicle*

(d) *horse*
(e) *tip*

7. Explain the following data in terms of the flexibility of the animate and inanimate domains.
(a) *The ham sandwich wants to pay.*
food to the person who ordered the food

(b) *She read Shakespeare.*
(c) *He looked at the stone lion.*
(d) *Nature is generous.*
(e) *Korea is rejoicing after the World Cup victory.*

8. Provide denotations of the following deverbal nouns using neo-Davidsonian event semantics.
(a) *building*
$[\![\textit{building}]\!] = \lambda y \lambda x \lambda e.\textbf{building}'(e) \wedge \textit{agent}(e) = x \wedge \textit{theme}(e) = y$
⟨*object*, ⟨*animate*, ⟨*bounded-durative-event*, *t*⟩⟩⟩

(b) *drop*
(c) *report*
(d) *production*
(e) *obsession*

9. Categorize the following abstract nouns into sub-types (bodily states, mental properties, emotional states, behavioral properties), and provide examples, if there are any, where they can be counted.
(a) *honesty*
Behavioral properties cannot be counted.

(b) *hunger*
(c) *intelligence*
(d) *annoyance*
(e) *justice*

10. Provide denotations of the abstract nouns in 9.
(a) *honesty*
$[\![\textit{honesty}]\!] = \lambda s \lambda w \exists x.\textbf{honest}'(s, x) \wedge \textit{loc}(w, s)$

Notes

1 An alternative to Link's theory argues that mass nouns do have minimal parts, but they cannot be pluralized because they are already plural inherently (Chierchia, 1998). In this theory differences among mass nouns (e.g., *water* versus *furniture*) are explained away by appealing to vagueness.

2 Landman (1991) points out an interesting asymmetry between these operations. Packaging water into standard servings and then taking the set of parts of the serving gives back the original water. However, grinding a stick into sawdust and then packaging the sawdust does not give the original stick, but a package of sawdust.

3 Grimm and Levin (2017) argue that the relevant events must be simple, minimal events involving one drinking, rather than the complex event fused from all the drinking events. Minimal events are those which cannot be further decomposed into sub-events, defined in (i). $e' < e$ means e' is larger than e.

(i) Minimal event with respect to a predicate: $\min(e, P) = P(e) \wedge \neg\exists e'.\ e' < e \wedge P(e')$

4 As previously discussed, the term stage-level comes from Carlson's (1977) distinction between stage-level and individual-level predicates among stative predicates. The former describes a more permanent property (e.g., *altruistic*) whereas the latter expresses a temporary property (e.g., *available*).

5 Temporal and locative nouns, albeit inanimate, occur frequently in genitives, as in (i), due to their inherent referential anchor function.

(i) a. yesterday's news > news of yesterday
  b. Korea's capital > the capital of Korea

6 We will discuss the metonymic and metaphoric extensions in the next chapter.

7 Deverbal nouns may be derived from their cognate verbs through zero derivation, as examples in (ia) show, but they typically employ Latinate nominalizing suffixes in English, listed in (ib).

(i) a. zero derivation: *collapse, increase, decrease, change, crash, turn, fall, drop*, etc.
  b. Latin-nominalizing suffixes -*ment*, -*tion*, -*al*: *detachment, establishment, government, movement, development, explosion, destruction, production, creation, consumption, arrival, denial, approval, disposal, rental*, etc.

8 Grimm's (2013) corpus study shows that countable interpretations dominated in general, regardless of the lexical aspect of the cognate verb. Contra Brinton (1998), there are many zero-derived nouns that are not countable, e.g., *blame*, *chatter*, *dissent*, or *swagger*.

8 Metonymy and Metaphor

8.1 Metonymy and Its Neighboring Concepts

8.1.1 Diverse Relations in Metonymy

In this chapter, we will discuss metonymic and metaphoric extensions of nominal senses. Although these are called figurative use of language, their use is largely conventionalized and regular, and is commonly found in everyday speech. Formal semanticists used to set these non-literal meanings aside, relegating them to pragmatics, but much progress has recently been made to explicate their semantics using formal tools, deepening our understanding of their meaning.

As was briefly discussed in Chapter 1, metonymy is a case where a noun denotes something that is conceptually related to its actual referent. The relationships can be quite diverse, as illustrated in (1).

(1)
a. There were new <u>faces</u> at the party. (part for whole)
b. Your <u>shoes</u> are untied. (whole for part)
c. The <u>kettle</u> is boiling. (container for content)
d. He's got a <u>Picasso</u> in his den. (producer for product)
e. <u>Washingto</u>n is insensitive to the needs of the people. (place for institution)
f. Let's not let Thailand become another <u>Vietnam</u>. (place for event)
g. The <u>car</u> is waiting in the driveway. (object for user)
h. The <u>newspaper</u> telephoned today. (institution for people)
i. The rest of the <u>house</u> was sleeping. (structure for people)

Let us call the intended referent A′ and the literal referent A. In a metonymic relation A → A′, part-to-whole, whole-to-part or part-to-part relations of a referential domain are inferred, but they are not strictly entailed: A kettle needs not contain water, a product may not have a known producer, etc. We also have a sense that the literal meaning results in a sortal mismatch between the argument and the predicate. For example, *boil* requires a liquid

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argument but instead a solid artifact argument *kettle* is given to it in (1c) above. To resolve the sortal mismatch, it is interpreted as denoting liquid in it. The following questions immediately arise regarding metonymy. Where does the relation between the actual denotation and the related denotation come from? How do we determine the appropriate relation, which largely depends on pragmatics and world knowledge?

8.1.2 Metonymy and Reference Transfer

Metonymy has many neighboring concepts. This section and the next will compare metonymy with other, related types of semantic shifts. The relationship between A and A′ is tight and conventional in metonymy. For example, containers are artifacts whose main function is to contain something, and institutions exist for the people affiliated with them. Because both A and A′ come from the same referential domain, no reference shift actually occurs in metonymy, which is evidenced by the acceptability of anaphora and copredication, as shown in (2). *The pot* refers both to the artifact and the content in it, *Plato* refers both to the person and his book, and *the newspaper* refers both to the printed material and the institution that printed it. These related senses can be invoked in the same sentence, allowing copredication, and can be referred back using pronouns, permitting anaphora.

(2) a. <u>The pot</u> is boiling. <u>It</u> is made of metal.
b. <u>The pot</u>, which is boiling, is made of metal.
c. <u>Plato</u> was a great man. <u>He</u> is on the top shelf.
d. <u>Plato</u>, who was a great man, is on the top shelf.
e. I used to work for <u>the newspaper</u> that you are reading.

Metonymy is thus clearly distinguished from actual **reference transfer** supported only by a specific discourse situation, discussed in Nunberg (1979). Unlike metonymy, anaphora and copredication are not acceptable in the case of reference transfers, as shown in (3). The examples in (3) demonstrate that the ham sandwich and the person who ordered it do not come from the same semantic domain but only loosely connected via a restaurant scene.

(3) a. <u>The ham sandwich</u> left in a hurry. *<u>It</u> was too salty.
b. *<u>The ham sandwich</u>, who left in a hurry, was too salty.
c. <u>The ham sandwich</u> left in a hurry. <u>He</u> left no tip.

Metonymy also differs from accidental homonymy, which does not allow copredication, engendering a zeugma effect, as in (4).

(4) *The <u>bank</u> is overflowing and is specializing in IPO. (Asher, 2011)

For this reason, Pustejovsky (1995) argues that the information that a kettle is for boiling something is not only part of our world knowledge but is encoded in the lexical entry of *kettle* and available for syntactic selection. According to him, this information is coded as an argument to the predicate that fills the telic role of *kettle.*

8.1.3 Metonymy, Coercion and Dot Objects

As previously discussed, coercion occurs when an object is interpreted as an event, in which case there is a type shift from entities to events involving those entities. As Pylkkanen (2008) observes, unlike metonymy, coercion does not allow anaphora and copredication between objects and events, as shown in (5b).

(5) a. I enjoyed reading those books but it ruined my eyes.
  b. *I enjoyed those books but it ruined my eyes.

Metonymy also differs from dot objects that we discussed in Chapter 6, whose literal meaning encompasses different aspects of one and the same referent. One of the examples of dot objects we discussed was *book*, which is inseparably a physical object and information at the same time. By contrast, the container and the content, for example, are distinct and separable. Whereas *kettle* does not have *water* as one of its entries in dictionaries, *book* has *information* as one of its entries. Copredication and anaphora are acceptable for dot objects as shown in (6) simply because their reference never changes. We normally do not even notice that we are predicating two different aspects of *book*.

(6) a. This book is thick and boring.
  b. I put the book back on the shelf. It was unreadable.

Table 8.1 summarizes the different sense extension relations. They form a scale from the closest to the farthest semantic relationship between the senses.

Table 8.1 Different sense extension relations

dot object	*metonymy*	*reference transfer*	*coercion*	*homonymy*
literal meaning containing two aspects or tropes of the same entity	two closely related but separable parts of the same entity	different and otherwise unrelated entities connected via utterance context	different types between entities and events involving those entities	unrelated senses of an accidentally identical form

In this chapter, we will focus on metonymy, comparing it mainly to reference shift.

Reflection

- How do dot objects, metonymy, coercion, polysemy and homonymy differ? Why is it important to distinguish between them?
- How is the relation between the actual referent and the intended referent determined in metonymy? Is metonymy a uniform phenomenon? Do you think it is possible to offer a principled account for such diverse relations?
- Do you think metonymy and reference transfer differ semantically, or differ only in degree of conventionalization? Can you imagine a situation where some novel reference transfer becomes conventionalized metonymy?

8.2 Theories of Metonymy

Two divergent approaches to metonymy have been proposed. **Rule-based approaches** treat them as a result of conventionalized and regular rule applications, differing only with respect to whether the rule is lexical, as in the analyses of Copestake and Briscoe (1995) and Pustejovsky (1995), or compositional, as in Dölling's (1995) account. These approaches view meaning adjustments as irregular reinterpretations that are triggered by semantic conflicts arising in sortal mismatches. The potential to adjust the meaning is added in individual cases that require for it. **Radical pragmatic theories**, on the other hand, assume an independent pragmatic account of extended reference, obviating the need to introduce linguistic conventions (Nunberg, 1979). These theories reject the primacy of literal meaning or a categorical difference between the literal and metonymic senses. These theories claim that world knowledge is crucial in inferring which extensions in meaning are appropriate for a word, resulting in various proposals, such as relevancy, saliency and cue validity, among others. In what follows, we will discuss these alternative theories in turn in more detail.

8.2.1 Radical Pragmatic Theories

Radical pragmatic theories reject the involvement of linguistic conventions in metonymy. As briefly mentioned in Chapter 1, in these theories, literal meaning is not primary and hence there is no categorical difference between the literal and metonymic senses. Among the various factors, Nunberg (1979) proposes **cue validity** as crucial, which concerns the conditional probability of an entity being in a category given that it has a feature. In the context of metonymy, higher cue validity means higher probability of one concept occurring in the context of another. The licensing of cue-validity through cultural beliefs explains impossible metonymies. For example, (7a) is acceptable because of the common belief that a creative individual is responsible for the intrinsic value of her creation, thus acquiring a high cue-validity, whereas (7b) is unacceptable precisely because there is no such belief (Papafraugou, 1996).

(7) a. If you want to study Classics, you have to know <u>Homer</u> pretty well.
b. ??Mary won the cooking contest, although <u>Jane</u> was very tasty as well.

Nunberg (1979) assimilates metonymy (and polysemy in general) to deferred reference or indexicality. Fauconnier (1985) also views metonymy as a type of deferred reference, which is made available via the links established between objects on the basis of psychology, culture or even local pragmatics. These links are captured by what Fauconnier calls "**connectors**," which are basically pragmatic functions. Metonymy is subsumed under a more general identification principle, defined in (8).

(8) If two objects *a* and *b* are linked by a pragmatic function F (b = F(a)), a description of *a*, d_a, may be used to identify its counterpart *b*.

How are these links established? Fauconnier proposes that the connectors form part of what Lakoff (1987) call **Idealized Cognitive Models** (ICM) consisting of complex concepts and general categories that are available to us to making sense of our experiences. Metonymic connectors are assumed to operate on elements within the same ICM.

A departure from the aforementioned associationist view of metonymy is taken by Papafraugou (1996). She rejects traditional rule-based and case-specific associative theories as well as Gricean inference calculation theories for figurative languages including metonymy, instead proposing a **relevance theory**-based account for it. Nunberg's, Fauconnier's and Lakoff's theories all assume structured cognitive models including "stand-for" relations, cognitive apparatus prior to experience. This means that concepts like PART, WHOLE, CONTAINER, CONTAINED, CAUSE, ACTION, etc., must be *a priori* and so does the ability to relate them prior to any experiential input. Papafraugou (1996) rejects the idea that metonymy presupposes such preexisting cognitive structure containing a list of isolated metonymic concepts, such as container for contained and place for event; instead, it derives from our general abstract conceptualizing capacity, which is metarepresentational, experience-triggered and context-dependent. She argues that the possible metonymic relations can be as diverse as encyclopedic relations are, and thus need not be listed as rules at all. Rather, metonymy exists because isolating salient properties of objects for the purpose of referring or identifying reduces cognitive effort and thus increases relevancy. Interpretive uses of concepts, therefore, need not be taught as they arise naturally. She supports this claim by several empirical facts. First, the relation typically goes from concrete to abstract and simple to complex (e.g., physical object to person) but not the other way around. Second, the instantiations of a single metonymic concept do not form a natural class. For example, the "object for user" relation is realized with increasing creativity in (9), raising the question as to the level of abstraction on which metonymic functions are to be defined.

(9) a. <u>The buses</u> are on strike.
 b. Are you <u>the cab</u> parked outside?
 c. I wouldn't marry <u>a Mercedes</u> but I could live with <u>a Volvo</u>.

She also points out that the dichotomy between conventional and creative metonymy is not so clear-cut, citing examples like (10).

(10) You should avoid marrying <u>a sheep</u> at all costs. (someone born in the Year of the Sheep)

Psycholinguistic supports exist for radical pragmatic theories of metonymy. Pylkännen (2008), based on psycho- and neuro-linguistic studies, suggests that metonymy is outside of grammar and may well be part of social cognition. If this was confirmed, syntax-semantics mismatch in general may be able to find a much easier solution. Frisson and Pickering (1999) showed that both literal and familiar metonymic meaning are activated at the same time, and metonymy does not result in processing cost for native speakers, unlike type-shifting coercion, which does. In their later study, Frisson and Pickering (2007) showed that even novel metonymy (e.g., *read Needham*) does not delay reading time if the context establishes the author-book relation. Pinango et al. (2017) used a variety of psycho- and neuro-linguistic methods to compare the processing of conventional metonymy and reference transfer and argued that conventionalization does not create a new category, but rather acts as a facilitator that assists the use of metonyms in a gradient manner.

8.2.2 Rule-Based Approaches

Copestake and Briscoe (1995) treat metonymy as a semi-productive sense extension, formally identical to derivational morphology, where lexical rules create derived senses from basic senses. Grinding and portioning/packaging we discussed in the previous chapter are captured by lexical rules in this system. The lexical entry of *lamb*, for example, has two qualia types ANIMAL and C-SUBST, where the latter is a type for comestible naturally derived substances, which are selected in different predications. Lexical rules also apply to phrases, as in (12), to which the PLACE to GROUP sense extension applies.

(11) <u>The south side of Cambridge</u> voted Conservative.

Support for lexical rule approach comes from Nunberg and Zaenen (1992), who observe cross-linguistic variation in metonymy. Conventionalized subcases of grinding vary among different languages; Eskimo does not allow grinding of animals, while English lacks grinding of fruits and nuts to produce liquids. This theory is compatible with preemption of metonymy by synonyms, which is common in lexical meaning extensions.

On the other hand, Dölling (1995) uses an implicit shift operator which is introduced in the process of composition, rather than lexical rules. Type-shifting, since Partee and Rooth (1983), has been a common semantic tool to solve syntax-semantics mismatch problems. Metonymy can be viewed as involving a **sortal shift operator** that are parallel to type shifting operators. The compositional approach captures meaning adjustments by a semantic structure that is underspecified in parts and thus allows for a pragmatic specification of particular meaning components. The potential to exploit conceptual knowledge is thus built into the semantic structure in advance. Dölling (1995) views metonymy as part of larger phenomena of relations linking entities from different sortal domains. For example, objects are instances of kinds. The predicate **inst′** ("instance of") denotes a relation between the domain of objects and the domain of kinds.

(12) $\forall x \forall y.\mathrm{inst}'(\mathrm{x}, y) \rightarrow \mathrm{object}'(x) \wedge \mathrm{kind}'(y)$

The relation between an institution and the people who are associated with it in some capacity (supporters, representatives, employees, etc.), **ass′** ("associated with") is used.

(13) $\forall x \forall y.\mathrm{ass}'(x, y) \rightarrow \mathrm{person}'(x) \wedge \mathrm{institution}'(y)$

Psycholinguistic findings supporting rule-based accounts of metonymy are as follows. Klein and Murphy's (2002) categorization and inference tasks showed that metonymic senses were not related to the literal sense, suggesting that they are stored separately in the mental lexicon, similar to derived words. They also found that using a word in one sense competed with using it in another sense, rather than facilitating it. Rabagliati et al. (2011) discovered that conceptual metrics, such as similarity, centrality, salience, etc., did not increase the acceptability of metonymy in their experiments, which led them to conclude that metonymy is rule-governed. In their experiments, both conceptual connections and acceptability were collected from the same participants through paraphrases and verbal ratings. Slavakova et al. (2013) report that different languages treat novel and conventional metonymy differently. Their Korean group judged novel (instrument for agent and loose association, i.e., reference shift) and regular (producer for product and possessor for possessed) metonymy equally accurately to the baseline in the paraphrase task and the acceptability rating task. Large standard deviations and variability among individual Korean speakers led them to conclude that they are most likely computing the meaning shifts online without much conventionalization. By contrast, English speakers made a clear distinction between regular and novel metonymy, with regular metonymy lexicalized and novel metonymy computed online. Such cross-linguistic and individual differences, they argue, point to the rule-based and conventional nature of metonymy.

8.2.3 An Integrated Approach

Comparing these two contrasting approaches, radical pragmatic theories are attractive as they offer a unified and intuitive explanation to metonymy, but scholars do not agree on the exact nature of the underlying cognitive mechanism. Rule-based theories appear to be more descriptively accurate for individual cases, but do not offer an answer to the fundamental question why metonymy exists in the first place. Recent experimental evidence from either point of view, however, surprisingly converges on the same conclusion. The lack of additional processing cost for metonymy discovered in Frisson and Pickering (1999, 2007) shows that no recalculation from literal meaning is involved. This means that either a very abstract or underspecified meaning is initially accessed, or metonymic senses, once developed, take on a life on their own, and are stored in memory as separate entries for a direct access. Klein and Murphy (2002), who showed that metonymic senses are not related to the literal sense, and Rabagliati et al. (2011), who found that conceptual metrics, such as similarity, centrality, salience, etc., did not increase the acceptability of metonymy, further support separate storage of metonymy. It could very well be the case that each theory describes different historical stages of metonymy development. Radical pragmatic theories account for the initial stage: It is clear that metonymy has natural and universal conceptual underpinnings. As Papafraugou (1996) argues, metonymy derives from our general abstract conceptualizing capacity, such as isolating salient properties of objects for the purpose of referring or identifying. This explains cross-linguistic similarities in metonymic relations and early development of metonymy in children. Rule-based theories explain the later stage better: Once developed via a natural and universal cognitive process, further lexicalization and conventionalization patterns become only semi-productive, compounded by frequency effect, preemption and competition. This would explain cross-linguistic variations.

Let us pursue flexible rule-based analyses which fit better with formal analyses and better represent the current stage. A possession relation holds in (14), where the verb *hire* requires a human argument but instead is predicated of a body part.

(14) We don't hire long hairs.

To avoid a sortal clash resulting in a failure to interpret the sentence, a specific **shifting operation** $\boldsymbol{f_R}$ is postulated, connecting a body part to a person related to it by free relation R (Borschev and Partee, 2001). In (15a), *long* *hairs* denote a plural individual (Link, 1983), represented as the constant l. The formula can be loosely paraphrased as "There is a *y* which bears relation *R* to the unique body part which in the given context instantiates the kind *long hair*." The constitution set of a person contains various body parts, which contains hair as a member. To interpret (14), the information that people have hair is encoded as a presupposition and thus available for syntactic selection.

(15) a. $[\![\textit{long hairs}]\!] = \mathrm{l}$ — *object*
b. $[\![\textit{hire}]\!] = \lambda y \lambda x.\mathrm{hire}'(x, y)$ — $\langle \textit{animate}, \langle \textit{animate}, t\rangle\rangle$
c. $[\![\textit{hire long hairs}]\!] = [\lambda y \lambda x.\mathrm{hire}'(x, y)](\mathrm{l}) = \lambda x.\mathrm{hire}'(x, f_R(\mathrm{l}))$ — $\langle \textit{animate}, t\rangle$

According to Borschev and Partee (2001), the job of the compositional semantics ends here, and world knowledge takes over to determine what *R* is. In case of (15), *R* is part-of relation, which Arapinis (2015) assumes to be the default relation in metonymy ($[\![R]\!] = \lambda x \lambda y.\mathrm{part}'(x, y)$). In (15c), $f_R(\mathrm{l})$ will be substantiated into $f_{have}(\mathrm{l})$, which can denote people with long hairs.

In other cases, the relation *R* is less clear. For example, in (16), a location name signifies an institution, people or an event that are associated with it, which are variable and thus may be more pragmatic than lexical.

(16) a. <u>The newspaper</u> telephoned today. (institution for people)
b. <u>Washington</u> is insensitive to the needs of the people. (place for institution)
c. People still remember <u>Vietnam</u>. (place for event)

To represent such relations, we can either employ a constant whose interpretation is left vague or utilize context-dependent variables with some lexically specified constraints on their values. In any case, non-linguistic knowledge will have to enter the semantic composition in many instances of interpreting the given constant or variable. Let us consider (16a), which is true if and only someone working for or representing the newspaper called. To represent such knowledge, let us expand the use of our meaning postulate to include commonsense entailments (Hobbs, 2004). To understand this sentence, our background knowledge base, encoded in meaning postulates, must include the following facts. (17a) says institutions have people who work for it. (17b) says if *x* works for *y*, then *y* can be used to refer to *x*.

(17) a. $\forall x.\mathrm{institution}'(y) \rightarrow \exists y.\text{work-for}'(y, \mathrm{x}) \wedge \mathrm{person}'(y)$
b. $\forall x \forall y.\text{work-for}'(x, y) \rightarrow R(y, x)$

The compositional analysis of (16a) is given in (18).

(18) a. $[\![\textit{the newspaper}]\!] = \text{n}$ *object*
b. $[\![\textit{called}]\!] = \lambda x.\text{called}'(x)$ $\langle \textit{animate, t} \rangle$
c. $[\![\textit{called}]\!]([\![\textit{the newspaper}]\!]) = [\lambda x.\text{called}'(x)](\text{n}) = \lambda x.\text{called}'(f_{\textit{work-for}}(\text{n}))$

(16b) is true if and only if people representing the government located in Washington D.C. are insensitive. In the case of the metonymically shifted meanings of *Washington* in this example, the specified semantic interpretation is obtained by using contextual knowledge to fix the relation *R* as *located-in*, shifting the place to one of the most prominent institutions that is located in it. From there, there is another shift from the institution to people who work for it. (19a) conveys that the government is located in the capital of a country and has representative officers who work to meet people's needs. The rule in (19b) states that if *x* represents *y*, then *y* can be used to refer to *x*.

(19) a. $\forall x \forall y.\text{capital-of}'(x, y) \wedge \text{country}'(y) \rightarrow \exists z \exists v.\text{government}'(z) \wedge \text{located-in}'(z, x) \wedge \text{represent}'(v, z) \wedge \text{meet-people's needs}'(v)$
b. $\forall x \forall y.\text{represent}'(x, y) \rightarrow R(y, x)$

A compositional analysis of (16b) will look like (20) in this approach. All of the logical forms in (20) straightforwardly follow from our existing knowledge base except for the conjunct insensitive′(x). Hence, we assume that it is the new information conveyed by the sentence.

(20) a. $[\![\textit{Washington}]\!] = \text{w}$ *object*
b. $[\![\textit{is insensitive}]\!] = \lambda x.\text{insensitive}'(x)$ $\langle \textit{animate, t} \rangle$
c. $[\![\textit{is insensitive}]\!]([\![\textit{Washington}]\!]) = [\lambda x.\text{insensitive}'(x)](\text{w})$
$= \lambda x.\text{insensitive}'(f_{\textit{work-for}}\,(f_{\textit{located-in}}(\text{w})))$

(16c), which is true if and only if people remember the Vietnam war, will involve a similar process of mapping a place to a significant event that happened there, captured by the meaning postulates in (21). (21a) states that places are where events happen, and (21b) ensures that if *x* happened in *y* and *x* is significant/widely known, then *y* can be used to refer to *x*.

(21) a. $\forall x.\text{place}'(x) \rightarrow \exists y.\text{happen}'(y, \text{x}) \wedge \text{event}'(y)$
b. $\forall x \forall y.\text{happen-in}'(x, y) \wedge \text{significant}'(x) \rightarrow R(y, x)$

(22) is the compositional analysis of (16c).

(22) a. $[\![\textit{Vietnam}]\!] = \text{v}$ *object*
b. $[\![\textit{remember}]\!] = \lambda y \lambda x.\text{remember}'(x, y)$ $\langle e, \langle \textit{animate, t} \rangle \rangle$
c. $[\![\textit{remember}]\!]([\![\textit{Vietnam}]\!]) = [\lambda y \lambda x.\text{remember}'(x, y)](\text{v})$
$= \lambda x.\text{remember}'(x, f_{\textit{happened-in}}(\text{v}))$ $\langle \textit{animate, t} \rangle$

Postulating *R* but leaving its content to context has an advantage over other more rigid approaches that try to find the basis of a metonymic reinterpretation in the structure of the lexical entries themselves. The latter cause a more severe problem in integrating linguistic and non-linguistic sources of knowledge in an effort to disambiguate and shift lexical senses in context.

Reflection

- Do you think metonymic meaning extension comes from language specific rules or general pragmatic knowledge? Explain why.
- If metonymy derives from conventionalized rules, why are the same metonymic extension observed in various typologically unrelated languages? On the other hand, if it is motivated by a universal pragmatic process, why is there crosslinguistic variation?
- Do you find the analysis postulating *R* but leaving its content to context plausible? How does the pragmatic knowledge interact with the semantic knowledge to interpret metonymy?

8.3 Metaphor as Conceptual Domain Mapping

8.3.1 Comparison- and Categorization-Based Theories

Metaphors have long been ignored in formal semantics as non-standard use of language since most of them are literally false. Consider (23), which can never be true under any circumstances in its literal interpretation.

(23) $[\![$*Fido is a rock*$]\!]$ = rock′(f) = 1 iff. Fido is a member of the set of rocks.

However, metaphor is in fact not restricted to poetic or rhetorical usages but commonplace in everyday conversation, serving an important function of reasoning about and communicating abstract concepts. While metaphor is commonly assumed to involve some kind of cross-domain mapping, little consensus exists among philosophers on how these mappings take place. A long-standing theoretical debate exists between **comparison-based theories** advocated by Miller (1979), Ortony (1979) and Tversky (1977), among others, and **categorization-based theories** in Glucksberg and Keysar (1990), Johnson (1996) and Kennedy (1990). The former argues that metaphor occurs when there is a feature-matching based on similarities between the two domains. The problem with this theory is that not all metaphors are based on feature sharing or perceptual similarities. Moreover, when they are, not every property shared by the target and source is relevant to the meaning of the metaphor. The latter argues that the source and the target domains are not directly compared, but instead the source domain triggers a metaphoric super-category whose prototype is reified as the source term. For instance, (24) invokes a metaphoric category of "any situation that is unpleasant and confining."

(24) My job is a jail.

Bowdle and Gentner (1999), however, point out that the source domain can trigger different kinds of metaphoric categories depending on the target domain, as illustrated in (25). (25a) implies that each child is unique, whereas (25b) implies that youth is ephemeral. In fact, possible metaphoric categories are not limited to these, but infinite.

(25) a. A child is a snowflake.
b. Youth is a snowflake.

8.3.2 Conceptual Metaphor Theory

In linguistics, Lakoff and Johnson's (1980) *Metaphors We Live By* offers probably the best-known analysis of metaphors, called **Conceptual Metaphor (CM) Theory**. According to the authors, the essence of metaphor is understanding and experiencing one kind of thing in terms of another. They also emphasize the corporeal nature of this experiential grounding—the notion of **embodiment** as the body is a source domain par excellence for experientially grounded metaphoric mappings. Since metaphor is fundamentally a cognitive phenomenon, rather than a purely lexical one, they argue, it should be analyzed as a mapping between two cognitive domains that include many lexical items. These domains comprise coherent sets of human beliefs, actions, experiences or imaginations. For example, in the "love is a journey" metaphor, which underlies many expressions given in (26), the experience of being in a loving relationship is mapped onto the experience of traveling.

(26) a. Look how far we've come.
b. We are at a crossroads.
c. We'll just have to go our separate ways.
d. We cannot turn back now.
e. We are stuck.
f. This relationship is a dead-end street.

The analysis of conceptual metaphor involves the mappings between the source and the target domains inherent in metaphoric patterns. These domains for the "love is a journey" metaphor are given in Table 8.2.

Lakoff and Johnson (1980) and Lakoff (2008) do not restrict metaphors to emotional concepts. They argue that many of the most basic concepts in our cognitive systems are also comprehended normally via metaphor-concepts

Table 8.2 The source and target domains of "love is a journey" metaphor

Source	*target*
the travellers	the lovers
the means of transport	the relationship itself
the journey	the evolution of the relationship
the obstacles encountered	the difficulties experienced
decisions about which way to go	choices about what to do
the destination of the journey	the goals of the relationship

like time, quantity, state, change, action, cause, purpose and means. For example, time is understood in terms of things (i.e., entities and locations) and motion, where the present time is assumed to be at the same location as a canonical observer. The concept of quantities involves at least two metaphors. The first is the "more is up, less is down" metaphor. A second is the "linear scales are paths" metaphor which organizes an abstract domain in the relation of space like up–down, inside–out, front–behind, shallow–deep and so forth.

Despite its intuitive appeal, the CM Theory has been subject to various criticisms. Kövecses (2005; 2010) points out that the sources CM theory use are rather limited and do not reflect the actual cases in which metaphorical expressions are used in natural discourse. While metaphorical expressions found in corpora or dictionaries can be attributed to larger conceptual mappings, those used in everyday conversation between individuals may not be categorized as easily. Which components of conceptual domains lend themselves to metaphoric mappings is also unclear. For example, McGlone (2007) points out that in "theories are buildings" metaphor, theories can be said to have foundations, but not windows. The most serious problem is that Lakoff's proposed bodily experiences cannot account for both the universality of certain conceptual mappings and the cultural specificity of others. For example, "knowing is seeing" mapping is used in English, but in a large number of Australian languages, the mapping is realized as "knowing is hearing" (Ibarretxe-Antuñano, 2013). The fact that even primary metaphors, such as knowledge and perception, change in different languages casts doubt on CM's claim about universality of conceptual metaphors. It remains to be seen whether metaphor is universal and cognitively grounded, or subject to crosslinguistic variation through "culture sieve," a term proposed by Ibarretxe-Antuñano (2013) to describe the filtering effect of the culture on common bodily experiences. Evans (2007, 2010) convincingly argues that CM is actually not a linguistic theory but a theory about the role of non-linguistic conceptual processes. For our purpose of describing compositional contributions of words, it is unclear whether the example like (27b) result in type or sortal mismatches between the arguments and its predicates, while the example in (27a) clearly do.

(27) a. Fido is a rock.
b. Look how far we've come.

Therefore, whether (27b) is interpreted as referring to a relationship may well be outside the domain of semantics and even pragmatics. We still need some kind of theory that explains how the cognitive system interfaces with the linguistic system, but such theory, strictly speaking, would not be a semantic theory. In the next section, we will introduce formal theories of metaphor.

Reflection

- Why is metaphor often set aside in formal semantics? Do you think such attitude is justified?
- Why do you think people conceptualize social relations in terms of spatial concepts like vertical axis and horizontal paths?
- What are the shortcomings of the Conceptual Metaphor Theory? Do you think it is a linguistic theory or not?

8.4 Formal Approaches of Metaphor

8.4.1 A Reductionist Approach

Asher and Lascarides (2001), van Ganabith (2001) and Vogel (2001) agree that it is not only possible but also necessary to give a systematic formal analysis to metaphor because it is part of the productive linguistic system. van Ganabith (2001) is a formal analysis of metaphor which assimilates it to simile. Like Asher and Lascarides (2001), he also views metaphor as a reinterpretation due to a type/sortal mismatch. To avoid stating a blatant falsehood of equating human and animal, he points out that what is conveyed by (28a) is not that the hearer is a member of the set of foxes. Instead, it can be paraphrased as (28b).

(28) a. You are a fox.
b. There is a property that is common between you and every fox.

van Ganabith (2001) provides a compositional analysis of (28a) as in (29). The copula *be* introduces a relation R, which is an identity relation by default (i.e., $[\![R]\!] = \lambda y \lambda x. y = x$). When there is a type mismatch, as in (28a), it is type shifted to a relation of common property, given in (29b).

(29) a. $[\![you]\!] = \mathrm{h}$ *animate*

b. $[\![are]\!] = \lambda Q \lambda x \exists P.P(x) \wedge \forall y.Q(y) \to P(y)$ $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$

c. $[\![fox]\!] = \lambda z.\mathrm{fox}'(z)$ $\langle natural\text{-}kind, t\rangle$

d. $[\![are]\!]([\![fox]\!]) = [\lambda Q \lambda x \exists P.P(x) \wedge \forall y.Q(y) \to P(y)](\lambda z.\mathrm{fox}'(z))$
$= [\lambda x \exists P.P(x) \wedge \forall y.\lambda z.\mathrm{fox}'(z)](y) \to P(y) = \lambda x \exists P.P(x) \wedge \forall y.\mathrm{fox}'(y)$
$\to P(y)$ $\langle e, t\rangle$

e. $[\![are\ a\ fox]\!]([\![you]\!]) = [\lambda x \exists P.P(x) \wedge \forall y.\mathrm{fox}'(y) \to P(y)](\mathrm{h})$

f. $[\![you\ are\ a\ fox]\!] = \exists P.P(\mathrm{h}) \wedge \forall y.\mathrm{fox}'(y) \to P(y)$
= 1 iff. if there exist a property that is common to every fox and the hearer. t

Formal semantics defines the truth condition, leaving the nature of the property or properties to contexts. Meaning postulates in (30) can fill in the necessary information for the comprehension of sentences like (28a), where the common property would be characteristics of foxes such as being sly and clever. (30b) states that if x and y have a common property, then y can be used to describe x.

(30) a. $\forall x.\mathrm{fox}'(x) \to \mathrm{sly}'(x) \wedge \mathrm{clever}'(x)$

b. $\forall x \forall y.\text{have-common-property}'(x, y) \to R(y, x)$

A problem with van Ganabith' (2001) analysis is that it cannot distinguish between metaphor and simile. The latter cannot be false because it simply says there is something in common between the two compared entities, which can be verified by a trivial property such as self-identity (the property of being identical to itself, $\lambda x.x = x$). Metaphor, by contrast, makes a contingent claim. To avoid this problem, van Ganabith (2001) requires P not be a universal property that applies to every entity. We can add the condition $\neg\forall y.P(y)$ to ensure this, as in (31).

(31) $[\![are]\!]([\![fox]\!]) = \lambda x.\exists P.P(x) \wedge \forall y.\mathrm{fox}'(y) \to P(y) \wedge \neg\forall y.P(y)$

Even with this amendment, what van Ganabith's reductionist theory offers is an existential assertion of any nontrivial likeness of the two categories, failing to explain the special force of metaphors that similes lack (Vogel, 2001). Psycholinguistic studies show that metaphors are perceived stronger than corresponding similes, and a unique related simile is not necessary to process metaphor (Glucksberg and Keyser, 1993).

8.4.2 An Intensional Approach

To remedy these problems, an intensional analysis of metaphor have been proposed (Hintikka and Sandu, 1994; Vogel, 2001, 2011). According to Vogel (2001), predicates are mapped to two characteristic sets rather than one, one of which is the set of objects satisfying the literal sense and the other set, initially empty, is the set of objects satisfying the predicate metaphorically. For each predicate, a different possible world provides the characteristic set. A particular world is either literal or metaphorical, depending on their extensions in that world. In this theory, literal vs. metaphoric meaning derives from the predicate-relative classification of the worlds. He employs the two classic modal operators, letting them to quantify over senses. Basically, this theory adds a set of indices corresponding to possible senses of predicates and relativize the interpretation to the set. A literal expression is true at an index if the index is among the literal one, whereas a metaphoric expression is true at an index which comes from a metaphoric class of indices. Therefore, there is no clear-cut division between literal and metaphoric language, but a uniform mechanism of mapping an expression with its extensions in possible worlds is at work. This is in line with the fact that some expressions are literal to some speakers and metaphoric to others. We can even capture the different dimensions a metaphor is sensitive to. The non-literal meaning of *library* in (32) can be a lender or a knowledgeable person. Each sense will be mapped to a different characteristic set in different possible worlds, and (32) will be true in some possible worlds where the extension of library includes people who lend books or who are knowledgeable.

(32) She is a library.

It is unclear, however, whether metaphor invariably involves intensionality. (32) asserts an experiential similarity between the subject and a library in the actual world, rather than saying that the meaning of library can differ from one world to another. Moreover, this theory is unconstrained in that it cannot explain why some metaphors are unacceptable. If metaphoric uses can always be explained by their intentions in some possible worlds, we will find few unacceptable metaphors.

8.4.3 A Pragmatic Rule Approach

Asher and Lascarides (2001), instead of attributing the verb with vague or underspecified semantics that needs to be completed by pragmatics, argue for separate conventional and metaphoric predications that are related in some predictable way. The motion verbs in (33) require spatial locations as object arguments, but the arguments given to them are not of the right type.

(33) a. He entered/came out of <u>a blue funk</u>.
b. He crossed <u>the line</u> (of permissible behavior).
c. She stayed right on <u>target</u>.
d. She is on top of <u>the situation</u>.
e. He was way off <u>base</u>.

Despite the type mismatch, the essential structure of motion verbs describing movements from a source to a goal via a path is still preserved in their metaphoric uses. For example, *enter* denotes a movement from near some location to its interior, presupposing that the location has extensions. *A blue funk* in (33a), which is a state having a temporal extension, can be conceived as such. (33a) means that he changed from being in a good mood to being in a bad mood, and vice versa. (34b) with *enter* becomes unacceptable precisely because *conclusion* lacks extensions that the verb requires; *A (disturbing) conclusion* doesn't seem to have a nearby zone. *Arrive*, on the other hand, refers to a movement not from a nearby location, but outside of it.

(34) a. We have arrived at a disturbing <u>conclusion</u>.
b. ??We have entered a disturbing <u>conclusion</u>.

When these verbs are conventionally used, the first argument must be a mobile entity and the second argument must be a spatial location. Their metaphoric use, on the other hand, triggers a type replacement from a physical location to abstract states. The argument of *enter* is not restricted to a physical space, but it must have extension, and a state or a mood can qualify. The abstract state-denoting object, however, does not change its sense, i.e., it is not reinterpreted as a physical space. Asher and Lascarides (2001) accomplish this by proposing a pragmatic rule saying that any scalar and non-scalar noun with an antonym can be construed as a location in qualitative space, meeting the conditions on their source-path-goal configurations. For example, a non-scalar noun *crisis* has an inner zone of a state of crisis and an outer zone of a state of equilibrium. Under this analysis, *enter a crisis* means that the subject was first in the state of equilibrium and then was in the state of crisis. Their pragmatic metaphor rule limits the possibilities, and discourse context fully determines the interpretation of a metaphoric use of a particular word.

Employing a similar method used for verbal polysemy, let us assume that *enter* takes only an event argument. When a location-denoting argument like *the room* is given to it, it has a literal interpretation of going in, as translated in (35a). When an abstract state argument like *the crisis* is given to it, it has the metaphoric reading of being in that state, as in (35b).

(35) a. $[\![\textit{enter}]\!]$ ⇒ $[\![\textit{enter}]\!]([\![\textit{the room}]\!])$
$\lambda e.\mathrm{enter}'(e)$ $\lambda x_{location}\lambda e.\text{go-in}'(e) \wedge \textit{theme}(e) = x_{location}$
$\langle \textit{punctual-event}, t\rangle$ $\langle \textit{location}, \langle \textit{punctual-event}, t\rangle\rangle$
b. $[\![\textit{enter}]\!]$ ⇒ $[\![\textit{enter}]\!]([\![\textit{the crisis}]\!])$
$\lambda e.\mathrm{enter}'(e)$ $\lambda x_{state}\lambda e.\mathrm{become}'(e, \mathrm{in}'(s)) \wedge \textit{theme}(e) = x_{state}$
$\langle \textit{punctual-event}, t\rangle$ $\langle \textit{state}, \langle \textit{punctual-event}, t\rangle\rangle$

Reflection

- Why is it necessary to provide a formal analysis to metaphors? Do you think formal theories of metaphor better explain the phenomenon than cognitive theories?
- What are strengths and weaknesses of the different formal approaches to metaphor (reductionist, intensional, rule-based)? Can you think of an analysis that avoids problems of these theories?
- Why do you think natural languages have metonymy and metaphor?

8.5 Conclusion

In this chapter, we discussed metonymy and metaphor, which exploit a contextually given relation between the actual denotation and the related denotation, whether it is a part-or relation, a resemblance relation, or a more open-ended relation that requires encyclopedic knowledge. We presented contrasting views of metonymy, such as lexical, compositional and radical pragmatic theories. After discussing various theories of metaphor, including the widely known conceptual metaphor theory, we discussed various formal analyses of them.

Points to Remember

- Metonymy must be distinguished from actual reference shift supported only by utterance context.
- Radical pragmatic theories of metonymy argue that it derives from general cognitive capacity and does not rely on conventional language-specific rules.
- Rule-based theories of metonymy propose lexical or type-shifting rules to explain the sense extension.
- Metaphoric mapping occurs between elements from a concrete, familiar domain to an abstract domain.
- Formal analyses of metaphor involve common properties, intentional semantics, or pragmatic rules.

Technical Terms to Remember

1. **Reference transfer:** Sense extension/shift that is supported only by a specific discourse situation.
2. **Rule-based approaches:** Approaches that treat metonymy as a result of conventionalized and regular rule applications.

3. **Radical pragmatic theories:** An independent pragmatic account based on world knowledge, obviating the need to introduce linguistic conventions.
4. **Cue validity:** The conditional probability of an entity being in a category where higher cue validity means higher probability of one concept occurring in the context of another.
5. **Connector:** Pragmatic functions that establish link between objects on the basis of psychology, culture or even local pragmatics.
6. **Idealized Cognitive Models** (ICM): A model consisting of complex concepts and general categories that are available to us to making sense of our experiences.
7. **Relevance theory:** Metonymy exists because isolating salient properties of objects for the purpose of referring or identifying reduces cognitive effort and thus increases relevancy.
8. **Sortal shift operator:** Operator that provides relations linking entities from different sortal domains to solve syntax-semantics mismatch problems, parallel to type shifting operators.
9. **Shifting operation f_R**: Shifting operator connecting an object to another object related to it by free relation *R*.
10. **Comparison-based theories:** Metaphor occurs when there is a feature-matching based on similarities between the two domains.
11. **Categorization-based theories:** The source and the target domains are not directly compared, but instead the source domain triggers a metaphoric super-category whose prototype is reified as the source term.
12. **Conceptual Metaphor (CM) Theory:** Metaphor establishes a mapping between two cognitive domains that include many lexical items whose essence is understanding and experiencing one kind of thing in terms of another.
13. **Embodiment:** The body is a source domain par excellence for experientially grounded metaphoric mappings.
14. **Reductionalist approaches:** A formal analysis of metaphor which assimilates it to simile.
15. **Intensional approaches:** Predicates are mapped to two characteristic sets, one of which is the set of objects satisfying the literal sense and the other set, initially empty, is the set of objects satisfying the predicate metaphorically.
16. **Pragmatic rule approaches:** Pragmatic rules adjust abstract entities to meet sortal requirements of the predicate without changing its type, and discourse context fully determines the interpretation of a metaphoric use of a particular word.

Suggested Reading

Nunberg (1979) is a classic reading in metonymy. See Papafragou (1996) for a more radical cognitive perspective. See Copestake and Briscoe (1995) for a rule-based approach to metonymy. See Hobbs (2004) for pragmatic inference in metonymy. Lakoff and Johnson (1980) is a classic reading on metaphor. See Asher and Lascarides (2001), van Ganabith (2001) and Vogel (2001) for more details on the formal analyses of metaphor.

Practice

1. Identify the actual referent of the italicized metonymy and the relationship.
   (a) The *pot* is boiling.
   the water in the kettle, container for content

   (b) I have a *BMW*.
   (c) I have hungry *mouths* to feed.
   (d) Your *shoes* are untied.
   (e) *Wall Street is in panic.*
   (f) People remember *Tiananmen Square*.
   (g) *The buses* are on strike.
   (h) *The office* called.
   (i) You woke up *the whole house.*
   (j) I eat *lamb*.
2. Identify the type of meaning relation among dot object, metonymy, reference transfer, coercion and homonymy.
   (a) *The book is heavy but interesting.*
   dot object

   (b) *The ham sandwich is anxious.*
   I hate the president's bull.
   (d) *The Times called.*
   (e) *I finished the book.*
3. Explain why the following sentences are ungrammatical.
   (a) **The bank is overflowing and is specializing in IPO.*
   ***Bank* is homonym and two unrelated senses are co-predicated in the same sentence.**

   (b) **The ham sandwich left in a hurry because it was too salty.*
   (c) **The ham sandwich, who left in a hurry, was too salty.*
   (d) **I enjoyed those books but it ruined my eyes.*
   (e) **I finished the book but it took a long time.*

4. Analyze the sentences in terms of rule-based theories (both lexical and compositional) and radical pragmatic theories (using pragmatic functions).

(a) *I read Shakespeare.*

Lexical rule: *Shakespeare* formal qualia: AUTHOR and WORK

Sortal shift rule: $\forall x \forall y.\text{create}'(x, y) \rightarrow \text{author}'(x) \wedge \text{work}'(y)$

Pragmatic function: F(Shakespeare) = his work

(b) *I eat chicken.*
(c) *The office called.*
(d) *Korea won.*
(e) *The DVD is long.*

5. Provide a compositional analysis of the sentences in 1 using the metonymic relation *R* and meaning postulates that substantiate it in context.

(a) The *pot* is boiling.

a. $[\![\textit{the pot}]\!] = \text{p}$ ***object***

b. $[\![\textit{is boiling}]\!] = \lambda x.\text{boiling}'(x)$ **$\langle$*substance, t*$\rangle$**

c. $[\![\textit{is boiling}]\!]([\![\textit{the pot}]\!]) = [\lambda x.\text{boiling}'(x)](\text{p}) = \text{boiling}'(f_{contained}(\text{p}))$ ***t***

(b) I have a *BMW*.
(c) I have hungry *mouths* to feed.
(d) Your *shoes* are untied.
(e) *Wall Street is in panic.*
(f) We forgot *Vietnam*.
(g) *The buses are on strike.*
(h) *The office* called.
(i) You woke up *the whole house.*
(j) I eat *lamb*.

6. What are the interpretations of the following metaphors? What kind of elements are compared in the source and the target domain in each example?

(a) *My job is a jail.*

My job is unpleasant. The confining aspect of a jail is compared to a similar aspect of the speaker's job.

(b) *You are a fox.*
(c) *Fido is a rock.*
(d) *Life is a journey.*
(e) *Juliet is the Sun.*

7. List examples based on the following metaphor.

(a) anger is heat

He blew up, I was seething with anger, etc.

(b) money is a liquid
(c) theories are buildings

(d) more is up less is down
(e) linear scales are paths

8. How would comparison-based theories and categorization-based theories differ in explaining the following sentences?

(a) *Fido is a rock.*

Comparison-based theories: feature sharing or perceptual similarities between Fido and rocks (solid, dependable, etc.).

Categorization-based theories: the source domain of *rock* invoke a metaphoric super-category of "anything that is solid and dependable" and Fido is a member of the set of those entities.

(b) *My job is a jail.*
(c) *Juliet is the Sun.*
(d) *A child is a snowflake.*
(e) *Love is a journey.*

9. Provide compositional analyses of the sentences in 8 using the reductionist approach.

(a) *Fido is a rock.*

a. $[\![\textit{Fido}]\!] = \mathrm{f}$ ***animate***

b. $[\![\textit{is}]\!] = \lambda Q \lambda x \exists P.P(x) \wedge \forall y.Q(y) \rightarrow P(y) \wedge \neg\forall y.P(y)$ $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$

c. $[\![\textit{rock}]\!] = \lambda z.\mathrm{rock}'(z)$ $\langle \textit{object}, t\rangle$

d. $[\![\textit{is}]\!]([\![\textit{rock}]\!]) = [\lambda Q \lambda x \exists P.P(x) \wedge \forall y.Q(y) \rightarrow P(y) \wedge \neg\forall y.P(y)](\lambda z.\mathrm{rock}'(z))$

$= [\lambda x \exists P.P(x) \wedge \forall y.\lambda z.\mathrm{rock}'(z)](y) \rightarrow P(y) \wedge \neg\forall y.P(y)$

$= \lambda x \exists P.P(x) \wedge \forall y.\mathrm{rock}'(y) \rightarrow P(y) \wedge \neg\forall y.P(y)$ $\langle e, t\rangle$

e. $[\![\textit{is a rock}]\!]([\![\textit{Fido}]\!]) = [\lambda x \exists P.P(x) \wedge \forall y.\mathrm{rock}'(y) \rightarrow P(y) \wedge \neg\forall y.P(y)](\mathrm{f})$

f. $[\![\textit{Fido is a rock}]\!] = \exists P.P(\mathrm{f}) \wedge \forall y.\mathrm{rock}'(y) \rightarrow P(y) \wedge \neg\forall y.P(y)$

= 1 iff. if there exist a non-trivial property that is common to every rock and Fido. **t**

(b) *Juliet is the Sun.*
(c) *My job is a jail.*
(d) *A child is a snowflake.*
(e) *Love is a journey.*

10. Provide compositional analyses of the following verb phrases using the pragmatic rule approach.

(a) *enter the crisis*

$[\![\textit{enter}]\!]([\![\textit{the crisis}]\!]) = [\lambda x_{state} \lambda e.\mathrm{become}'(e, \mathrm{in}'(s)) \wedge \textit{theme}(e) = x_{state}](\mathrm{c})$ $\langle \textit{state}, \langle \textit{punctual-event}, t\rangle\rangle = \lambda e.\mathrm{become}'(e, \mathrm{in}'(s)) \wedge \textit{theme}(e) = \mathrm{c}$ $\langle \textit{punctual-event}, t\rangle$

(b) *cross the line*
(c) *be on top of the situation*
(d) *arrive at the conclusion*
(e) *come out of the depression*

Part IV

Other Lexical Categories

9 Types of Adjectives

9.1 Typology of Adjectives

9.1.1 Overview

Adjectives are less extensively studied than verbs and nouns. Their meaning is also more complex, raising some difficult theoretical questions. Studying adjectives or modifiers in general involves not only thinking about modifiers themselves, but also those that are modified. In the process, contextual and discourse-related information must be invoked, which necessitates conventionalization in the lexical meaning of certain amount of extralinguistic or pragmatic knowledge. How to incorporate such knowledge is an important question that has far-reaching consequences for semantic theorization. Furthermore, a wide range of differences exist in terms of the acceptability of adjectival modification among nominal predicates, which also requires a principled explanation.

Noteworthy among unique characteristics of this category is its syntactic flexibility. Adjectives are used as the primary or the secondary predicates, as well as attributive modifiers of nouns, as examples in (1) illustrate.

(1) a. Fido is <u>faithful</u>.
b. Fido seems <u>faithful</u>.
c. I consider Fido <u>faithful</u>.
d. Fido is a <u>faithful</u> dog.

This syntactic flexibility leads us to question whether adjectives should be analyzed as inherently ambiguous category (Siegel, 1976; Dowty et al., 1981) or whether a unified analysis is possible (Kamp, 1975). Each move will have to be offset by complicating either the lexicon or the grammar, and further empirical investigation and careful thinking are necessary to weigh in on each theory.

When adjectives occur as stative predicates preceded by the copula *be*, as in (2a), like verbs and nouns in (2b) and (2c), respectively, they can take arguments (Kennedy, 2012).

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(2) a. The country is dependent on foreign oil.
b. The country depends on foreign oil.
c. The country has dependence on foreign oil.

One important difference between them is that adjectival predicates typically describe states that are perceived in terms of static scales along with some dimensions. As a result, only the adjective can directly combine with degree words, as shown in (3).

(3) a. The country is too dependent on foreign oil.
b. *The country too depends on foreign oil.
c. *The country has too dependence on foreign oil.

Relative degrees on scales indeed constitute a major part of adjective meaning, which have been a subject of much investigation (Hay et al., 1999; Kennedy, 2007; Kennedy and McNally, 2005; Rotstein and Winter, 2004; inter alia). Different types of scales, such as two-point, multi-point, open and closed scales, underlie meanings of different classes of verbs, such as punctual, durative, bounded and unbounded event verbs. Whereas the scale structure only indirectly influences the verb semantics, however, we feel the effect of scales more directly in case of adjective. We have also seen that some nouns (e.g., *book*) have more complex scale structures which allow them to give rise to an event meaning. However, these are limited to a small subset of nouns. Perhaps, what makes adjectives special and distinct from other lexical categories is their association with scales. For example, the meaning of *tall* involves the scale of height, *heavy* is about the weight scale, and that of *hot* requires the temperature scale. It would be a mistake, however, to equate adjective semantics entirely with scales. There are adjectives which cannot be captured in terms of a scale along with a single property dimension. Adjectives such as *tasty* or *fun*, called **non-dimensional adjectives** or more colorfully "predicates of personal taste," contribute to the sentence in a significantly different manner than scaler adjectives. Based on these distinctions, we can structure the domain of states in Figure 9.1.

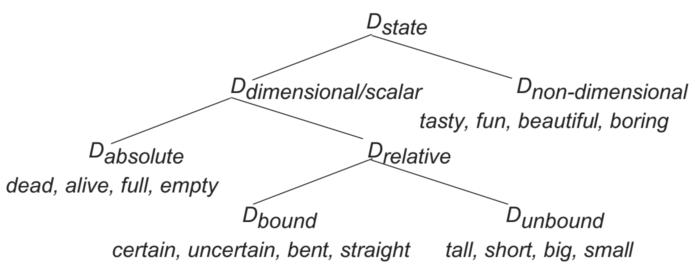

Figure 9.1 The hierarchy of many-sorted types in D_{state}.

Turning to their attributive use, unlike nouns and verbs, attributive adjectives are not obligatory components of a sentence. Instead, they recursively combine with the head noun that they modify to provide more detailed meaning, as illustrated in (4). Assuming that adjectives introduce properties, adjectives combine with nouns to yield a new property which is typically true of a subset of the entities that the original properties are true of, providing a finer grained meaning than what is expressed by using the noun alone. For example, *blue balloon* in (4b) denotes a subset of the set denoted by *balloon*.

(4) a. balloon
b. <u>blue</u> balloon
c. <u>big blue</u> balloon
d. <u>beautiful big blue</u> balloon

(5) demonstrates another structural puzzle of attributive adjectives, that is, their relative order. Modifiers or adjuncts, unlike arguments, can be added without the restriction on the number, but not in any random order. (5a) sounds much natural than (5b), suggesting that adjectives may bear scope relations to one another rather than added to the noun intersectively (Cinque, 2010; Svenonius, 2008).

(5) a. the <u>big blue</u> balloon
b. the <u>blue big</u> balloon

Attributive adjectives are classified either by their relationship with the head noun, or by their own meaning on the basis of the underlying scale structure. Depending on their relationship with the modified noun, they are divided into three sub-types of **intersective**, **subsective** and **intensional adjectives**. They are also divided into **absolute** and **relative adjectives** depending on the kind of scale their meanings rely on. Gradable adjectives are divided into **dimensional** ones like *tall* which rely on a single dimension (height) and non-dimensional or evaluative ones like *beautiful* which depend on multiple dimensions and/or subjective judgments.

This chapter will discuss how these different sub-types of adjectives are obtained from their grammatical behaviors, and their order in the attributive use.

9.1.2 Intersective Adjectives

The simplest form of adjectival modification is intersective. Adjectives like *Italian*, *carnivorous, red*, *square* and *metal* belong to the class of intersective adjectives. Intuitively, they refer to more or less objective properties that do not vary a lot from one context to another. For example, (6a) is true if and only if Fido is a member of the intersection of the set of individuals of Italian origin and the set of Pointers. This intuition is set-theoretically represented in (6b).

(6) a. Fido is an Italian Pointer.
b. ⟦*Italian Pointer*⟧ = ⟦*Italian*⟧ ∩ ⟦*Pointer*⟧

An intersective adjective denotes a property of the subject independently from the noun it modifies. If Fido is an Italian Pointer, he is Italian and he is a Pointer. (7a) entails both (7b) and (7c).

(7) a. Fido is an Italian Pointer.
b. Fido is Italian.
c. Fido is a Pointer.

Due to their lack of dependency on the noun denotation, we can freely replace *Pointer* with an arbitrary other noun that also characterizes Fido, e.g., *guide dog*, and arrive at a true sentence, as in (8). The entailment from (8a) and (8b) to (8c) is valid, since if Fido is also a guide dog, in addition to being a Pointer, he is in the intersection of the set of Italians, the set of Pointers, and the set of guide dogs.

(8) a. Fido is an Italian Pointer.
b. Fido is a guide dog.
c. Fido is an Italian guide dog.

Intersective adjectives appear to introduce simple properties that intersect with the nominal property (basic type ⟨*e, t*⟩).

9.1.3 Subsective Adjectives

Adjectives such as *skillful, lousy, experienced* and *typical* behave differently from intersective adjectives. (9a) entails that Fido is a hunter but does not entail that he is skillful. The meaning of these adjectives and noun together is not the intersection of the two properties denoted by each, but instead is a subset of the meaning of the noun (Partee, 1995). That is, the set of skillful hunters is a subset of the set of hunters, as the set-theoretic representation in (9b) indicates. Thus, they are called subsective adjectives.

(9) a. Fido is a skillful hunter.
b. ⟦*skillful hunter*⟧ ⊆ ⟦*hunter*⟧

Unlike intersective adjectives, subsective adjectives makes their contributions to the truth-conditions with regard to the noun they modify. (10a) means that Fido is skillful as a hunter but does not guarantee that he is also skillful at other things. For instance, being skillful at hunting is quite different from being skillful at guiding the blind. Therefore, the conclusion in (10c) does not follow from (10a) and (10b). In general, we can evaluate skills only with respect to a particular activity. The same holds for other similar adjectives like *lousy*, *experienced* and *typical*.

(10) a. Fido is a skillful hunter.
 b. Fido is a guide dog.
 c. Fido is a skillful guide dog.

Since their meaning depends on the nouns they modify, subsective adjectives appear to be a predicate modifier (basic type $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$), unlike intersective adjectives, which denote a property (basic type $\langle e, t\rangle$). If subsective adjectives are higher-order, then this means that the syntactic category adjective does not form a semantically uniform and coherent class, which could be seen as undesirable in view of compositionality.

To abide by the compositionality principle, scholars have made effort to treat adjectives uniformly as simple properties intersecting with the noun denotations. Gradable or vague adjectives, like *small, big, expensive, cheap, old, heavy, short* and*tall*, are apparent subsective adjectives that are given an intersective analysis. Vague adjectives, at first glance, behave like subsective adjectives. The set of small dogs is a subset of the set of dogs, and the set of big mice is a subset of the set of mice, as represented in (11). This makes sense because a small dog is bigger than a big mouse, because their sizes are compared differently. Their relativity comes from their dependence on a standard of bigness (or smallness, etc.) that is appropriate to the objects being compared.

(11) a. $[\![\textit{small dog}]\!] \subseteq [\![\textit{dog}]\!]$
 b. $[\![\textit{big mouse}]\!] \subseteq [\![\textit{mouse}]\!]$

However, an intersective interpretation can be derived by adding a contextually supplied **comparison class** as an extra argument, as in (12a) (Bierwisch, 1989; Klein, 1980; Kennedy and McNally, 2005; Kennedy, 2007). In (12a), small′(x, c) indicates that x is small when compared to the members of the comparison class c. If we introduce *c* as the context type, relative adjectives are functions from contexts to functions from objects to truth values.

(12) a. $[\![\textit{small}]\!] = \lambda x.\text{small}'(x, \text{c})$ $\langle c, \langle \textit{object}, t\rangle\rangle$
 b. $[\![\textit{dog}]\!] = \lambda x.\text{dog}'(x)$ $\langle \textit{animate}, t\rangle$
 c. $[\![\textit{small}]\!] \cap [\![\textit{dog}]\!] = \lambda x.\text{small}'(x, \text{c}) \wedge \text{dog}'(x)$ $\langle c, \langle \textit{animate}, t\rangle\rangle$

The impression that *small* is a subsective adjective comes from the fact the value for c in most discourse contexts is supplied by the head noun, obscuring the adjective's actual independence from it. But **vagueness** resolution does not solely rely on the choice of head noun. Kamp and Partee (1995) cite (13a) to illustrates that a comparison class can come from discourse context and world knowledge, and other factors than the noun denotation can be more influential; a tall snowman for a two-year-old can be short to fraternity brothers. (13b) from Kennedy (2007) explicitly denies that the standard of expensiveness comes from the head noun.

(13) a. My 2-year-old son/the fraternity brothers built a really tall snowman.
b. His car is an expensive BMW, though it's not expensive for a BMW.

By incorporating context variables, we seem to have reached a uniform intersective analysis for the majority of adjectives. Unfortunately, such treatment would leave the core cases of subsective adjectives unexplained. Some adjectives are genuinely ambiguous between intersective and subsective readings, as illustrated in (14). In (14a), the standard of beauty can be determined for what is appropriate for dancers (for an intersective reading) but doing so does not explain why a beautiful dancer can be someone who only dances beautifully (subsective reading). Likewise, the subsective reading of (14b), namely, he has been a friend for a long time, cannot be accounted for by merely adjusting the comparison class for oldness.

(14) a. She is a beautiful dancer.
b. He is an old friend.

The two senses are indeed discernable in many contexts. For example, the use of prepositions may disambiguate the two readings of the sentences, as shown in (15). *For* in (15a) introduces a comparison class, engendering an intersective interpretation, whereas *as* in (15b) indicates a subsective reading.

(15) a. She is beautiful for a dancer.
b. She is beautiful as a dancer.

Moreover, in subsective readings, sentences in (16) are not contradictory because someone who only dances beautifully is not necessarily beautiful, and a long-time friend can still be young.

(16) a. That beautiful dancer isn't beautiful.
b. That old friend isn't old.

This is not possible for purely intersective adjectives, as shown in (17). The sentence is contradictory because to be an Italian Pointer, it must be both Italian and a Pointer.

(17) *That Italian Pointer isn't Italian.

We will explore theoretical solutions to this puzzle in the next chapter.

9.1.4 Intensional Adjectives

The last class of adjectives are intensional (non-subsective) adjectives, such as *alleged, probable, likely, potential*, etc. The sentence in (18a) entails neither (18b), which is not even grammatical, nor (18c).

(18) a. He is an <u>alleged</u> murderer.
b. *He is alleged.
c. He is a murderer.

The set of alleged murderers is obviously not a subset of the set of murderers, as the set-theoretic representation in (19) specifies. For this reason, these adjectives are also known as non-subsective adjectives.

(19) $[\![\textit{alleged murderer}]\!] \not\subset [\![\textit{murderer}]\!]$

Alleged murderers are murderers in some alleged worlds, rather than in the actual world. This is why these adjectives are also called intensional adjectives. Here again, whether adjectives are uniformly property-denoting is put into question. Unlike intersective or gradable adjectives, intensional adjectives seem genuine predicate modifiers taking nouns as argument, which explains why they do not occur in the predicate position, as shown in (20).

(20) *This murderer is <u>alleged/probable/likely/potential</u>.

Intensional adjectives are of basic type $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$, quantifying over the set of worlds that are compatible with the adjective meaning, e.g., *alleged* is a function from the set of worlds that are compatible with what has been alleged in the actual world to truth values.

There is also a class of adjectives called **privative adjectives**, which generates even stronger negative entailments than intensional adjectives. (21) entails this is not a gun.

(21) This is a <u>fake</u> gun.

Note that in a set-theoretic term, the intersection of the set of guns and the set of fake things is empty.

(22) $[\![fake]\!] \cap [\![gun]\!] = \emptyset$

Instead of analyzing them as a separate class, Partee (2003) offers a treatment of privative adjectives as subsective adjectives with looser interpretation. She argues that adjectives like *fake, pretend, fictitious* and *artificial* coerce the head noun into a loose interpretation, allowing fake guns to be included in the set of guns. Such analysis explains why these adjectives, unlike non-intersective ones, are fine in a predicate position as in (23a), and why (23b) is not a trivial question.

(23) a. This gun is <u>fake</u>.
b. Is that gun real or fake?

In this section, we have divided attributive adjectives into intersective, subsective and non-subsective/intensional adjectives in terms of their interaction with the head noun that they modify. While intersective adjectives, including vague adjectives, denote simple properties that combine with the noun meaning, subsective and intensional adjectives appear to be higher-order predicate modifiers, taking the noun as their arguments to yield more complex properties. We will discuss whether a uniform analysis of all adjectives is possible and provide a formal semantic analysis of the various types of adjectives in the next chapter.

Reflection

- What are some theoretical problems involved with adjective semantics? Do you think it is desirable to provide a uniform semantics for all adjectives?
- What are the semantic differences between intersective, subsective, and intensional adjectives? Why is it sometimes difficult to distinguish between intersective and subsective adjectives?
- Explain why *she is former* is ungrammatical. How is the meaning of this kind of adjectives semantically represented?

9.2 Scale Structure

9.2.1 Absolute and Relative Adjectives

Another classification of adjectives relies on the underlying scale structure that they presuppose. Figure 9.2 graphically represent two major kinds of

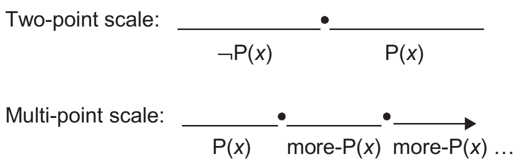

Figure 9.2 Two-point and multi-point scales.

scales. Adjectives that rely on two-point scales describe a binary opposition between two states that cannot have a gradable value (e.g., *awake/asleep*, *alive/dead*, *opaque/transparent, full/empty, visible/invisible, pregnant*, *free*, *absolute*, *impossible*, *necessary/unnecessary*, *total*). We will call them absolute adjectives. Only adjectives that operate on multi-point scales, called relative adjectives, are gradable.

Absolute adjectives are not compatible with comparatives and superlatives, whereas relative adjectives are, as shown in (24).

(24) a. **more/most dead*
b. *taller/tallest*

In the equative, absolute adjectives systematically license inferences to the positive form. (25a) entails (25b).

(25) a. This is as opaque/transparent as that.
b. This is opaque/transparent.

By contrast, relative adjectives do not allow the entailment to the positive form. (26a) does not entail (26b) (Rett, 2007).

(26) a. Fido is as tall as Garfield.
b. Fido is tall.

Relative adjectives cannot be modified by **proportional modifiers** such as *half* and *mostly*, and **maximality modifiers** like *fully* and *completely*, which are only compatible with closed scales, as shown in (27) and (28) (Kennedy and McNally, 2005). *Half* locates a degree whose distance from the bottom of a scale (its minimal degree) is the same as the distance from the top (its maximal degree), and thus requires a closed interval. *Mostly* locates a degree whose distance from the bottom of a scale is larger than the distance from the top, also requiring a closed scale. The ungrammaticality of (28) is expected given that open scales lack the minimum and the maximum points.

(27) a. The glass is half/mostly/completely full/empty.
b. Her eyes were half/mostly/fully open/closed.
c. These images are half/mostly/fully visible/invisible.

(28) a. *A 15-year-old horse is half/mostly/fully old.
b. *That car is half/mostly/fully expensive.
c. *Fido seemed half/mostly/fully tall.

Multi-point scales come in four logically possible types, as depicted in Figure 9.3 (Kennedy, 2007; Kennedy and McNally, 2005). Lack of dots indicates openness, and dots signify closeness.

A closed scale includes the upper and the lower bounds (0 and 1). Absolute adjectives such as *full/empty* and *open/closed* are closed scale adjectives. **Upper closed scales** have a maximal degree whose value is 1. However, they are open on the lower end, so, while including all degrees that approach the limit of 0, lack a degree whose value is less than that of all the others. **Lower closed scales** include such a minimal value, equal to 0. They also include all degrees that approach the limit of 1 but lack a degree that is greater than all the others. Adjectives presupposing partially closed scales are also gradable, rather than absolute. Adjectives like *certain/uncertain* are upper closed scale adjectives (because to be certain, you have to be completely certain), and adjectives like *bent/straight* are lower closed scale adjectives (because to be bent, it only has to be slightly bent). An **open scale** excludes the upper and the lower bounds (0 and 1), only containing real numbers between them. Vague adjectives, e.g., *tall* and *short*, make a reference to open scales. The nature of underlying scale has motivated the use of a context argument in the previous section, since it is the context that determines where the standard lies.

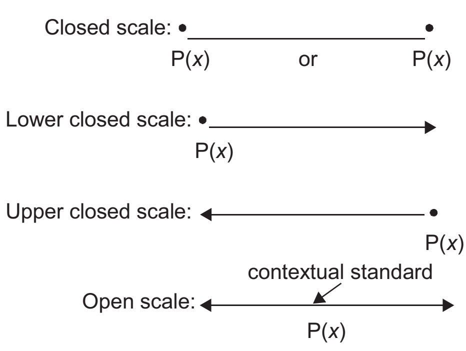

Figure 9.3 Closed and open (multi-point) scales.

9.2.2 Polar Antonyms

Gradability interacts with their positive/unmarked and negative/marked pairs in polar antonyms in a systematic way. In (29), the adjectives on the left side of the double arrow (indicating opposition) are positive/unmarked pairs and those on the right side are negative/marked pairs.

(29) a. *tall* ↔ *short*
b. *wide* ↔ *narrow*
c. *old* ↔ *young*
d. *fast* ↔ *slow*
e. *hot* ↔ *cold*
f. *dirty* ↔ *clean*
g. *safe* ↔ *dangerous*

Systematic differences exist between **positive and negative gradable adjectives** (Kennedy, 2001; cf. Sassoon, 2013). First, negative/marked adjectives never accept measure phrases, as shown in (30). Measure phrases denote positive rather than negative degrees because they must refer to intervals that extend from the origin point on a scale.

(30) a. Fido is twenty inches tall/*short.
b. The fence is six feet wide/*narrow.
c. Garfield is six years old/*young.

Second, negative adjectives are awkward with factor phrases like *twice* in the equative, as shown in (31).

(31) a. That is twice as tall/?short as this.
b. That is twice as wide/?narrow as this.
c. That is twice as old/?young as this.

Third, negative adjectives do not occur in nominalizations that name the dimension along which they measure, as in (32).

(32) a. The length/*shortness of the coffee table is four feet.
b. The width/*narrowness of the coffee table is three feet.

Fourth, in *wh*-questions, negative adjectives trigger a presupposition. (33) with *short* is biased, already assuming that the hearer is short.

(33) How tall/short are you?

Lastly, adjectives in the matrix and comparative clause must either both be positive or both be negative, which explains why (34) is unacceptable.

(34) *Fido is shorter than Garfield is tall.

Antonymous pairs of gradable adjectives map their arguments onto the same scale (*tall* and *short* both measure degree of height, etc.), but impose inverse orderings on their shared domains. In the lower closed scale in Figure 9.4, the standard for the positive member of an antonym pair that uses that scale is a minimum degree (e.g., *bent*, *bumpy*, *dirty*, *worried*) and that for the negative member is a maximum degree (e.g., *straight*, *flat*, *clean*, *unworried*). Note that, if a scale is open on the upper end, the positive should have no maximum and the negative should have no minimum.

On the upper closed scale in Figure 9.5, the standard for the positive member of an antonym pair is a maximum degree (e.g., *certain*, *safe*, *pure*, *accurate*) and the standard for the negative member is a minimum degree (e.g., *uncertain*, *dangerous*, *impure*, *inaccurate*). If there is any amount of uncertainty, it is uncertain, whereas to be certain, it has to be completely certain. If a scale is open on the lower end, then the positive antonym should have no minimum degree and the negative antonym should have no maximum.

It is predicted that **degree modifiers** that pick out maximal degrees on the scales, such as *absolutely*, *completely*, *totally* and *perfectly*, will be incompatible with positive members of antonym pairs that use a lower closed scale, and the degree adverbs that refer to minimum degrees on the scale, like *slightly* and *partially*, will be incompatible with positive members of antonym pairs that call for an upper closed scale (Rotstein and Winter, 2004; Kennedy and McNally, 2005). It is also predicted that open scale (relative) adjectives will reject the modification by either modifier, whereas closed scale adjectives will be compatible with both. These expectations are born out, as shown in (35)–(38).

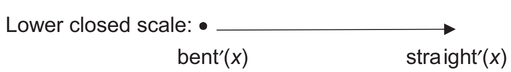

Figure 9.4 Lower closed scale.

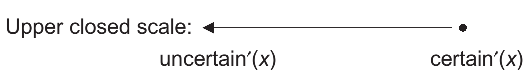

Figure 9.5 Upper closed scale.

(35) Open scales
a. *perfectly/*slightly tall, deep, expensive, likely
b. *perfectly/*slightly short, shallow, inexpensive, unlikely

(36) Lower closed scales
a. *perfectly/slightly bent, bumpy, dirty, worried
b. perfectly/*slightly straight, flat, clean, unworried

(37) Upper closed scales
a. perfectly/*slightly certain, safe, pure, accurate
b. *perfectly/slightly uncertain, dangerous, impure, inaccurate

(38) Closed scales
a. perfectly/slightly full, open, opaque
b. perfectly/slightly empty, closed, transparent

Reflection

- How are adjectives classified depending on the underlying scale structure?
- How do you distinguish between positive/unmarked and negative/marked member of polar antonyms?
- Why do open scale adjectives require a contextually given standard of comparison?

9.3 Non-Dimensional or Evaluative Adjectives

9.3.1 Subjectivity

While some scholars treat all gradable adjectives as "evaluative" as the standard can vary among different individuals (Rett, 2007), a rather clear semantic difference exists between the scalar adjectives discussed in the previous section and evaluative adjectives, such as *beautiful* and *tasty*. These adjectives describe subjective evaluations, rather than making factual statements, and thus cannot be described in terms of a single property dimension. Scalar adjectives are called dimensional adjectives, since they are gradable on the basis of a single property dimension such as size, height, weight, temperature, cost, etc. Evaluative adjectives are non-dimensional that are less clearly delimited and less systematically structured (Bierwisch, 1989). Among the evaluative adjectives, so-called "predicates of personal taste," like *tasty* and *fun*, received much attention (Lasersohn, 2005).

(39) a. This chili is <u>tasty</u>.
b. Roller coasters are <u>fun</u>.

Other evaluative adjectives include aesthetic (*beautiful*), moral (*wrong*), bouletic (*preferable*), normative (*usual*) and epistemic (*likely*) adjectives (Coppock, 2018; Kennedy and Willer, 2016; McNally and Stojanovic, 2014; Silk, 2021). Note that this distinction is similar to process versus event distinction in the verb meaning; while event verbs, like dimensional adjectives, describe changes on a dimensional scale, process verbs defy such characterization, like non-dimensional adjectives.

These adjectives are felt to be more subjective, describing the speaker's opinion and judgment rather than objective facts. Due to such subjectivity, there can be a genuine disagreement between the discourse participants, but at the same time there is a sense that neither is at fault, as illustrated in (40). If A means that this chili is tasty to her, it is puzzling how B can refute such a subjective claim. Alternatively, if it is an objective statement about the taste of the chili, they cannot be both be right, but we have the feeling that they are.

(40) A: This chili is tasty.
B: No, it isn't.

While evaluative adjectives give rise to faultless disagreement in comparatives, dimensional adjectives do not. While both A and B in (41) are right in some sense, only one of them is right in (42).

(41) A: This cake is <u>tastier</u> than that cake.
B: No, that cake is <u>tastier</u> than this cake.

(42) A: Fido is <u>taller/older</u> than Garfield.
B: No, Garfield is <u>taller/older</u> than Fido.

While dimensional adjectives come in positive-negative antonym pairs (e.g., *tall* vs. *short*, *heavy* vs. *light*, *hot* vs. *cold*), non-dimensional adjectives lack a single clear antonym, but instead involve groups of adjectives clustered at each pole of a scale, as exemplified in (44).

(43) a. *brave, bold, courageous* ↔ *cowardly, timid, fearful*
b. *pretty, beautiful, gorgeous, handsome* ↔ *ugly, hideous, repellent, unattractive*

9.3.2 Context-Sensitivity

An adjective in its objective use is in principle measurable. On the other hand, evaluative adjectives are not easily measurable. Silk (2021) argues that the context-sensitivity of evaluative adjectives must be distinguished from the general standard-sensitivity of gradable adjectives. He offers diagnostics to single out evaluative adjectives. Unlike dimensional adjectives, which cannot occur in the *x find* construction, they are felicitous in it.

(44) a. *I find Fido taller than Garfield.
b. *I find this door more open than that door.
c. I find Fido smarter than Garfield.

As previously observed, in the comparative or the equative, while closed scale adjectives systematically license inferences to the positive form, open scale adjectives do not. This means that relative adjectives lack a lexically encoded minimum standard. Non-dimensional adjectives, like closed scale adjectives, license the inference to the positive form in comparatives, as shown in (45), which means that they are lexically equipped with minimal standards.

(45) a. Fido is taller than Garfield. X⇒ Fido is tall.
b. Fido is smarter than Garfield. ⇒ Fido is smart.
c. That door is more open than this door. ⇒ That door is open.

Non-dimensional adjectives also align with closed scale adjectives in that they are compatible with *slightly* and *completely*, as shown in (46a). They contrast with relative adjectives, which cannot be modified by these adverbs, as shown in (46c).

(46) a. Fido is slightly/completely stupid.
b. The door is slightly/completely closed.
c. *Fido is slightly/completely tall.

It appears that while evaluative adjectives are also gradable, determining the standard of comparison for them depends more heavily on discourse context including the speaker's perspectives and judgments, rather than on a simple scalar dimension. Silk (2021) argues that *tasty* is sensitive both to a standard of comparison, but also to a body of tastes that evaluates how tasty things are. Similarly, *beautiful* depends on a body of aesthetic values evaluating how beautiful things are, and *likely* depends on a body of epistemic norms evaluating how likely things are. The sensitivity to a body of taste/aesthetic values/epistemic norms, which he calls a **perspective**, is part of lexical meaning of these adjectives. In other words, while regular scalar adjectives are unidimensional, evaluative adjectives are multidimensional (Sassoon, 2013). For example, while *tall, fast*, etc. presuppose scales that order individuals according to height, speed, etc., and nothing else, multiple criteria is used to order individuals in terms of properties described by multidimensional adjectives like *beautiful, healthy, interesting,* *smart, brave*, etc. Being healthy, for example, does not depend on a single factor, but on many different aspects, including the state of the cardiovascular system, nervous system, immune system, among others (McNally and Stojanovic, 2014; Sassoon, 2013). Similarly, there are different parameters or dimensions of being smart (math skills, good memory etc.), and the impact of these dimensions in the overall evaluation can vary from one person to another. Due to this difference, we only have to decide a standard of comparison for the denotation of unidimensional adjectives but need to also consider the relative weight of the dimensions for multidimensional adjectives. Therefore, only evaluative adjectives are compatible with *in some/every way/respect* and *except for* (Sassoon, 2013).

(47) a. *She is tall in <u>some/every way/respect</u>.
b. She is interesting in <u>some/every way/aspect</u>.

(48) a. *She is tall <u>except for</u> her legs.
b. She is interesting <u>except for</u> her taste in music.

McNally and Stojanovic (2014) argue that evaluative adjectives come in two distinct types; **experiential evaluative adjectives** that require an experiencer (*tasty, fun, boring, disgusting, shocking*) and **non-experiential evaluative adjectives** that involve a positive or negative judgment or evaluation by the speaker (*good, bad, excellent, terrible, beautiful, ugly, mediocre*). (Deverbal) experiential evaluative adjectives can be modified by *to* or *for* adverbials, but non-experiential evaluative adjectives cannot.

(49) a. The situation was <u>shocking/disgusting/boring/offensive</u> to us.
b. ??The situation was <u>good/bad/excellent</u> to us.

Predicates like *smart* or *lazy* are predicates of scalar variation, but they do not refer to internalized experience as part of their semantics (unlike *tasty*).

Many adjectives are polysemous between unidimensional and multidimensional readings. *Heavy* in (50) in its literal weight reading is unidimensional, but in its metaphoric reading, it is multidimensional (McNally and Stojanovic, 2014).

(50) This book is <u>heavy</u>. I can't carry it around/I can't read it because it depresses me.

We will provide a formal semantic analysis of non-dimensional/evaluative adjectives, focusing on predicates of personal tastes, in the next chapter.

Reflection

- What are the semantic differences between dimensional and non-dimensional adjectives?
- What are the semantic differences between adjectives like *good/bad* and those like *fun/boring*? What are some grammatical reflexes of such semantic differences?
- How can we capture the subjectivity and context-sensitivity of non-dimensional adjectives? Do you think they should be encoded in the lexical entry of these adjectives, or derived pragmatically?

9.4 The Order of Attributive Adjectives

9.4.1 Inherent and Non-Inherent Qualities

When multiple adjectives appear in the attributive position to modify a noun, they follow specific orders of number, evaluative, size, shape, age, color, origin/nationality and material adjectives, as illustrated in (51) (Cinque, 2010; Scott, 2002; Svenonious, 1994, 2008; Valois, 2007). Any other orders either result in infelicity or less preferred.[1]

(51) many nice big round new red smooth Canadian apples

Laenzlinger (2005) organizes them into five categories, given in (52).

(52) quantificational < speaker-oriented < scalar physical properties < measure < non-scalar physical properties

Cinque (2010) offers a simpler order of speaker-oriented, subject-oriented and manner/thematic adjectives.

Is the relative order of adjectives semantically motivated or simply a formal constraint? A common generalization regarding the order is that non-inherent qualities precede inherent quality adjectives. Evidence for this tendency comes from the fact that the order of adjectives from the same category (e.g., age) changes meaning depending on how close they are to the noun; the closer the adjective is to the noun, the more inherent the meaning becomes. For example, (53a) means that the car is old but the speaker recently got it, whereas (53b) means the speaker once had a car that was new, but no longer has it. The outer age adjective describes the acquisition time, whereas the inner age adjective describes the property of the car.

(53) a. my new old car
b. my old new car

Furthermore, idiomatic adjective + N combination cannot be separated by other adjectives, as shown in (54) (Svenonious, 2008).

(54) a. whole wheat French toast (idiomatically)
b. French whole wheat toast (only compositionally)

9.4.2 Intersective and Subsective Readings

Adjectives that are ambiguous between intersective and subsective readings (e.g., *beautiful*) tend to have subsective readings when they are close to the noun. The higher adjective receives the intersective reading. (55a) means a person who is ugly and dances beautifully but cannot mean a person who is beautiful but dances in an ugly manner. This impossible meaning is the only meaning of (55b) where the order of the adjectives is switched.

(55) a. an ugly beautiful dancer.
b. a beautiful ugly dancer.

The relative order of the noun and the adjective can even affect truth conditions. (56a) is ambiguous when the stars are visible at the speech time, or when the stars are inherently visible, being able to be seen by the naked eye. (56b), on the other hand, has only the currently visible interpretation (Kennedy, 2012).

(56) a. The visible stars include Capella, Betelgeuse and Sirius.
b. The stars visible include Capella, Betelgeuse and Sirius.

Pre-nominal adjective *unsuitable* in (57) is ambiguous between **restrictive** and **non-restrictive** interpretations, as illustrated in (57) (Huddleston and Pullum, 2002; Larson and Marušic, 2004).

(57) a. Every unsuitable word was deleted.
b. Every word that was unsuitable was deleted. (restrictive)
c. Every word was deleted. They were unsuitable. (nonrestrictive)

When this adjective appears post-nominally, however, it can only be interpreted restrictively, as shown in (58).

(58) a. Every word unsuitable was deleted.
b. Every word that was unsuitable was deleted. (restrictive)
c. *Every word was deleted. They were unsuitable. (nonrestrictive)

It has been argued that nonrestrictive adjectives contribute expressive meaning, indicating the speaker's subjective attitude that does not directly affect the truth condition of the sentence (Potts, 2005, 2007). **Expressives** like *damn well* are awkward after VP, parallel to the lack of nonrestrictive reading in the postnominal position.

(59) a. He'll <u>damn well</u> cheat.
b. *He'll cheat <u>damn well</u>.

A possible analysis for the parallelism is to assume that evaluative adjectives take an additional perspective argument only in prenominal position, which needs to be explained through principles governing the syntax-semantics interface.

Reflection

- Why do you think number, evaluative, size, shape, age, color, origin and material adjectives modify the noun in that order?
- Why do adjectives that are ambiguous between intersective and subsective readings (e.g., *beautiful*) have subsective readings when they are close to the noun?
- Do you think the order of attributive adjectives is constrained by morphosyntax or semantics/ pragmatics? Why?

9.5 Conclusion

In this chapter, we discussed a variety of types adjectives represent. We first divided attributive adjectives into three types of intersective, subsective and non-subsective/intensional adjectives depending on their relationship with the head noun and their entailments. We then explored a different classification between absolute and relative adjectives based on the underlying scale structure. We also investigated non-dimensional or evaluative adjectives, which lack a single dimension of comparison and whose meaning depends on the speaker's subjective judgments. We briefly touched on the position of adjectives in their attributive use and underlying semantic explanations for the observed order. Adjective meaning is diverse and complex yet systematic. There is an ongoing debate about their semantics, which we will discuss in more detail in the next chapter.

Points to Remember

- Attributive adjectives are classified based on their relationship with the nouns that they modify into intersective, subsective and intensional adjectives.
- Intersective adjectives like *red* denote properties that intersect with the nominal property.
- Subsective adjectives like *skillful* denote properties that are subsets of the nominal property.
- Vague adjectives like *small* are apparent subsective adjectives that can be analyzed as intersective adjectives using a contextually supplied comparison class argument.
- Intensional adjectives like *alleged* denote properties in possible worlds.
- Adjectives can also be classified based on their own meanings in terms of scalarity into dimensional and non-dimensional adjectives.
- Dimensional adjectives that rely on two-point scales like *awake/asleep* are absolute adjectives. Adjectives that operate on multi-point scales are relative adjectives.
- Relative adjectives operate on different types of scales (open, upper closed, lower closed, closed) and their polar antonym pairs show systematic grammatical behaviors reflecting the underlying scales.
- Non-dimensional or evaluative adjectives lack a single dimension of comparison and their meaning depend on the speaker's perspective.
- When multiple adjectives appear in the attributive position to modify a noun, they follow the order of number, evaluative, size, shape, age, color, origin/nationality and material adjectives.
- An interesting contrast in interpretation between pre-nominal and post-nominal adjectives invokes the notion of speaker's expressive meaning.

Technical Terms to Remember

1. **Dimensional adjective:** Gradable adjectives on the basis of a single property dimension such as size, height, weight, temperature, cost, etc.
2. **Non-dimensional adjectives:** Evaluative adjectives which depend on multiple dimensions and/or subjective judgments.
3. **Intersective adjective:** Adjectives denoting simple properties that intersect with the nominal property.
4. **Subsective adjective:** Adjectives denoting a subset of the meaning of the noun.

5. **Intensional adjectives:** Adjectives that quantify over the set of worlds that are compatible with the adjective meaning.
6. **Privative adjectives:** Adjectives with negative entailments.
7. **Absolute adjectives:** Adjectives relying on two-point scales, describing a binary opposition between two states that cannot have a gradable value.
8. **Relative adjectives:** Adjectives that operate on multi-point scales.
9. **Comparison class:** A set of objects that are compared for the standard of a gradable adjective.
10. **Proportional modifiers:** Modifiers that locate a relative degree from the bottom of a scale (its minimal degree) to the top (its maximal degree), which requires a closed interval.
11. **Maximality modifiers:** Modifiers that indicate a maximal degree of a property scale, and thus require a closed interval.
12. **Upper closed scales:** Scales that have a maximal degree whose value is 1 but lack a degree whose value is less than that of all the others because they are open on the lower end.
13. **Lower closed scales:** Scales that include a minimal value, equal to 0 but lack a degree that is greater than all the others because they are open on the top end.
14. **Open scales:** Scales excluding the upper and the lower bounds (0 and 1), only containing real numbers between them.
15. **Positive/unmarked gradable adjectives:** The member of antonymous pairs of gradable adjectives which maps their arguments onto the same scale but imposes inverse orderings on their shared domains.
16. **Negative/marked gradable adjectives:** The member of antonymous pairs of gradable adjectives which never accepts measure phrases, is awkward with factor phrases, does not occur in nominalizations that name the dimension along which they measure, and triggers a presupposition in *wh*-questions.
17. **Degree modifiers:** Modifiers that pick out maximal or minimum degrees on the scales.
18. **Perspective:** The sensitivity to a body of taste/aesthetic values/epistemic norms.
19. **Experiential evaluative adjectives:** Evaluative adjectives that require an experiencer.
20. **Non-experiential evaluative adjectives:** Evaluative adjectives that involve a positive or negative judgment or evaluation by the speaker.
21. **Restrictive adjective:** Adjectives that restrict the set denoted by the noun.
22. **Non-restrictive adjective:** Adjectives that simply add extra property to the noun denotation.
23. **Expressives:** Expressions that indicate the speaker's subjective attitude that does not directly affect the truth condition of the sentence.

Suggested Reading

Morzycki (2015) is a more detailed introduction to adjective semantics. Partee (1995) is a classic reading on different types of adjectives. See Kennedy and McNally (2005) and Kennedy (2007) for scale structures underlying different types of scalar adjectives.

Practice

1. Classify the following adjectives into intersective, subsective, intensional and privative adjectives.

(a) *excellent*

subsective

(b) *large*
(c) *beautiful*
(d) *probable*
(e) *cheap*
(f) *artificial*
(g) *alleged*
(h) *experienced*
(i) *blue*
(j) *pretend*

2. Provide the denotations and types of the following adjectives.

(a) *square*

$\lambda x.\text{square}'(x)$ $\langle object, t\rangle$

(b) *big*
(c) *red*
(d) *tall*
(e) *expensive*

3. What are the semantic types of the following adjectives?

(a) *beautiful*

$\langle\langle e, t\rangle, \langle e, t\rangle\rangle$

(b) *fast*
(c) *former*
(d) *metal*
(e) *skillful*

4. Classify the type of the following adjectives into absolute, relative and evaluative adjectives.

(a) *alive*

absolute

(b) *impossible*
(c) *big*
(d) *free*

(e) *fun*
(f) *hard*
(g) *cheap*
(h) *tasty*
(i) *opaque*
(j) *heavy*

5. Explain why the following sentences are ungrammatical

(a) **Fido is more dead than Garfield.*

***Dead* is an absolute adjective and cannot be used in comparatives.**

(b) **A 15-year-old horse is half old.*
(c) **Fido is twenty inches short.*
(d) **That car is fully expensive.*
(e) **That is twice as narrow as this.*

6. The adjective pairs below involve different sorts of scales. Specify the type of scales (e.g., closed, open, upper closed, lower closed) and identify which member of the pair is unmarked/positive.

(a) *narrow/wide*

open scale, *wide* is positive

(b) *dry/wet*
(c) *bent/straight*
(d) *safe/dangerous*
(e) *certain/uncertain*
(f) *pure/impure*
(g) *old/young*
(h) *tall/short*
(i) *opaque/transparent*
(j) *clean/dirty*

7. What are the antonyms of the following adjectives? Which one is the positive members? Provide tests to determine them.

(a) *tall*

Antonym is short; tall is the positive member; How tall are you?; She is as tall as him.

(b) *narrow*
(c) *old*
(d) *slow*
(e) *big*

8. Explain the following data in terms of underlying scales.

(a) **perfectly/*slightly tall, deep, expensive, likely*

Gradable adjectives cannot be modified by maximum or minimum degree modifiers because these modifiers require close scales.

(b) *perfectly/slightly short, shallow, inexpensive, unlikely*
I *perfectly/slightly bent, bumpy, dirty, worried*
(d) *perfectly/slightly straight, flat, clean, unworried*

(e) *perfectly/*slightly certain, safe, pure, accurate*
(f) **perfectly/*slightly uncertain, dangerous, impure, inaccurate
(g) *perfectly/slightly full, open, opaque*
(h) *perfectly/slightly empty, closed, transparent*

9. Explain why the following sentences are ungrammatical.
(a) **I find Fido faster than Garfield.*
***Find* is only compatible with evaluative adjectives.**

(b) **I find this window more open than that window.*
(c) **This car is slightly/completely expensive.*
(d) **This box is heavy in some/every way/respect.*
(e) **This box is heavy except for its bottom.*

10. Describe the meaning differences and offer an explanation.
(a) *visible stars* vs. *stars visible*
***Visible stars* is ambiguous between the stars that are visible at the speech time, or those that are inherently visible, being able to be seen by the naked eye, whereas *stars visible* has only the currently visible interpretation.**

(b) *ugly beautiful dancer* vs. *beautiful ugly dancer*
(c) *my old new car* vs. *my new old car*
(d) *unsuitable word* vs. *word unsuitable*
(e) *whole wheat French toast* vs. *French whole wheat toast*

Note

1 The same ordering restrictions hold cross-linguistically, both in pre-nominal adjective languages and in post-nominal adjective languages (Cinque, 2010; Sproat and Shih, 1991; Svenonius, 2008).

10 Theories of Adjective Meaning

10.1 Type Homogeneity Versus Heterogeneity Hypotheses

10.1.1 Predicate Versus Modifier Analyses

The previous chapter raised a question regarding whether a uniform treatment of adjectives is possible. This chapter will take up that question and explore this possibility. There are two contrasting hypotheses about the adjective meaning, namely, the **adjective type homogeneity hypothesis** and the **adjective type heterogeneity hypothesis**. Those who support the adjective type homogeneity hypothesis treat all adjectives uniformly as predicate modifiers (of basic type $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$) (Kamp, 1975; Lewis, 1972; Montague, 1974; Wheeler, 1972). A predicate modifier analysis of adjectives is especially suitable for subsective adjectives like *skillful*. Since the application of adjectival property is restricted to the noun meaning, subsective adjectives may be true modifiers that take the head noun as an argument to yield a new property, as the logically translation in (1) shows.

(1) a. $[\![\textit{skillful}]\!] = \lambda P \lambda x.\text{skillful}'(P)(x)$ $\langle\langle \textit{animate}, t\rangle, \langle \textit{animate}, t\rangle\rangle$
b. $[\![\textit{hunter}]\!] = \lambda x.\text{hunter}'(x)$ $\langle \textit{animate}, t\rangle$
c. $[\![\textit{skillful}]\!]([\![\textit{hunter}]\!]) = [\lambda P \lambda x.\text{skillful}'(P)(x)]$
$(\lambda y.\ \text{hunter}'(y))$
$= [\lambda x.\text{skillful}'(\lambda y.\ \text{hunter}'(y))](x) = \lambda x.$
$\text{skillful}'(\text{hunter}'(x))$ $\langle \textit{animate}, t\rangle$

Intersective adjectives like *Italian* lend themselves to a simpler composition in which the adjective and the modified noun each denote a property that is conjoined together, as (2c) represents. Their types must match, and the type of the whole phrase will be settled on that of the head noun. *Italian Pointer* is of type $\langle \textit{animate}, t\rangle$, although *Italian* refers to a property of entities.

(2) a. $[\![\textit{Italian}]\!] = \lambda x.\text{Italian}'(x)$ $\langle e, t\rangle$
b. $[\![\textit{Pointer}]\!] = \lambda x.\text{Pointer}'(x)$ $\langle \textit{animate}, t\rangle$
c. $[\![\textit{Italian}]\!] \cap [\![\textit{Pointer}]\!] = \lambda x.\text{Italian}'(x) \wedge \text{Pointer}'(x)$ $\langle \textit{animate}, t\rangle$

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It is nonetheless possible to treat intersective adjectives as predicate modifiers, assigning the same type as subsective adjectives, as shown in (3).

(3) a. $[\![Italian]\!] = \lambda P \lambda x.\text{Italian}'(x) \wedge P(x)$ $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$
b. $[\![Pointer]\!] = \lambda y.\text{Pointer}'(y)$ $\langle animate, t\rangle$
c. $[\![Italian]\!]([\![Pointer]\!]) = [\lambda P \lambda x.\text{Italian}'(x) \wedge P(x)]$
$(\lambda y.\text{Pointer}'(y))$
$= [\lambda x.\text{Italian}'(x) \wedge \lambda y.\text{Pointer}'(y)](x) = \lambda x.\text{Italian}'(x)$
$\wedge\ \text{Pointer}'(x)$ $\langle animate, t\rangle$

If we adopt this approach, the predicative use of adjectives will have to involve an unpronounced, semantically light noun like *entity*, since adjectives cannot directly combine with an individual. (4) is the semantic composition of *Fido is Italian* under the assumption that the uniform predicate modifier analysis is correct.

(4) a. $[\![is\ Italian]\!] = \lambda P \lambda x.\text{Italian}'(x) \wedge P(x)$ $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$
b. $[\![is\ Italian\ (entity)]\!] = [\lambda P \lambda x.\text{Italian}'(x) \wedge P(x)]$
$(\lambda y.\text{entity}'(y))$
$= [\lambda x.\text{Italian}'(x) \wedge \lambda y.\text{entity}'(y)](x) = \lambda x.\text{Italian}'(x)$
$\wedge\ \text{entity}'(x)$ $\langle e, t\rangle$
c. $[\![is\ Italian\ (entity)]\!]([\![Fido]\!]) = [\lambda x.\text{Italian}'(x)$
$\wedge\ \text{entity}'(x)](\text{f}) = \text{Italian}'(\text{f}) \wedge \text{entity}'(\text{f})$ t

This analysis, however, cannot explain why intensional/non-subsective adjectives like *alleged* cannot be licensed in the predicative position in the same way, as illustrated in (5).

(5) *Fido is alleged (entity).

Alleged quantifies over the set of worlds compatible with what has been alleged in the evaluation world w, allegations$'_w$, as represented in (6a). It requires that in all such worlds, its argument is a murderer. To accomplish this, we will relativize the denotations of *alleged* and *murderer* to possible worlds, as shown in (6b). *Murderer* denotes a function from a set of possible worlds to a set of murderers in each world, i.e., type $\langle animate, st\rangle$, and *alleged* modifies nouns denoting a person or an event, so its type is $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$.

(6) a. $[\![alleged]\!] = \lambda P \lambda x \lambda w \forall w' \in \text{allegations}'_w.P_{w'}(x)$ $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$
b. $[\![murderer]\!] = \lambda y \lambda w''.\text{murderer}'_{w''}(y)$ $\langle animate, st\rangle$
c. $[\![alleged]\!]([\![murderer]\!]) = [\lambda P \lambda x \lambda w \forall w' \in$
$\text{allegations}'_w.P_{w'}(x)](\lambda y \lambda w''.\text{murderer}'_{w''}(y))$
$= \lambda x \lambda w \forall w' \in \text{allegations}'_w.$
$\text{murderer}'_{w'}(x)$ $\langle animate, st\rangle$

In principle, *alleged* should be able to be used predicatively, as in (7), which means that Fido is an alleged entity in all possible worlds that are compatible with the allegations made in the actual world *w*.

(7) a. $[\![alleged]\!] = \lambda P \lambda x \lambda w \forall w' \in \text{allegations}'_w . P_{w'}(x)$ $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$
b. $[\![is\ alleged\ (entity)]\!] = [\lambda P \lambda x \lambda w \forall w' \in \text{allegations}'_w . P_{w'}(x)](\lambda y \lambda w''.\text{entity}'_{w''}(y))$
$= \lambda x \lambda w \forall w' \in \text{allegations}'_w . \text{entity}'_{w'}(x)$ $\langle e, st\rangle$
c. $[\![is\ alleged\ (entity)]\!]([\![Fido]\!]) = [\lambda x \lambda w \forall w' \in \text{allegations}'_w . \text{entity}'_{w'}(x)](\text{f})$
$= \lambda w \forall w' \in \text{allegations}'_w . \text{entity}'_{w'}(\text{f})$ st

Given that analysis like (7) is empirically problematic, we need further stipulations for intensional adjectives, weakening the adjective homogeneity hypothesis. In fact, an out-of-the-blue predicative use of a subsective adjective is also awkward, as (8) shows.

(8) ?Fido is <u>skillful</u> (entity).

This is unexpected under the adjective homogeneity hypothesis, assuming an analysis along the lines of (9).

(9) a. $[\![skillful]\!] = \lambda P \lambda x.\text{skillful}'(P)(x)$ $\langle\langle animate, t\rangle, \langle animate, t\rangle\rangle$
b. $[\![is\ skillful\ (entity)]\!] = [\lambda P \lambda x.\text{skillful}'(P)(x)](\lambda y.\ \text{entity}'(y))$
$= [\lambda x.\text{skillful}'(\lambda y.\ \text{entity}'(y))](x) = \lambda x.\ \text{skillful}'(\text{entity}'(x))$ $\langle animate, t\rangle$
c. $[\![is\ skillful\ (entity)]\!]([\![Fido]\!]) = [\lambda x.\text{skillful}'(\text{entity}'(x))](\text{f}) = \text{skillful}'(\text{entity}'(\text{f}))$ t

Without appropriate discourse support, the hearer will be left uncertain about the nature of the skillfulness. At least in principle, both the subsective "skillful-at-something" reading and the intersective "skillful-in-general" readings are possible. Then, it is puzzling why (8) out of the blue is not systematically ambiguous but instead semantically odd.

10.1.2 Doublet Theory

Given these difficulties, the adjective homogeneity hypothesis is perhaps an ideal that cannot be upheld. If we were to assume the adjective type heterogeneity hypothesis instead, we would have an independently motivated account for the observed differences: The two types of adjectives would correlate with the intersective vs. subsective distinction, with intersective adjectives denoting properties ($\langle e, t\rangle$), and subsective ones denoting properties of properties ($\langle\langle e, t\rangle, \langle e, t\rangle\rangle$). Many adjectives would then exist in two forms, **doublets** that happen to be homophonous (Siegel, 1976), explaining why some adjectives, such as *beautiful* in *beautiful writer*, give rise to a systematic intersective/subsective ambiguity.[1] It then simply becomes a lexical ambiguity between two senses of the word *beautiful*, similar to the lexical ambiguity in *bank* (side of river versus financial institution).

What is puzzling about this account is that it would be a pure accident that numerous adjectives happen to be ambiguous precisely in this manner. The doublet theory puts subsective and modal adjectives into a single category of predicate modifiers, which is also problematic. The two clearly differ; many subsective adjectives are gradable while modal adjectives are not. The latter's incompatibility with degree words, as shown in (10b), demonstrates the difference (Larson, 1998).

(10) a. the more/most/very <u>beautiful</u> writer
b. *the more/most/very <u>alleged</u> murderer

The theory further predicts that there should be no interpretive effect of relative ordering of adjectives since they would be ambiguous regardless of their position. Morzycki (2015) and Larson and Cho (2003) show that this expectation is not born out. As observed in the previous chapter, the higher adjective receives an intersective reading and the lower one has a subsective reading.

(11) a. <u>ugly beautiful</u> writer
b. <u>beautiful ugly</u> writer

10.1.3 Event-Based Theory

Faced with the difficulties involved with the doublet theory as well as predicate modifier theories, attempts have been made to unify the semantics of adjectives by treating them as simple properties. Larson (1998) argues that the intersective-subsective distinction needs to be teased apart from the semantic type distinction. He proposes instead that both intersective and subsective adjectives are property-denoting ($\langle e, t\rangle$), and that the apparent subsective readings are due to an event argument. For example, *dancer* can be understood naturally in terms of events since a dancer is someone who habitually dances. This notion of habitually dancing can be expressed with a generic operator GEN, which we used in Chapter 6 (Carlson and Pelletier, 1995; Chierchia, 1995). It binds an event argument of the predicate, as in (10).

(12) a. Garfield dances.
b. GEN*e*.dance′(g, *e*)

(12b) says that the generic or typical event is a dancing by Garfield, which is too strong. Instead, what we want to convey is that the contextually relevant generic event is a dancing by him. What counts as contextually relevant is left to discourse contexts, so (12a) means whenever it is appropriate for Garfield to dance, he typically dances. This intuition is translated in (13), in which the GEN operator is further restricted by the presupposition relevant$'_c(e)$ appearing between the operator and its scope.

(13) $\text{GEN}e.\text{relevant}'_c(e).\text{dance}'(\text{g}, e)$

The next step is to incorporate (13) into the denotation of the noun *dancer* itself, which is achieved by treating *dancer* as a property of dancing events, as in (14).

(14) $[\![dancer]\!] = \lambda e.\text{dance}'(e)$

(14) seems more appropriate as the denotation for the verb *dance*, which is not of the right type to occur in a nominal position. To avoid a type mismatch when it appears with determiners like *the*, let us combine it with the GEN operator and introduce an agent, as in (15).

(15) $[\![gen]\!]([\![dancer]\!]) = \lambda x\text{GEN}e.\text{relevant}'_c(e).\text{dance}'(e) \wedge agent(e) = x$

A dancer, then, is someone who is the agent of the typical dancing event in the relevant contexts. The ambiguity of *beautiful dancer* is naturally explained in this approach in terms of the relative scope of GEN. If it has a scope over the whole phrase, it gives rise to a subsective reading, as in (16a). If it has a scope over the noun only, an intersective reading obtains, as in (16b).

(16) a. $[\![gen\ beautiful\ dancer]\!] = \lambda x\text{GEN}e.\text{relevant}'_c(e).\text{beautiful}'(e) \wedge \text{dance}'(e) \wedge agent(e) = x$
b. $[\![beautiful\ gen\ dancer]\!] = \lambda x.\text{beautiful}'(x) \wedge \text{GEN}e.\text{relevant}'_c(e).\text{dance}'(e) \wedge agent(e) = x$

The order effect we observed in (11) derives from the fact that the GEN operator can only have scope in between the two adjectives, as shown in (17). The other scopes lead to a contradiction since a writer cannot be both beautiful and ugly at the same time or writes beautifully and in an ugly manner simultaneously. The acceptable scope is only compatible with the outer adjective being intersective and the inner one being subsective.

(17) a. $[\![ugly\ gen\ beautiful\ writer]\!]$
$= \lambda x.\text{ugly}'(x) \wedge \text{GEN}e.\text{relevant}'_c(e).\text{beautiful}'(e) \wedge \text{write}'(e) \wedge agent(e) = x$
b. $[\![beautiful\ gen\ ugly\ writer]\!]$
$= \lambda x.\text{beautiful}'(x) \wedge \text{GEN}e.\text{relevant}'_c(e).\ \text{ugly}'(e) \wedge \text{write}'(e) \wedge agent(e) = x$

The event-based theory treats subsective and intersective readings together as opposed to non-subsective/intensional ones, better explaining the intuition that the two senses of *beautiful* have more in common with each other than with adjectives like *alleged*. Moreover, because *beautiful* is not lexically ambiguous, there is no danger that the account of subsective readings will interfere with the account of its gradability. Despite these advantages, what is unappealing about the event-based account is postulating an event argument for nominals that are not event-denoting. Morzycki (2015) points out that the event-based account over-generates. For the subsective reading of *old friend*, for instance, we would need to assume that the noun *friend* is a property of a state of friendship, rather than a set of friends. Adopting such analysis would not explain why *brief friend* is not acceptable since a state of friendship can be brief.

Despite these loose ends, if we can assimilate genuine subsective adjectives to intersective adjectives by using event semantics, there will be very few true predicate modifying adjectives, and their exceptional behavior can be independently accounted for in terms of their intensionality.

Reflection

- Explain the adjective heterogeneity hypothesis and the adjective homogeneity hypothesis. Which is more desirable? What does the empirical evidence say?
- What are the strengths and weaknesses of the doublet theory?
- What are the strengths and weaknesses of the event-based theory? Do you think this analysis provides a better account of the intersective-subsective ambiguity than the doublet theory?

10.2 Theories of Vagueness

10.2.1 Vagueness, Ambiguity and Imprecision

Many natural language expressions are inherently vague, which make them more flexible but can also be quite unsettling. **Vagueness** does not sit well with formal semantics, which is founded on the binary notion of truth and falsity that leaves no room for grey areas. Then, why do speakers rarely have serious problems with vagueness in everyday use of language? We may try to remove vagueness by being very precise. For example, we might say Fido is not just tall, but twenty inches tall. This seems unnecessary, however, because *Fido is tall* is understood without causing any insurmountable interpretive difficulty. Vagueness is ubiquitous and most visible in gradable adjectives, which admit degree modification and occur in comparatives and related constructions. Accordingly, linguists have focused on gradable adjectives to study vagueness.

Investigating the semantics of vague predicates will shed light not just on vagueness and gradability themselves, but also on the underlying structure of adjective meaning and the role of scales and dimensions in lexical semantics.

A vague predicate is typically associated with so-called the **sorites paradox**, the paradox of the heap (sorites comes from Greek word for heap). If we remove a single grain of sand from a heap of sand, we still have a heap. Removing a single grain of sand would never be enough to turn the heap into a non-heap. However, if we repeat this process, we will eventually end up with a single grain of sand, which clearly is not a heap. But when does this transition happen? Even in hindsight, it would be difficult, if not impossible, to identify the crucial grain that changed heap to non-heap. This is a paradox because removing a single grain can never eliminate the heap, and yet we end up with a non-heap. While continuing to remove a grain, there will come a time that the judgment about heap or non-heap becomes unclear. The existence of **borderline cases** is another hallmark of vague predicates.

Vagueness is distinct from ambiguity. An ambiguous linguistic expression has more than one distinct interpretation and they do not give rise to borderline cases. Some instances of ambiguity involve two words that happen to be homophonous (lexical ambiguity or homonymy, e.g., *bank*). Other instances arise due to multiple syntactic structures that lead to multiple semantic representations (structural ambiguity). For example, *he ate the pizza on the table* has readings in which either he or the pizza is on the table, depending on whether *on the table* modifies *the pizza* or *ate*. Ambiguous words reject copredication, as previously noted, resulting in a zeugma effect. (18) sounds odd, proving that the two senses of *fine* ("thin" and "of high quality") are not just vague, but ambiguous.

(18) *Your hair and homework are <u>fine</u>.

Another form of indeterminacy that is distinguished from vagueness is **imprecision**. Vagueness is highlighted by borderline cases, where assigning a truth value is not so straightforward. Imprecision, on the other hand, is not an issue of truth or falsity, but of how close an approximation of truth is pragmatically sufficient in a particular context. Observe the contrast between (19a) and (19b).

(19) a. Fido is <u>tall</u>.
b. Fido is <u>twenty inches tall</u>.

The vagueness of (19a), which require contextual information for its truth or falsity, seems sufficiently resolved in (19b) with the addition of a measure phrase. However, imagine a situation where Fido is just a tiny bit shorter than exactly twenty inches. We might still judge (19b) to be true in that situation depending on how precisely we want to interpret the measure term. Hence, (19b), although not vague, is potentially imprecise. *Seem* is compatible with vague predicates, but not with ones that are merely imprecise.

(20) Fido seems (*<u>twenty inches</u>) tall.

Lasersohn (1999) observes that in everyday language use, we often judge sentences that are technically false to be true due to what he calls "**pragmatic halos.**" The pragmatic halo of an expression is a set of objects of the same type as its denotation which differ in only pragmatically ignorable ways (Mortzycki, 2015). The amount of pragmatic slack speakers allow is not typically made explicit and varies from one speaker to another.

Having distinguished vagueness from related concepts like ambiguity and imprecision, we are now ready to discuss major theories of vagueness in the following sections.

10.2.2 Fuzzy-Logic Theories

Fuzzy-logic theories reject the binary truth value, but instead argue for a scale consisting of infinitely many truth values (all real numbers between 0 and 1) (Lakoff, 1973; Smith, 2008; Zadeh, 1978). Allowing an infinite number of truth values, however, faces some serious problems as it undoes classical validities. Let us consider the interpretations of truth conditional connectives. Fuzzy connectives could be defined as in (21). (21a) states that the negation of a proposition is as true as the original proposition was false. (21b) says that conjoined proposition is as true as its least true conjunct, and (21c) says disjoined proposition is as true as its most true disjunct.

(21) a. $[\![\textit{not } \varphi]\!] = 1 - [\![\varphi]\!]$
b. $[\![\varphi \textit{ and } \psi]\!]$ = the lower of the truth values of $[\![\varphi]\!]$ and $[\![\psi]\!]$
c. $[\![\varphi \textit{ or } \psi]\!]$ = the higher of the truth values of $[\![\varphi]\!]$ and $[\![\psi]\!]$

This seemingly plausible interpretations fail to make ordinary truth value judgment for coordinated sentences like (22).

(22) a. Fido is tall or he isn't tall.
b. Fido is tall and he isn't tall.

If *Fido is tall* has a truth value of 0.5, its negation, *Fido isn't tall*, will have the same truth value, 0.5, making both (22a) and (22b) true, despite the fact that (22b) is a contradiction. Although we can imagine a situation where we are tempted to assign 0.5 for the truth value of *Fido is tall*, e.g., if Fido is a borderline case for *tall*, we still want to maintain, even in such a case, (22a) is true and (22b) is false.

Fuzzy logic approaches interpret comparatives by comparing truth values directly because truth values are now gradable. However, it is strange to say that (23a) means that *Fido is tall* is "truer" than *Garfield is tall*, as expressed in (23b). We are not comparing the degree of truth of sentences here, but the degree of height of two animals.

(23) a. Fido is taller than Garfield.
b. ⟦*Fido is tall*⟧ > ⟦*Garfield is tall*⟧

Furthermore, if putting all comparatives on the same scale of truth values is possible, as the fuzzy logic theory entails, it should in principle be possible to interpret comparatives composed of arbitrary pairs of sentences, such as (24). Fuzzy logic theories predict that (24) will be interpretable as *the temperature is high* has higher truth value than *John is tall*. Contrary to this expectation, one cannot compare height with degree of temperature, and (24) is ungrammatical precisely for this reason.

(24) *The temperature is higher than John is tall. (Nouwen et al., 2011)

In sum, having a single scale with infinite truth values is not very useful for explicating vague adjectives because their meaning crucially hinges on different scales along with different dimensions.

10.2.3 Super-Valuation Theories

Super-valuation theories pursue the idea that vague predicates are neither true nor false for borderline cases (Barker, 2002; Doetjes et al., 2011; Fine, 1975; Kamp, 1975; Kamp and Partee, 1995; Klein, 1980; van Rooij, 2008).). Let us call the standard extension of *tall*, namely, the set of tall things, the **positive extension** of *tall*, and call everything that isn't tall its **negative extension**. The borderline cases fall into an **extension gap**, the set of things in neither the positive nor the negative extension of *tall*. When this happens, we will not be able to determine the truth value of the sentence containing the borderline cases, as it will be in a corresponding truth-value gap.

To implement this idea formally, we first need to introduce extension gaps into the semantics. This can be done by assuming that vague predicates denote **partial functions**, ones that are simply undefined for individuals in their extension gap. In addition, we need a discourse context to determine what counts as a borderline case, as comparison classes for a vague adjective will change from one context to another, e.g., *big elephant* vs. *big mouse*. (25) defines the positive and negative extensions and extension gaps.

(25) a. $pos_c.P(x) = 1$ if and only if x is in the positive extension of P in context c.
b. $neg_c.P(x) = 1$ if and only if x is in the negative extension of P in context c.
c. $gap_c.P(x) = 1$ if and only if x is in the extension gap of P in context c.

The function is undefined if its individual argument, x, falls in the extension gap in context c. When defined, the function will produce 1 if x is in the positive extension, and 0 if x is in the negative extension. Hence, the denotation of a vague adjective *tall* in (26) presupposes that its argument does not fall into the extension gap and asserts that it is in the positive extension of tallness.

(26) $[\![tall]\!] = \lambda x.\neg gap_{\mathrm{c}}.\mathrm{tall}'(x).pos_{\mathrm{c}}.\mathrm{tall}'(x)$

Since contexts are not static but instead constantly updated as the discourse unfolds, the updating could in principle continue to the point that no extension gap remains. A context such as this is called a **total precisification**.

(27) a. Fido is tall or he isn't tall.
b. Fido is tall and he isn't tall.

On any total precisification, (27a) will come out true. If we assign Fido to the positive extension of *tall*, the sentence will be true because of the first conjunct; if we assign him to the negative extension, the second conjunct will make the sentence true. Likewise, (27b) will be false, since Fido will be in the positive or the negative extension under super-valuation, leading to a contradiction. The assignment of truth conditions on the basis of all total precisifications is called a **super-valuation**, and it renders a sentence such as (27a) super-true and (27b) super-false. The notion of super-truth does not change the system for simple positive sentences. Hence, it remains the case that *Fido is tall* would be undefined if Fido is in the extension gap.

A major drawback of super-valuation theories is, like fuzzy logic theories, the absence of a sufficiently articulated notion of scales. Although they involve orderings among individuals, the comparative ultimately involves quantification over precisifications rather than over degrees on a particular scale. As a result, arbitrary cross-scale comparisons are expected to be acceptable. Conceptually, it is also questionable whether we can always reach a total precisification even if we try (Nouwen et al., 2011).

Reflection

- How are ambiguity, imprecision and vagueness different from one another?
- What are some advantages and problems with fuzzy logic theories and super-valuation theories?
- What do you think of the criticisms toward super-valuation theories? Do you think it is impossible to draw a sharp line for all borderline cases? If we have to abide by the binary truth, as fuzzy logic theories are proven untenable, how can the truth value be determined for borderline cases?

10.3 Degree-Based Theories

10.3.1 Scales and Degrees

Degree-based theories of vagueness introduce degrees as primitives to directly represent measurement (Bartsch and Vennemann, 1973; Bierwisch, 1989; Kennedy, 1997, 2007; Kennedy and McNally, 2005; von Stechow, 1984). Degrees are members of a scale that is a strict ordering. The axioms of strict ordering are given in (28). Strict orders are transitive, antisymmetric and reflexive. (28a) says if one degree is at least as small as a second, and the second at least as small as a third, then the first is at least as small as the third. (28b) states that two degrees can be at least as small as each other only if they are actually identical. According to (28c), every degree is at least as small as itself.

(28) $\forall d, d', d'' \in S$:
 a. $\preccurlyeq$ is transitive: $[d \preccurlyeq d' \wedge d' \preccurlyeq d''] \rightarrow d \preccurlyeq d''$
 b. $\preccurlyeq$ is antisymmetric: $[d \preccurlyeq d' \wedge d' \preccurlyeq d] \rightarrow d = d'$
 c. $\preccurlyeq$ is reflexive: $d \preccurlyeq d$

10.3.2 Degree Arguments and the Implicit Degree Word

Degrees are atomic types, which are points on a scale abstractly representing measurements. Each scale can be mapped to some particular dimension of measurements, such as length, temperature and weight. All degrees on the same scale are totally ordered with respect to each other, permitting a direct comparison, whereas a comparison across scales is illicit. Degree-based theories argue that gradable predicates have an extra degree argument. For example, *tall* denotes a measure function that takes an entity and yields its height, as in (29).

(29) $[\![tall]\!] = \lambda d \lambda x.\text{tall}'(d, x)$ $\langle degree, \langle e, t\rangle\rangle$

The composition of gradable adjectives combined with a measure phrase is given in (30). Measure phrases like *twenty inches* denote a degree (of type *d*).

(30) a. $[\![twenty\ inches]\!] = \text{20-inch}'$ *degree*
 b. $[\![tall]\!] = \lambda d \lambda x.\text{tall}'(d, x)$ $\langle degree, \langle object, t\rangle\rangle$
 c. $[\![tall]\!]([\![twenty\ inches]\!]) = [\lambda d \lambda x.\text{tall}'(d, x)]$
 $(\text{20-inch}') = \lambda x.\text{tall}'(\text{20-inch}', x)$ $\langle object, t\rangle$
 d. $[\![twenty\ inches\ tall]\!]([\![Fido]\!]) = [\lambda x.\text{tall}'(\text{20-inch}', x)](\text{f})$
 $= \text{tall}'(\text{20-inch}', \text{f})$ t

If there is no explicit measure phrase, it means that the subject is taller than the contextually given standard. To spell this out, degree theorists introduce an implicit morpheme *pos* defined in (31) (Kennedy, 2007; Kennedy and McNally, 2005). We have already used *pos* for the meaning of degree achievements in Chapter 4. Here, G is a variable for any gradable predicate of type $\langle degree, \langle e, t\rangle\rangle$, and *stnd* is a function from gradable predicate meanings to degrees that meets the standard of comparison for the predicate in the context of utterance.

(31) $[\![pos]\!] = \lambda G\lambda x.G(x) \geqslant stnd(G)$

(32) shows the composition of *Fido is tall* using *pos*. Applied to *tall*, it denotes a property true of an object just in case its height exceeds the given standard. (32d) means that Fido's height is greater than the contextually provided standard of tallness.[2]

(32) a. $[\![pos]\!] = \lambda G\lambda x.G(x) \geqslant stnd(G)$ $\quad\langle\langle degree, \langle e, t\rangle\rangle, \langle e, t\rangle\rangle$
b. $[\![tall]\!] = \lambda d\lambda x.\text{tall}'(d, x)$ $\quad\langle degree, \langle object, t\rangle\rangle$
c. $[\![pos]\!]([\![tall]\!]) = \lambda x.\text{tall}'(x) \geqslant stnd(\text{tall})$ $\quad\langle object, t\rangle$
d. $[\![pos\ tall]\!]([\![Fido]\!]) = \lambda x.\text{tall}'(x) \geqslant stnd(\text{tall})$ $\quad t$
$(\text{f}) = \text{tall}'(\text{f}) \geqslant stnd(\text{tall})$

Degree-based theories treat (33a) as tautological and (33b) as contradictory, as desired.

(33) a. $[\![\textit{Fido is tall or he isn't tall}]\!] = \text{tall}'(\text{f}) \geqslant stnd(\text{tall}') \vee \neg\text{tall}'(\text{f}) \geqslant stnd(\text{tall}')$
b. $[\![\textit{Fido is tall and he isn't tall}]\!] = \text{tall}'(\text{f}) \geqslant stnd(\text{tall}') \wedge \neg\text{tall}'(\text{f}) \geqslant stnd(\text{tall}')$

Although relatively free of serious problems, introducing degrees as new atomic entities seems theoretically less parsimonious. Moreover, degree-based theories equate vagueness with gradability, which are closely related but not always identical. Not all vague predicates are gradable; for example, *door* is vague (between car doors and house doors) but not gradable, and there are many other vague lexical categories than gradable adjectives. To be a comprehensive theory, degree-based theories will have to be supplemented with an independent theory of the vagueness for these expressions.

Reflection

- What evidence exists for the degree argument for gradable adjectives?
- In what sense are degree-based theories better than fuzzy logic theories or super-valuation theories?
- Super-valuation theories take the positive form of an adjective to be basic and define the comparative in terms of it. Degree-based theories do the opposite because a positive adjective has a meaning of the form "more *G* than the standard for *G*." Yet across languages, the positive form is the less syntactically complicated one. Does this pose a problem for the degree-based theories?

10.4 Predicates of Personal Taste

10.4.1 Relativist Accounts

Among the evaluative adjectives, the meaning of *fun* and *tasty* received much attention. They are specifically called "**predicates of personal taste**" because their meaning depends on the speaker's subjective judgment, rather than objective criteria.

(34) a. Roller coasters are <u>fun</u>.
b. This chili is <u>tasty</u>.

A major debate is ongoing between **relativists** and **contextualists**. The (truth) relativist account of predicates of personal taste (Lasersohn, 2005; MacFarlane, 2007; Stephenson, 2007; Wright, 2001; inter alia) proposes to relativize the content with respect to judges, treating the content of a sentence as a set of world-time-individual triples, rather than world-time pairs. (35) is the denotation of *tasty* in the relativist account, which is relativized with respect to a judge parameter.

(35) $[\![tasty]\!]^{w,t,j} = \lambda x.x$ tastes good to j in w at t

According to this view, although the disagreement in examples like (36) is over the perspective-neutral proposition *this chili is tasty*, neither A nor B is wrong since it may be true at $\langle w, t, j_A \rangle$ but false at $\langle w, t, j_B \rangle$.

(36) A: This chili is tasty.
B: No, it isn't.

This view has a merit of treating the predicates as monadic but a drawback in complicating the semantics of all predicates by including an individual index.

It is stipulated that the individual index does not play any role for objective predicates. That stipulation, however, is problematic because which predicates qualify as predicates of personal taste is far from being settled. Moreover, it is not clear what the nature of the disagreement regarding the perspective-neutral proposition really is. We have an intuition that it is not simply a matter of a clash of (rightful) opinions, but an actual debate about whether one's perspective accords with the actual facts.

10.4.2 Contextualist Accounts

On the opposing side of the debate, the **contextualist account** (Glanzberg, 2007; Pearson, 2013; Schaffer, 2011; Sundell, 2011; inter alia) argues that predicates of personal taste have an implicit experiencer $\text{PRO}_{(\text{ARB})}$ argument whose identity is fixed by the context. Typically, it is either the speaker or a generic person. According to Schaffer (2011), the faultless disagreement, in case it is substantial and persisting, is about the "expert" opinion with the intention to report some shared standard. The following dialogue provides evidence. If it is a matter of facts that *this wine is tasty* is true for A but false for B, then there is no point of A providing further explanations to defend her perspective.

(37) A: The wine is tasty.
B: No, the wine is not tasty.
A: But consider the subtle hints of blackberry.

The other possibilities are **entrenchment** like (38) and **retraction** as in (39). In case of the former, there is no genuine disagreement. In case of the latter, the disagreement is resolved through a concession on the part of the original speaker, A.

(38) A: This chili is tasty.
B: No, it isn't.
A: Listen, I was just saying that it is tasty to me/I like it.

(39) A: This chili is tasty.
B: No, it isn't. It has pork in it.
A: Okay. I was wrong.

Pearson (2013) argues that predicates of personal taste like *tasty* make statements about whether something is tasty to people in general, based on the first-person experience. (40) presents the denotation of *tasty* in the contextualist account, which is only relativized to world (and time) indices as usual.

(40) $[\![tasty]\!]^{c,w} = \lambda x \lambda y.x$ has direct experience of y in $w.y$ is tasty to x in w

There is some evidence for the existence of an implicit experiencer argument. The sentences containing these adjectives can be felicitously uttered only when the speaker has direct experiential evidence for the claim, as verified by (41) (Pearson, 2013; Stephenson, 2007).

(41) ?This chili is tasty, but I haven't tried it.

The experiential presupposition projects under negation, question and an antecedent of a conditional, as shown in (42) (Pearson, 2013).

(42) a. The chili isn't tasty. (the speaker tasted the chili.)
b. Is the chili tasty? (the hearer tasted the chili.)
c. If the chili is tasty, I want to try some, too. (the hearer tasted the chili.)

Contextualist accounts have a merit of explaining the intuition that there is a genuine disagreement regarding the proposition itself, not simply over the (relative) states of affairs in the world. Furthermore, they leave alone the denotation of predicates as $\langle e, (s)t\rangle$, rather than more complicated $\langle e, \langle e, (s)t\rangle\rangle$. A drawback would be treating the predicates in question as dyadic, containing an invisible experiencer argument.

Reflection

- What are adjectives that are not scalar? What are distinctive characteristics of them? How do you analyze their meanings?
- What are special properties of predicates of personal taste? What are theoretical approaches to them? Which do you think is a better theory?
- What are some other adjectives you can think of that require subjectivity?

10.5 Conclusion

In this chapter, we explored the possibility of a uniform treatment of all adjectives. We also examined various theories of vagueness, such as fuzzy-logic theories, super-valuation theories and degree-based theories. Finally, we investigated evaluative adjectives, focusing on the predicates of personal taste.

Points to Remember

- The doublet theory assumes general ambiguity between intersective and subsective adjectives and has a problem of treating intersective and intensional adjectives alike.
- An event-based approach provides a uniform treatment of adjectives as simple properties but tends to overgenerate.
- The fuzzy-logic theories advocate for gradable truths. They face some serious problems as they undermine classic validities.
- Super-valuation theories rely on extension gaps and total precisifications. It is controversial whether a total precisification is always possible.
- Degree-based theories introduce degrees as a new atomic primitive.
- The relativist approach of predicates of personal taste argues for a judge parameter for these predicates.
- The contextualist approach of predicates of personal taste offers a syntactic solution by invoking an implicit experiencer argument.

Technical Terms to Remember

1. **Adjective type homogeneity hypothesis:** All adjectives are uniformly predicate modifiers.
2. **Adjective type heterogeneity hypothesis:** Intersective adjectives denote properties and subsective ones denote properties of properties.
3. **Doublet theory:** Adjectives that are ambiguous between intersective and subsective readings exist in two forms, doublets that happen to be homophonous.
4. **Event-based theory:** Both intersective and subsective adjectives are property-denoting and the apparent subsective readings are due to an event argument.
5. **Vagueness:** The standard of comparison needed for the interpretation of gradable predicates comes from discourse context.
6. **Sorites paradox:** The paradox of the heap where removing a single grain can never eliminate the heap, and yet we end up with a non-heap.
7. **Borderline cases:** The cases where assigning a truth value is not straightforward.
8. **Imprecision:** The degree of an approximation of truth that is pragmatically sufficient in a particular context.
9. **Pragmatic halos:** A set of objects of the same type as its denotation which differ in only pragmatically ignorable ways.

10. **Fuzzy-logic theories:** Theories that reject the binary truth value, but instead argue that there is a scale consisting of infinitely many truth values.
11. **Super-valuation theories:** Theories that argue that vague predicates are neither true nor false for borderline cases.
12. **Positive extension:** The standard extension of a predicate.
13. **Negative extension:** Everything that isn't in the extension of a predicate.
14. **Extension gap:** The set of things in neither the positive nor the negative extension of a predicate.
15. **Partial function:** Functions that are simply undefined for individuals in the extension gap.
16. **Total precisification:** Contexts in which no extension gap remains.
17. **Super-valuation:** The assignment of truth conditions on the basis of all total precisifications.
18. **Degree-based theories:** Gradable predicates have an extra degree argument where degrees are primitives that directly represent measurement.
19. **Predicates of personal taste:** Predicates whose meaning depends on the speaker's subjective judgment, rather than objective criteria.
20. **(Truth) relativist account:** A proposal to relativize the content with respect to judges, treating the content of a sentence as a set of world-time-individual triples, rather than world-time pairs.
21. **Contextualist account:** Predicates of personal taste have an implicit experiencer $\text{PRO}_{(\text{ARB})}$ argument whose identity is fixed by the context.
22. **Entrenchment:** The speaker is only stating her/his personal opinion so there is no genuine disagreement.
23. **Retraction:** The disagreement is resolved through a concession on the part of the original speaker.

Suggested Reading

McNally and Kennedy (2008) is an edited volume that contains a wide range of articles on adjective semantics by leading scholars. See Lasersohn (2005) and Schaffer (2011) for further details of predicates of personal taste.

Practice

1. Provide compositional analyses of the following phrases adopting the adjective type homogeneity and adjective type heterogeneity hypotheses.
(a) *red apple*

a. $[\![red]\!] = \lambda x.\text{red}'(x)$ $\langle thing, t\rangle$
b. $[\![apple]\!] = \lambda x.\text{apple}'(x)$ $\langle natural\text{-}kind, t\rangle$

c. $[\![\mathit{red}]\!] \cap [\![\mathit{apple}]\!] = \lambda x.\mathbf{red}'(x) \wedge \mathbf{apple}'(x)$ $\langle \mathit{natural\text{-}kind}, t\rangle$
a. $[\![\mathit{red}]\!] = \lambda P \lambda x.\mathbf{red}'(x) \wedge P(x)$ $\langle\langle \mathit{thing}, t\rangle, \langle \mathit{thing}, t\rangle\rangle$
b. $[\![\mathit{apple}]\!] = \lambda y.\mathbf{apple}'(y)$ $\langle \mathit{natural\text{-}kind}, t\rangle$
c. $[\![\mathit{red}]\!]([\![\mathit{apple}]\!]) = [\lambda P \lambda x.\mathbf{red}'(x) \wedge P(x)](\lambda y.\mathbf{apple}'(y))$
$= [\lambda x.\mathbf{red}'(x) \wedge \lambda y.\mathbf{apple}'(y)](x) = \lambda x.\mathbf{red}'(x) \wedge \mathbf{apple}'(x)$ $\langle \mathit{natural\text{-}kind}, t\rangle$

(b) *beautiful writer*
(c) *is red*
(d) *is beautiful*
(e) *is American*

2. Provide compositional analyses of the following phrases using intensional semantics.
(a) *alleged thief*

a. $[\![\mathit{alleged}]\!] = \lambda P \lambda x \lambda w \forall w' \in \mathbf{allegations}'_w.P_{w'}(x)$ $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$
b. $[\![\mathit{thief}]\!] = \lambda y \lambda w''.\mathbf{thief}'_{w''}(y)$ $\langle \mathit{animate}, st\rangle$
c. $[\![\mathit{alleged}]\!]([\![\mathit{thief}]\!]) = [\lambda P \lambda x \lambda w \forall w' \in \mathbf{allegations}'_w.P_{w'}(x)](\lambda y \lambda w''.\mathbf{thief}'_{w''}(y))$
$= \lambda x \lambda w \forall w' \in \mathbf{allegations}'_w.\mathbf{thief}'_{w'}(x)$ $\langle \mathit{animate}, st\rangle$

(b) *potential threat*
(c) *likely candidate*
(d) *possible outcome*
(e) *necessary tool*

3. Explain why the following sentences are awkward or ungrammatical.
(a) ?*Fido is skillful.*
It doesn't say what Fido is skillful at.

(b) **Fido is alleged.*
(c) **Fido is possible.*
(d) ?*Fido is experienced.*
(e) **Fido is potential.*

4. Provide compositional analyses of the following adjectival phrases using event semantics. If they are ambiguous between intersective and subsective readings, provide both translations.
(a) *beautiful singer*
$[\![\mathit{gen\ beautiful\ singer}]\!] = \lambda x \textsc{gen} e.\mathbf{relevant}'_c(e).\mathbf{beautiful}'(e) \wedge \mathbf{sing}'(e) \wedge \mathit{agent}(e) = x$
$[\![\mathit{beautiful\ gen\ singer}]\!] = \lambda x.\mathbf{beautiful}'(x) \wedge \textsc{gen} e.\mathbf{relevant}'_c(e).\mathbf{sing}'(e) \wedge \mathit{agent}(e) = x$

(b) *skillful surgeon*
(c) *experienced hunter*
(d) *lousy cook*
(e) *ugly dancer*

5. Describe the interpretations and provide an event-based semantic analysis of the following phrases.

(a) *beautiful ugly painter*

The gen operator can only have scope in between the two adjectives. The other scopes lead to a contradiction since a painter cannot be both beautiful and ugly at the same time or paints beautifully and in an ugly manner simultaneously.

$[\![\textit{beautiful gen ugly painter}]\!]$
$= \lambda x.\mathbf{beautiful'}(x) \wedge \textsc{gen}e.\mathbf{relevant'}_c(e).\mathbf{ugly'}(e) \wedge \mathbf{paint'}(e) \wedge \textit{agent}(e) = x$

(b) *ugly beautiful painter*

6. Determine which sentences are vague, ambiguous or potentially imprecise.

(a) *Fido is tall.*

vague

(b) *Fido is twenty inches tall.*
(c) *Fido went to the bank.*
(d) *Fido is heavy.*
(e) *Fido's hair is fine.*

7. How does different theories of vagueness explain the tautology in (a) and contradiction in (b)?

(a) The class is long or it isn't long.

Fuzzy logic: $[\![\text{not } \varphi]\!] = 1 - [\![\varphi]\!]$ If *the class is long* has a truth value of 0.5, its negation, *the class isn't long*, will have the same truth value, 0.5, so (a) is true.

Super-valuation: under total precisification, (a) is super true.

Degree-based: $[\![\textit{the class is long or isn't long}]\!] = \mathbf{long'}(c) \geqslant \textit{stnd}(\mathbf{long'}) \vee \neg\mathbf{long'}(c) \geqslant \textit{stnd}(\mathbf{long'})$ tautology

(b) *The class is long and it isn't long.

8. Provide the denotation of the following adjectives using the super-valuation theory.

(a) *small*

$[\![\textit{small}]\!] = \lambda x.\neg \textit{gap}_c.\mathbf{small'}(x).\textit{pos}_c.\mathbf{small'}(x)$

(b) *big*
(c) *high*
(d) *heavy*
(e) *wide*

9. Provide compositional analyses of the following sentences using degree-based semantics.

(a) *Fido is old.*

a. $[\![\textit{pos}]\!] = \lambda G \lambda x.G(x) \geqslant \textit{stnd}(G)$ $\quad \langle\langle \textit{degree}, \langle e, t\rangle\rangle, \langle e, t\rangle\rangle$
b. $[\![\textit{old}]\!] = \lambda d \lambda x.\mathbf{old'}(d, x)$ $\quad \langle \textit{degree}, \langle \textit{object}, t\rangle\rangle$
c. $[\![\textit{pos}]\!]([\![\textit{old}]\!]) = \lambda x.\mathbf{old'}(x) \geqslant \textit{stnd}(\mathbf{old'})$ $\quad \langle \textit{object}, t\rangle$
d. $[\![\textit{pos old}]\!]([\![\textit{Fido}]\!]) = [\lambda x.\mathbf{old'}(x) \geqslant \textit{stnd}(\mathbf{old'})](\mathbf{f}) = \mathbf{old'}(\mathbf{f}) \geqslant \textit{stnd}(\mathbf{old'})$ $\quad \mathbf{t}$

(b) *Fido is seven years old.*
(c) *This homework is long.*
(d) *This homework is two pages long.*
(e) *This house is expensive.*

10. Provide their denotations of the following predicates of personal tastes based on the relativist and contextualist theories.

(a) *fun*

Relativist: $[\![\textit{fun}]\!]^{w,t,j} = \lambda x.x$ **is fun to j in** w **at** t

Contextualist: $[\![\textit{fun}]\!]^{c,w} = \lambda x \lambda y.x$ **has direct experience of** y **in** $w.y$ **is fun to** x **in** w

(b) *interesting*
(c) *pleasurable*
(d) *tedious*
(e) *boring*

Notes

1 Siegel (1976) bases his claim on the existence of languages like Russian which have a systematic contrast in adjectives related to the choice between property and predicate modifier denotations.

2 Matters are in fact a bit more complicated than this. Kennedy (2007), based on the felicitous example like (i), argues that just a variable over comparison classes is not sufficient to determine the meaning of positive forms of gradable adjectives, but requires a context-sensitive function that makes the object "stand out" in the utterance context relative to the kind of measurement.

(i) Nadia's height is greater than the average height of a gymnast, but she is still not tall for a gymnast.

11 The Semantics of Adverbs

11.1 Interpretive Issues Regarding Adverbs

11.1.1 Adverbs and Adverbials

Unlike the lexical categories we discussed so far, adverbs do not form a coherent category because they are quite heterogeneous. The adverb is more or less treated as a lexical wastebasket; whatever does not belong to other lexical categories is thrown into this category. Consequently, adverbs are hard to define because no clear morphosyntactic or semantic features characterize them, but instead they are frequently defined on the basis of their syntactic function of being used as adverbials in a sentence. The term **adverbial**, according to Maienborn and Schäfer (2011), refers to a particular syntactic function, typically that of further specifying the circumstances of the situation described by the verb or the sentence. Although a deadjectival -*ly* adverb in (1a) can be identified as such through its morphology, words like *well* in (1b) are classified as adverbs solely based on their adverbial function. Moreover, the adverbial is not restricted to lexemes, but includes prepositional phrases, as in (1c). We will focus on simple adverbs in this chapter and discuss prepositions in the next chapter.

(1) a. She dances <u>beautifully</u>.
b. She dances <u>well</u>.
c. She dances <u>for hours in her studio</u>.

Like adjectives, adverbs are mostly optional adjuncts and modifiers, as sentences without them are well formed. Exceptionally, some limited number of predicates require them, as in (2).

(2) a. Fido treated Garfield <u>badly</u>.
b. Fido behaved <u>well</u>.
c. Garfield lies <u>on the mat</u>.

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Unlike adjectives, which exclusively modify nouns, adverbs can modify a wide variety of heterogeneous constituents of the sentence; this flexibility is a hallmark of adverbs. They typically modify verbs, as we saw in (1) above, but some of them can modify adjectives or other adverbs, as in (3).

(3) a. Fido runs extremely/too/very fast.
    b. Fido is a ridiculously cute dog.

Despite their flexibility, adverbs still cannot occur as attributive modifiers of nouns, as shown in (4).

(4) a. *the well runner
    b. *the extremely conditions

Although most adjective-modifying adverbs describe a degree of the adjective or adverbial property, as in (3), some are not related to degrees. For example, the adverb in (5) is unrelated to degrees but evaluative (Morzycki, 2008).

(5) Fido is admirably loyal.

11.1.2 Predicational and Functional Adverbs

Ernst (2002) names those adverbs that are typically gradable or related to gradable predicates **predicational adverbs**. They assign a (gradable) property to the meaning of the verb or the sentence they combine with, and commonly realized as deadjectival adverbs by adding *-ly* to an adjective stem. He further divides predicational adverbs into three sub-classes of manner, subject-oriented, and speaker-oriented adverbs. **Manner adverbs** specify the manner in which the described event is performed. *Quickly* in (6a) is a manner adverb that modifies the verb *run*, elaborating on the manner in which the described action is carried out. **Subject-oriented adverbs** describe a property of the subject of the sentence. *Carelessly* in (6b) attributes the carelessness to the subject of the sentence, Garfield, rather than the manner in which he touched the stove. (6b) can be paraphrased as *it was careless of Garfield to touch the stove*. **Speaker-oriented adverbs** indicate the speaker's attitude toward the sentence or modify the speech act itself. *Honestly* in (6c) does not modify the propositional content of the sentence but instead add to the meaning of the speaker's utterance on (6c), stating that the speaker is speaking honestly.

(6) a. Fido runs quickly.
    b. Garfield carelessly touched the stove.
    c. Honestly, I don't know what you are talking about.

Ernst (2002) calls (phrasal) adverbials like (7) **non-predicational** or functional adverbials, which are not gradable or related to gradable predicates, but typically quantificational. They include locative adverbials in (7a), temporal adverbials in (7b), quantificational adverbials in (7c), and focus adverbs in (7d).

(7) a. Fido ran <u>in the backyard</u>.
b. Fido ran <u>for two hours</u> yesterday.
c. Fido <u>always/frequently/often/rarely/seldom/never</u> runs.
d. Fido <u>only/even</u> gave his bone to Garfield.

These adverbials have been extensively studied in compositional semantics. We will mainly focus on lexical adverbs in this chapter, instead of adverbials consisting of different phrasal forms. The meaning of prepositions, like *in* and *for*, will be investigated in the next chapter.

A major theoretical debate concerns whether adverbs are verb phrase (VP) modifiers or sentence modifiers, and whether they combine with the modified verbs intersectively or take the verbs as arguments. Sometimes, we can tell whether an adverb is a VP modifier or a sentence modifier by the position of the adverb. Sentence adverbs have a hierarchically higher attachment site and combine with the overall proposition expressed by the rest of the sentence without the adverb. A speaker-oriented adverb in (6c) above exemplifies such a case. Verb-modifying adverbs, on the other hand, have a lower attachment site within the VP, and are more restrictively modify the verbal event, such as manner adverbs in (6a) above. It is controversial whether subject-oriented adverbs are VP modifiers or sentence modifiers, which we will discuss more in depth shortly. A complication arises, however, because a single adverb can sometimes be used as manner, as in (8a), and subject-oriented, as in (8b), and speaker-oriented, as in (8c).

(8) a. I spoke to you <u>honestly</u>. (= I spoke to you in an honest manner.)
b. <u>Honestly</u>, I spoke to you. (= It was honest of me to speak to you.)
c. <u>Honestly</u>, I don't like you. (= Honestly speaking, I don't like you.)

It is a considerable theoretical interest whether many adverbs are lexically ambiguous between VP modifiers and sentence modifiers, or the ambiguity is a matter of syntactic positions.

11.1.3 The Universal Adverb Hierarchy

Cinque (1999) treats adverbial phrases as specifiers of unique functional projections rather than adjuncts. This claim is based on the rigid relative order of the adverbs which reflects a fixed universal hierarchy of clausal functional projections. If adverbs were adjuncts, such ordering restriction is unaccounted for. (9) is his universal order of functional heads, which, he claims, enter into specifier-head agreement with corresponding adverbs.

(9) [*frankly* Mood$_{\text{speech act}}$ [*fortunately* Mood$_{\text{evaluative}}$ [*allegedly* Mood$_{\text{evidential}}$ [*probably*
Mod$_{\text{epistemic}}$ [*once* Tense$_{\text{past}}$ [*then* Tense$_{\text{future}}$ [*perhaps* Mood$_{\text{irrealis}}$ [*necessarily*
Mod$_{\text{necessity}}$ [*possibly* Mod$_{\text{possibility}}$ [*usually* Asp$_{\text{habitual}}$ [*again* Asp$_{\text{repetitive}}$ [*often*
Asp$_{\text{frequentitive}}$ [*intentionally* Mod$_{\text{volitional}}$ [*quickly* Asp$_{\text{celerative}}$ [*already* Tense$_{\text{anterior}}$
[*no longer* Asp$_{\text{terminative}}$ [*still* Asp$_{\text{continuative}}$ [*always* Asp$_{\text{perfect}}$ [*just* Asp$_{\text{retrospective}}$
[*soon* Asp$_{\text{proximative}}$ [*briefly* Asp$_{\text{durative}}$ [*characteristically* Asp$_{\text{generic/progressive}}$ [*almost*
Asp$_{\text{prospective}}$ [*completely* Asp$_{\text{completive}}$ [*well* Voice [*fast/early* Asp$_{\text{celerative}}$ [*again*
Asp$_{\text{repetitive}}$ [*often* Asp$_{\text{frequentitive}}$ [*completely* Asp$_{\text{completive}}$]]]]]]]]]]]]]]]]]]]]]]]]]]]]]

Scholars have challenged such elaborate functional projections and the bold claim that the hierarchy is universal, advocating instead to go back to the traditional adjunct analysis of adverbs. Costa (2000) points out that a coordination of adverbs from different classes like the frequency and manner adverbs in (10) poses a serious problem with Cinque's functional specifier hypothesis.

(10) He often and nicely reads the book to the grandmother.

Alexiadou (1997) claims that obligatory complement adverbs in (2) above, repeated in (11), defy the functional specifier analysis.

(11) a. Fido treated Garfield badly.
b. Fido behaved well.
c. Garfield lies on the mat.

Ernst (2002) shows that the relative order of adverbs is not invariably fixed, as evidenced by (12). If adverbs are only licensed in the specifier of a unique functional projection, as Cinque argues, the variable adverb order cannot be explained. He argues that the behavior of adverbs is better explained by their semantic scope than purely syntactic approaches.

(12) a. She frequently was suddenly being rejected by publishers.
b. She suddenly was being frequently rejected by publishers.

As was previously observed in (8) above, the same adverb can appear in different positions with different meanings. (13) contains similar examples where the meaning does not change (it is consistently a subject-oriented adverb) but it can appear in any position between the main and the auxiliary verbs.

(13) a. He <u>foolishly</u> may have been trying to impress you.
b. He may <u>foolishly</u> have been trying to impress you.
c. He may have <u>foolishly</u> been trying to impress you.
d. He may have been <u>foolishly</u> trying to impress you.

To explain (13), Cinque (1999, 2004) further stipulates that the verb and the NPs move leftward. More generally, in Cinque-style cartographic framework, exceptions to the supposedly universal hierarchy are explained away by head movements of the verb and topicalization and focus movement of the adverbs. He argues that the adverb order is an accident of evolution that is not grounded in independent semantic scope principles because certain functional distinctions, but not others, are made in language. This conflicts with the recent syntactic development in minimalism, which tries to minimize the uninterpretable, formal features, but emphasizes the cognitive factors controlling the grammar.

In line with Ernst (2002), we will assume that the relative order of adverbs come from their semantic scope instead of complicating the syntactic phrase structure. As we have observed, adverbs' interpretation changes as they take different positions in a sentence, as the paraphrase in (14) shows (Ernst, 2002; Jackendoff, 1972).

(14) <u>Happily</u>, Fido would <u>happily</u> eat the bone <u>happily</u>.
"It is fortunate that Fido would be happy to eat the bone in a happy way"

To be interpreted as a speaker-oriented adverb modifying the speaker's attitudes or properties of speech act itself, the adverb must take scope of the entire sentence, as the first instance of *happily* in (14). Subject-oriented adverbs describing the subject's attitudes or properties may need to be above the VP to get interpreted as such, like the second occurrence of *happily* in (14). Manner adverbs indicating the manner in which the described action is performed occur lower than subject-oriented adverbs and closest to the verb, as instantiated by the sentence-final *happily* in (14). The order restrictions are naturally explained by the semantic types of different adverbs. The speaker-oriented adverbs modify speech acts or the speaker's expressive meanings, taking scope over the entire proposition. They are of type $\langle st, st\rangle$, a function from propositions to propositions. Subject-oriented adverbs, which indicate the subject's mental or agentive properties, modify VP and of type $\langle\langle e, (s)t\rangle,$

$\langle e, (s)t\rangle\rangle$. Manner adverbs are also VP modifiers but simply conjoined with the verb meaning using event semantics (type $\langle e, (s)t\rangle$).

Reflection

- Why is it difficult to define adverbs as a coherent lexical category? What is the difference between adverbs and adverbials? What are the differences between predicational and non-predicational (functional) adverbs?
- How are predicational adverbs categorized? On what ground? What are the characteristics of each class?
- The same adverb can have different meanings depending on its position. Can you give an example? How can you explain this phenomenon without assuming Cinque-style syntactic hierarchy?

11.2 Typology of Adverbs

11.2.1 Manner Adverbs

The class of manner adverbs is fairly well defined, both syntactically and semantically. Jackendoff (1972) distinguished manner adverbs as a subclass of the verb phrase adverbs, those that appear sentence-finally but not sentence-initially. Syntactically, McConnell-Ginet (1982) takes manner adverbs to be not only associated with the VP but to be VP-internal. Clear cases of manner adverbs are such adverbs as *quickly*, *slowly*, *carefully*, *violently*, *loudly* and *tightly*. Manner adverbs characterize the manner in which an event described by the VP takes place. (15) contains some examples and paraphrases in parentheses. All these adverbs can be questioned by "how…?"

(15) a. Fido barked <u>loudly</u>. (Fido barked in a loud manner.)
b. Fido runs <u>fast</u>. (Fido runs in a fast manner.)
c. Garfield dances <u>beautifully</u>. (Garfield dances in a beautiful manner.)
d. Garfield caught a mouse <u>skillfully</u>. (Garfield caught a mouse in a skillful manner.)

Manner adverbs cannot take scope over the sentence negation, suggesting that they are inside the VP. The inference in (16) is invalid; the manner adverb, *fast* does not concern the negated event. This is expected because a sentence negation means that there is no event described by the verb, and if so, it will be impossible to specify its manner (Maienborn and Schäfer, 2011).

(16) Fido does not run fast. ≠ Fido does not run, and he does so fast.

Many manner adverbs exhibit regular polysemy, having a factive speaker-oriented meaning when sentence-initial and their more standard manner reading sentence-finally, as in (17).

(17) a. Disgustingly, I cleaned the fish in the sink.
b. I cleaned the fish in the sink disgustingly.

While the same adverb yields different interpretations depending on the position in (17), other adverbs exclusively belong to just one category. For these non-polysemous adverb types, we can observe the position constraints imposed on them more clearly because using certain adverbs in the wrong position results in ungrammaticality, rather than different readings. As (18a) demonstrates, exclusively manner adverbs like *lavishly* cannot take a higher position. The sentence cannot be interpreted as the speaker being lavishing in furnishing the house.

(18) a. *I lavishly have furnished the house.
b. I have furnished the house lavishly.

Semantically, manner adverbs are distinguished by a set of entailment properties from other types of adverbs (Davidson 1967; Parsons 1990). They allow a similar entailment patterns with intersective adjectives like *Italian*. Just as (19a) entails both (19b) and (19c), (20a) seems to entail (20b) through (20d).

(19) a. Fido is an Italian Pointer.
b. Fido is Italian.
c. Fido is a Pointer.

(20) a. Fido ran quickly quietly.
b. Fido ran quickly.
c. Fido ran quietly.
d. Fido ran.

They are scopeless. As illustrated in (21), the order in which the adverbials appear does not influence the interpretation of the sentence: (21a), (21b) and (21c) are synonymous.

(21) a. Fido hit Garfield on the head hard with his paw.
b. Fido hit Garfield hard on the head with his paw.
c. Fido hit Garfield hard with his paw on the head.

Additionally, manner modifiers have conjunctive interpretations, meaning that they can be dropped from a sentence, preserving its truth, as we observed in the entailment relations in (20) above. This might seem to indicate that manner adverbial modification is a simple intersective predicate modification. If so, manner adverbs have the basic type ⟨*e*, *t*⟩ which can intersect with the verb denotation, restricting it to its subset, as in (22).

(22) $[\![\textit{run quickly}]\!] = [\![\textit{run}]\!] \cap [\![\textit{quickly}]\!]$

Crucially, however, the truth of (19b-d) does not guarantee the truth of (20a) as would typically be the case for intersective modifiers. Moreover, a simple intersective treatment of manner adverbs is problematic since, while the combinatorics work, the resulting interpretation is inadequate. For example, (20b) would require the subject argument to be quick, not the running. To remedy this problem, we need to allow the manner adverb to predicate over events, rather than individuals (Parsons, 1990). We have already used Davidsonian event semantics for deverbal nouns as well as verbs. Extending the event analysis to manner verbs, sentences like (20b) will attribute the speed to the running event.[1] On the Davidsonian account, adverbial modifiers are taken to be event predicates which combine as co-predicates of the verb, as we represented in (23). Given this analysis, it is not surprising that the order of combination does not matter. Furthermore, since (20a) entails both (20b) and (20c), but is not entailed by them, it is clear why we can drop event predicates.

(23) a. $\lambda e.\text{run}'(\text{f}, e) \wedge \text{quick}'(e) \wedge \text{quiet}'(e)$
b. $\lambda \text{e}.\text{run}'(\text{f}, e) \wedge \text{quick}'(e)$
c. $\lambda \text{e}.\text{run}'(\text{f}, e) \wedge \text{quiet}'(e)$
d. $\lambda \text{e}.\text{run}'(\text{f}, e)$

11.2.2 Subject-Oriented Adverbs

Jackendoff (1972) coined the term subject-oriented adverbs to refer to those which describe properties of the subject and license certain entailments involved with it. (24a) can be paraphrased as (24b), attributing Fido with the property of wisdom based on the action described by the sentence.

(24) a. Fido <u>wisely</u> avoided the fight.
b. It was wise of Fido to avoid the fight.

The inference from (25a) and (25b) is valid. This means that subject-oriented adverbs do not create an intensional context, but veridical.

(25) a. Fido <u>wisely</u> avoided the fight.
b. Fido avoided the fight.

Many manner adverbs, such as *foolishly*, *cleverly* and *rudely*, also have subject-oriented readings. As previously mentioned, the position of the adverb often differentiates the meaning. *Cleverly* in (26a) has a subject-oriented reading, whereas the same adverb in (26b) has a manner reading, as the paraphrases indicate.

(26) a. Fido cleverly dodged the attack. (= Fido was clever in dodging the attack.)
b. Fido dodged the attack cleverly. (= Fido dodged the attack in a clever manner.)

In general, subject-oriented adverbs must occur higher than manner adverbs, as shown in (27).

(27) a. I wisely finished the homework quickly.
b. *I quickly finished the homework wisely.

These adverbs interact with voice due to its subject-orientedness (McConnell-Ginet, 1982). In (28a) it was the speaker who was wise, and in (28b), it was the hearer.

(28) a. Wisely, I instructed you.
b. Wisely, you were instructed by me.

Unlike manner adverbs, subject-oriented adverbs take scope over the negation. (29a) entails (29b). If the sentence is negated, it means that the subject had the attitudes toward the lack of action, e.g., Fido was wise not to respond to the insult. This suggests that subject-oriented adverbs may well be sentential modifiers.

(29) a. Fido wisely did not respond to the insult.
b. Fido did not respond to the insult.

Subject-oriented adverbs are divided into mental attitude adverbs and agent-oriented adverbs. **Mental attitude adverbs** like the one in (30) describe the attitude of the subject with regard to the action described by the verb. Similar adverbs include *calmly, wisely, (un)willingly,* and *anxiously*.

(30) Fido reluctantly left his master.

Agent-oriented adverbs, on the other hand, attribute a property to the agentive subject based on the action described by the verb. The subject in sentences with agent-oriented adverbs must be volitional (Wyner, 1998), explaining the ungrammaticality of sentences like (31a). In (31b), Fido is the agent of the dismissing as well as the experiencer of a state of arrogance.

(31) a. *The accusation <u>arrogantly</u> dismissed Fido.
b. Fido <u>arrogantly</u> dismissed Garfield.

Unlike manner adverbs, subject-oriented adverbs take scope over the negation. (32a) entails (32b). If the sentence is negated, it means that the subject had an attitude toward the lack of action, e.g., Fido was wise not to respond to the insult.

(32) a. Fido wisely did not respond to the insult.
b. Fido did not respond to the insult.

Given that subject-oriented adverbs take scope over the sentence negation, we may treat them as sentential operators of type $\langle (s)t, (s)t \rangle$. The sentential operator analysis, however, turns out to be wrong for subject-oriented adverbs. To understand this point, we need to examine the behavior of **intensional adverbs** discussed in Thomason and Stalnaker (1973). Although it is not a general property of subject-oriented adverbs, certain lexically specified mental attitude adverbs create intensional contexts. (33) shows that the subject oriented adverb *intentionally* creates an opaque context, quantifying over worlds compatible with Oedipus's intentions. In intensional contexts, expressions with the same denotation, such as *Jocasta* and *Oedipus's mother* in (29), are not freely interchangeable. The inference from (33a) and (33b) to (33c) is invalid because it may well be the case that Oedipus was unaware of (33b).

(33) a. Oedipus <u>intentionally</u> married Jocasta.
b. Jocasta is Oedipus's mother.
c. Oedipus <u>intentionally</u> married his mother.

To be precise, concluding (33c) is invalid only in one of the readings of the sentence, which is ambiguous between *de re* and *de dicto* readings. *De re* reading is a belief report with a referential expression in which there are particular individuals of whom the attitude holder has a certain belief. *De dicto* reading is a belief report with a referential expression that is true if and only if there are some individuals who satisfy the predicate in each possible world that is compatible with what she/he believes (Chierchia, 1989; Quine, 1956). If Oedipus himself recognizes the person he married is actually his mother, a *de dicto* reading obtains. On the other hand, if he does not and only the speaker recognizes the fact, a *de re* reading follows. The crucial point is that an intensional context is created within VP, not for the whole sentence. As a result, switching the subject with an expression with the same referent does not change the meaning of the sentence, as shown in (34). The conclusion (34c) drawn from (34a) and (34b) is valid.

(34) a. Oedipus intentionally married Jocasta.
b. Oedipus is the son of Laius.
c. The son of Laius intentionally married Jocasta.

Through this extra discussion of intensional adverbs, we discover that subject-oriented adverbs, on a par with manner adverbs, are VP modifiers. Therefore, we will treat *intentionally* as an inherently intensional modifier that apply to the VP rather than the whole sentence. However, the above discussion also leads us to conclude that subject-oriented adverbs, unlike manner adverbs, are predicate modifiers of type $\langle\langle e, st\rangle, \langle e, st\rangle\rangle$.

11.2.3 Speaker-Oriented Adverbs

Speaker-oriented adverbs describe the speaker's attitudes toward the proposition or his/her comments regarding the utterance itself. They are divided into three sub-types of speech act, evaluative and modal adverbs. **Evaluative adverbs**, such as *amazingly, surprisingly, (un)fortunately, remarkably, strangely, oddly* and *curiously*, form a small but interesting class of adverbs. They express the speaker's personal opinion about the proposition expressed by the modified sentence. (34a) can be paraphrased as (35b). Note that it is the speaker who finds Fido losing his bone unfortunate.

(35) a. Unfortunately, Fido lost his bone.
b. It is unfortunate that Fido lost his bone.

Evaluative adverbs are awkward when directly negated, as (36) shows, indicating that they have a scope over the entire sentence.

(36) *Fido is not unfortunately lost his bone.

The inference from (37a) to (37b) is valid, implying that evaluative adverbs are veridical and not inherently intensional.

(37) a. Unfortunately, Fido lost his bone.
b. Fido lost his bone.

Non-opacity of evaluative adverbs is confirmed in (38). The inference from (38a) together with (38b) to (38c) is valid.

(38) a. Unfortunately, Fido attacked Garfield.
b. Garfield is the orange cat.
c. Unfortunately, Fido attacked the orange cat.

These adverbs are impossible before questions, as shown in (39) (Bonami and Godard, 2008).

(39) *Fortunately, who rescued Fido?

In English, they do not easily occur inside questions, as in (40a), or in the antecedents of conditionals, as in (40b) (Ernst, 2009).

(40) a. ?Who fortunately rescued Fido?
b. ?If, remarkably, Fido can catch a rabbit, he probably can't do it today.

(41a) shows that speaker-oriented or evaluative adverbs must scope over subject-oriented ones, as expected. If the order is reversed, the sentence becomes unacceptable, as shown in (41b).

(41) a. You obviously have cleverly been preparing for the test.
b. *You cleverly have obviously been preparing for the test.

Given these observations, unlike manner and speaker-oriented adverbs, which were treated as VP modifiers, evaluative adverbs are best to be treated as proposition modifiers of type $\langle st, st \rangle$. Note that, however, the resulting proposition concerns the speaker's attitudes which do not directly contribute to the truth condition of the sentence. In other words, the content of an evaluative adverb is not part of the main sentential content, as recognized by many researchers (Bach, 1999; Bartsch, 1976; Bellert, 1977; Jayez and Rossari, 2004; Potts, 2005). In the case of simple assertion, the speaker asserting a proposition without an evaluative adverb commits himself to the truth of the proposition, at the same time as he asks the addressee(s) to evaluate it. When an evaluative adverb is used, on the other hand, the same speech acts are performed, but the speaker additionally commits herself to the proposition associated with the adverb while withdrawing it from the addressee's evaluation. As evidence, evaluative adverbs cannot normally be challenged by the other discourse participants, as the oddness of (42b) demonstrates.

(42) a. Fido unfortunately lost his bone.
b. ??That's not true, I think it is very good news. He should lose weight.

This data makes sense if the evaluative adverb denotes the judgment of the speaker independently of her commitments effected by the main speech act. The evaluative adverbs can be said to convey an "ancillary commitment" of the speaker. This assumption directly accounts for the two basic semantic properties: veridicality and absence of opacity of evaluative adverbs we observed in (37) and (38) above. Since the adverb does not contribute to the main assertion, its effect is independent of the presence of the adverb. That is to say, in an assertion the speaker is committed to the truth of the proposition conveyed by the sentence with or without the adverb. Even though evaluative adverbs, which take a propositional argument, can in principle create opacity, assuming that a single agent cannot explicitly entertain contradictory beliefs, opacity is excluded by this pragmatic principle (Bonami and Godard, 2008).

Adverbs like *certainly* or *probably* are **epistemic adverbs** describing the degree of speaker's confidence about the proposition, as illustrated in (43). Epistemic adverbs include gradable modal adverbs indicating varying degrees of possibilities and obligations, such as *obligatorily, necessarily, inevitably, hopefully, ideally, probably, certainly, definitely, surely* and *clearly*.

(43) a. Possibly, Fido lost his bone. (= It is possible that Fido lost his bone.)
b. Necessarily, Fido will win the race. (= It is necessary that Fido will win the race.)

Like evaluative adverbs, epistemic adverbs cannot be directly negated, suggesting that they are sentential operators.

(44) *Fido has not probably lost his bone.

Unlike evaluative adverbs, however, epistemic adverbs create an intensional context; the inference from (45a) to (45b) is not valid.

(45) a. Fido has probably lost his bone.
b. Fido has lost his bone.

Among the speaker-oriented adverbs, evaluative adverbs occur above epistemic ones, but not vice versa, as shown in (46).

(46) a. Unsurprisingly you will probably fail the test.
b. *Probably you will unsurprisingly fail the test.

Speaker-oriented adverbs can occupy the lower position, as long as a subject oriented adverb does not occur above it, as shown in (47), in which *obviously* is still interpreted as a speaker-oriented adverb.

(47) You have obviously been preparing for the test.

The standard analysis of epistemic adverbs is to treat them as modal, i.e., as quantifiers over possible worlds, which will be provided in the next section.

Lastly, **speech-act adverbs**, aka pragmatic, discourse-oriented or utterance-modifying adverbs, such as *frankly*, *seriously*, *confidentially*, characterize the speaking event itself, as the paraphrase in (49b) indicates. They do not support paraphrases in which their adjective counterpart is predicated of a proposition, as in (48c).

(48) a. <u>Frankly</u>, you blew it.
b. I say to you frankly that you blew it.
c. *It is frank that you blew it.

These adverbs do not modify the content of the proposition. One way to analyze them is to postulate an underlying speech act verb like *say*. The view that there is an underlying speech act verb in all sentences is called the **performative hypothesis** (Lakoff, 1972; Ross, 1970; Sadock, 1974). Performative hypothesis holds that all sentences involve an underlying verb of speaking that expresses their illocutionary force (saying, asking, ordering, etc.). Evidence comes from the fact that certain verbs (called **performative verbs**) makes the sentence true simply by (an authoritative person) uttering it, as in (49).

(49) a. I (hereby) christen this ship The Robot Monkey.
b. I (hereby) declare you legally divorced.
c. I (hereby) claim this island for Spain.
d. I promise you a rose garden.

A modern rendering of this hypothesis is using an **assertion operator** ASSERT that applies to a proposition and return a property of an event of having asserted it, defined in (50) (Ginzburg and Sag, 2001; Krifka, 2001).

(50) $[\![assert]\!] = \lambda p \lambda e.\text{ASSERT}(p, e)$

When applied to a proposition it will yield a speaking event. Equipped with the ASSERT operator and the ability to refer to the speech event itself, speech-act adverbs can be analyzed as a simple intersective adverb, as we will observe in Section 11.3.3.

Like evaluative adverbs, speech-act adverbs are not part of what is asserted that can be open to debate. To express disagreement with this sentence, one could not felicitously say (51B).

(51) A: <u>Frankly</u>, you blew it.
B: No, that's not true. I blew it, but you weren't being frank.

Instead, the addressee tends to simply accept that the utterance was a frank one and will focus on the content of the assertion that he or she blew it. Potts (2005) proposes that a natural approach to this would involve treating the contribution of *frankly* as a distinct kind of meaning: **conventional implicature** (in short CI), on a separate dimension of meaning from ordinary content. CI derives from lexical meaning but do not directly contribute to the truth condition. They resist semantic embedding and tend to involve the perspective of the speaker in some way (Harris and Potts, 2009; Potts, 2005, 2007; Schlenker, 2007). Appositives in (52) have been given a CI analysis (Potts, 2005). The resistance to embedding is reflected in (52b), which denies that Lance wound up disappointing everyone, but not that he was a cyclist.

(52) a. Lance, a cyclist, wound up disappointing everyone.
b. It's not true that Lance, a cyclist, wound up disappointing everyone.

A parallel phenomenon is observed with speech-act adverbs. (53b) denies that the addressee's speech was bad, but not that the speaker's utterance was frank.

(53) a. <u>Frankly</u>, your speech was bad.
b. <u>Frankly</u>, your speech was not bad.

Speech-act adverbs can appear in questions, as shown in (54), being directed at the addressee rather than the speaker. It is not the asking in (54) that is serious—it is the desired answer. This contrasts with evaluative adverbs, which are unacceptable in this context, as we saw in (39) above. This is because speech-act adverbs take a speaking event with illocutionary force as argument, while evaluative adverbs take propositions with no sentential force.

(54) <u>Seriously</u>, are you drunk?

CI theory captures the speech act adverbs' resistance to embedding, as shown in (55).

(55) a. ?I suspects that <u>seriously</u>, you blew it.
b. ?I wondered whether, <u>confidentially</u>, you blew it.
c. ?I doubts that <u>frankly</u>, you blew it.

CI analysis can also be employed to analyze evaluative adverbs like *unfortunately*, since they express the speaker's attitudes without directly contributing to the truth condition of the sentence. Under the CI analysis, the type of evaluative adverbs would be type $\langle st, t^c \rangle$, where t^c is the conventional-implicature analogue of the ordinary truth value type t defined as such by Potts (2005). Note that, however, CI analyses cannot provide an interpretation for intersective speech-act adverbs, or one on which their meaning is identical to their manner counterparts. It is also less parsimonious since it not only introduces a whole another dimension of meaning but also entail multiple ambiguity of numerous adverbs.

Reflection

- What are the semantic properties of manner adverbs? Why is a simple intersective analysis inadequate?
- What is evidence for treating subject-oriented adverbs as VP modifiers? What are the similarities and differences between mental attitude adverbs and agent-oriented adverbs?
- What sub-classes are there in the speaker-oriented adverbs? What kind of semantic analysis is appropriate for each class?

11.3 Theoretical Approaches to Adverbs

11.3.1 The Predicate Analysis

The predicate analysis of adverbs employs event semantics and treats adverbs as predicates of events. Despite some initial objections, ample evidence has been put forward for an extra event argument in the verb meaning (Parsons, 1990). Without them, explaining the multiple occurrences of adverbials in (56), or the fact that (56) entails all the sentences in (57), becomes quite difficult.[2]

(56) Fido hit Garfield hard on the head with his paw.

(57) a. Fido hit Garfield hard.
b. Fido hit Garfield on the head.
c. Fido hit Garfield with his paw.
d. Fido hit Garfield.

Moreover, the pronoun *it* in (58) refers to the event of Fido hitting Garfield, providing further evidence that natural language treats events as if they were individuals in their own right.

(58) a. It was done hard.
b. It was done with his paw.
c. It was done on the head.

Using event semantics, we can treat them as directly modifying the underlying event. In the logical translation of (56) given in (59), the verb *hit* takes an extra event argument *e* in addition to its required individual arguments, Fido and Garfield, facilitating the treatment of any number of adverbials simply as conjoined conditions predicating over the same event described by the main verb.

(59) a. $[\![\textit{Fido hit Garfield}]\!] = \lambda e.\text{hit}'(\text{f, g}, e)$
b. $[\![\textit{hard}]\!] = \lambda e.\text{hard}'(e)$
c. $[\![\textit{on}]\!]([\![\textit{the head}]\!]) = [\lambda x\lambda e.\text{on}'(x, e)](\text{h}) = \lambda e.\text{on}'(\text{h}, e)$
d. $[\![\textit{with}]\!]([\![\textit{his paw}]\!]) = [\lambda x\lambda e.\text{with}'(x, e)](\text{p}) = \lambda e.\text{with}'(\text{p}, e)$
e. $[\![\textit{Fido hit Garfield}]\!] \cap [\![\textit{hard}]\!] \cap [\![\textit{on the head}]\!] \cap [\![\textit{with his paw}]\!] = \lambda e.$ $\text{hit}'(\text{f, g}, e) \wedge \text{hard}'(e) \wedge \text{on}'(\text{h}, e) \wedge \text{with}'(\text{p}, e)$

The predicate analysis is most suitable for manner adverbials. (60) is the composition of *Fido ran quickly*. Manner adverbs have the type ⟨*process*, *t*⟩, which intersects with the verb denotations to yield an unsaturated VP. It gives the right result, ensuring that the running, not Fido, was quick.

(60) a. $[\![\textit{quickly}]\!] = \lambda e.\text{quick}'(e)$ ⟨*process*, *t*⟩
b. $[\![\textit{run}]\!] = \lambda x\lambda e.\text{run}'(x, e)$ ⟨*thing*, ⟨*process*, *t*⟩⟩
c. $[\![\textit{run}]\!] \cap [\![\textit{quickly}]\!] = \lambda x\lambda e.\text{run}'(x, e) \wedge \text{quick}'(e)$ ⟨*thing*, ⟨*process*, *t*⟩⟩
d. $[\![\textit{run quickly}]\!]([\![\textit{Fido}]\!]) = [\lambda x\lambda e.\text{run}'(x, e) \wedge \text{quick}'(e)]$ $(\text{f}) = \lambda e.\text{run}'(\text{f}, e) \wedge \text{quick}'(e)$ ⟨*process*, *t*⟩
e. $[\![\textit{Fido ran quickly}]\!] = \exists e.\text{run}'(\text{f}, e) \wedge \text{quick}'(e)$ *t*

11.3.2 The Operator Analysis

Modal/epistemic adverbs are treated as sentential operators, functions from propositions to propositions (type ⟨*st*, *st*⟩) (Cresswell, 1973; Kamp, 1975; Montague, 1974; Parsons, 1970/1972). As discussed in Chapter 2, interpretation of intensional sentences involves alternative sets of states of affairs other than the actual one. The set of possible worlds (or scenarios) are related to the actual world in terms of a proper accessibility relation, as defined in (61).

(61) $\text{W} = \{w, w', w'', \ldots\}$ where $\forall w \in \text{W}, wR\text{w}$
(w is the actual world and R is a suitable accessibility relation).

The meaning of modal expressions depends on different accessibility relations. The accessible possible worlds can be **epistemic**, those that are compatible with the speaker's knowledge and belief, in case of (62a), **circumstantial** or root ones, those that are compatible with the way things are disposed to, as in (62b), or **deontic** ones, those that are compatible with the way things should be, as exemplified by (62c). These different conversational backgrounds are called a **modal base** (Kratzer, 1977, 1991, 2012). This analysis explains how the same modal expression can give rise to different interpretations by simply adjusting the relevant conversational background.

(62) a. Fido must be hungry. (given the available evidence and knowledge)
b. Garfield can catch a mouse. (given the relevant circumstances including Garfield's ability)
c. You must go to jail. (given what is required by the law)

Let us logically represent the meaning of *necessarily* and *possibly*. R is an appropriate contextually provided accessibility relation (e.g., worlds compatible with what is known from the evaluation world w). (63a) states that *necessarily p* is true if and only if p is true in all worlds accessible from the evaluation world w, and (63b) says *possibly p* is true if and only if there are some world(s) accessible from w where p is true.

(63) a. $[\![necessarily]\!] = \lambda p \lambda w \forall w' \in R(w).p(w')$
b. $[\![possibly]\!] = \lambda p \lambda w \exists w' \in R(w).p(w')$

(64) contains compositional steps to derive *necessarily Fido won*. It is true if and only if in all accessible worlds from the evaluation world that are compatible with the speaker's knowledge, Fido won.

(64) a. $[\![necessarily]\!] = \lambda p \lambda w \forall w' \in R(w).p(w')$ $\langle st, st\rangle$
b. $[\![necessarily]\!]([\![Fido\ won]\!]) = [\lambda p \lambda w \forall w' \in R(w).p(w')]$
$(\lambda w.\text{won}'(\text{f}, w))$
$= \lambda w \forall w' \in R(w)[\lambda w.\text{won}'(\text{f}, w)](w') = \lambda w \forall w' \in R(w).\text{won}'(\text{f}, w')$ $\langle st\rangle$

(65) shows a compositional analysis of *possibly Fido died*. It is true if and only if there is a possible world accessible from the evaluation world that are compatible with the speaker's knowledge in which Fido died.

(65) a. $[\![possibly]\!] = \lambda p \lambda w \exists w' \in R(w).p(w')$ $\langle st, st\rangle$
b. $[\![possibly]\!]([\![Fido\ died]\!]) = [\lambda p \lambda w \exists w' \in R(w).p(w')]$
$(\lambda w.\text{died}'(\text{f}, w))$
$= \lambda w \exists w' \in R(w)[\lambda w(\text{died}'(\text{f}, w)](w') = \lambda w \exists w' \in R(w).\text{died}'(\text{f}, w')$ $\langle st\rangle$

Modal adverbs are characterized by different degrees of certainty, as (66) illustrates (Anand and Brasaveanu, 2010). In general, gradable modal adverbs indicate varying degrees of possibilities and obligations (e.g., *obligatorily, necessarily, inevitably, hopefully, ideally, probably, certainly, definitely, surely, clearly*).

(66) a. Fido <u>very probably</u> lost his bone.
b. Fido <u>quite possibly</u> lost his bone.
c. Fido is <u>more likely</u> to be hungry than Garfield.

An epistemic modal base is not sufficient to interpret examples in (66). To pinpoint very probable possible worlds, for example, we need an ordering source that induces an ordering on the accessible world in addition to the modal base, because gradable adverbs equally use the epistemic modal base but still need to be distinguished from one another. Kratzer (1991) uses another conversational background, called an **ordering source**, which is a stereotypical conversational background (paraphrased as "given the normal course of events"). A world w is at least as close to the ideal represented by a set of proposition A as a world w' if and only if all propositions in A which are true in w' are also true in w. A proposition p is a better possibility than a proposition q in a world w with respect to a modal base and an ordering source if and only if p is at least as good a possibility as q but q is not at least as good a possibility than p in w with respect to the modal base and the ordering source. Simply put, not all accessible possible worlds are created equal; those that conform to ideals or "normal" course of events will represent better possibilities. This gives us a tool to express the gradient nature of modality.

An operator analysis is also appropriate for evaluative adverbs like *amazingly* and *unfortunately*, which describe the speaker's personal opinion about the proposition expressed by the modified sentence. They support paraphrases in which their adjective counterparts are predicated of a proposition, as observed in (35) above. Evaluative adverbs are also sentence modifiers; they resist a scope under the negation, as we saw in (36) above. (67) shows the interpretation of an evaluative adverb *unfortunately*. It takes a proposition as its input and yields another proposition as its output.

(67) $[\![\textit{unfortunately}]\!] = \lambda p \lambda w.\text{unfortunate}'(p, w) \quad \langle st, st\rangle$

(68) contains a compositional analysis of *Fido unfortunately lost*. It is true if and only if there was an event of Fido losing and that event is unfortunate (to the speaker).

(68) $[\![\textit{unfortunately}]\!]([\![\textit{Fido lost}]\!]) = [\lambda p \lambda w'.\text{unfortunate}'(p, w')](\lambda w \exists e.\text{lost}'(\text{f}, e, w))$
$= \lambda w'.\text{unfortunate}'([\lambda w \exists e.\text{lost}'(\text{f}, e, w)](w') = \lambda w'.\text{unfortunate}'(\exists e.\text{lost}'(\text{f}, e, w')) \quad \langle st\rangle$

The operator analysis, however, is not appropriate for speech-act adverbs as well as manner adverbs, which are simple VP modifiers rather than manipulating the world argument of the whole proposition. Unlike epistemic or evaluative adverbs, typical manner adverbs like *quietly* are not intensional. Note that the inference from (69a-b) to (69c) is valid. Therefore, a uniform treatment of adverbs as sentential operators is inadequate.

(69) a. Oedipus <u>quietly</u> married Jocasta.
b. Jocasta is Oedipus's mother.
c. Oedipus <u>quietly</u> married his mother.

11.3.3 Analyses of Speech-Act Adverbs

The predicate analysis is also proven successful in its treatment of speech act adverbs with the aid of the assertion operator, which we defined in (50) above. Equipped with the ASSERT operator and the ability to refer to the speech event itself, speech-act adverbs can be analyzed as a simple intersective adverb, as in (70d).

(70) a. $[\![\textit{you blew it}]\!] = \exists e.\text{blow-it}'(\text{h}, e)$ (h is the hearer) $\quad t$
b. $[\![\textit{assert}]\!] = \lambda p \lambda e'.\text{ASSERT}(p, e') \quad \langle t, \langle \textit{speech-act}, t\rangle\rangle$
c. $[\![\textit{assert}]\!]([\![\textit{you blew it}]\!]) = [\lambda p \lambda e'.\text{ASSERT}(p, e')](\exists e.\text{blow-it}'(\text{h}, e))$
$= \lambda e'.\text{ASSERT}(\exists e.\ \text{blow-it}'(\text{h}, e))(e') \quad \langle \textit{speech-act}, t\rangle$
d. $[\![\textit{frankly}]\!] = \lambda e'.\text{frank}'(e') \quad \langle \textit{speech-act}, t\rangle$
e. $[\![\textit{frankly}]\!] \cap [\![(\textit{assert})\ \textit{you blew it}]\!] = \lambda e'.\text{frank}'(e') \wedge \text{ASSERT}(\exists e.$
$\text{blow-it}'(\text{h}, e))(e') \quad \langle \textit{speech-act}, t\rangle$
f. $[\![\textit{frankly you blew it}]\!] = \exists e'.\text{frank}'(e') \wedge \text{ASSERT}(\exists e.\text{blow-it}'(\text{h}, e))(e') \quad t$

(70e) is true if and only if an event of asserting the proposition that you blew it was a frank one. This suffers from a classic problem of the performative hypothesis since it would always come out true so long as the utterance is frank. Albeit somewhat stipulative, this problem can be corrected by simply adding a conjunct representing the asserted content, as in (71). The sentence will be judged true only if the addressee in fact blew it.

(71) $[\![\textit{frankly you blew it}]\!] = \exists e'.\text{frank}'(e') \wedge \text{ASSERT}(\exists e.\text{blow-it}'(\text{a}, e))(e') \wedge$
$\exists e.\text{blow-it}'(\text{h}, e)$

Reflection

- What are modal bases and ordering sources? Why do we need these concepts for semantics of epistemic adverbs?
- Why is the traditional analysis of adverbs as sentential modifiers problematic? What is evidence for treating manner and speech act adverbs uniformly as predicates over events?
- Speaker-oriented adverbs do not directly contribute to the truth condition of the sentence. What is the evidence for this claim? What are some of the ways to properly incorporate this aspect?

11.4 Treating Adverbs as Arguments of Verbs

11.4.1 Verb Augmentations

We have postulated an event argument for predicate and treated manner adverbs as predicates over events, rather than individuals, as in (72b). The logical translation, however, still seems odd because the adverb specifies only one aspect of the event, i.e., the speed. A plain analysis of the manner adverb as predicate over events does not capture this.

(72) a. Fido runs <u>quickly</u>.
b. $\exists e.\text{run}'(\text{f}, e) \wedge \text{quick}'(e)$

Similarly, *softly* modify the sound volume of the event, *skillfully* focuses equally on the outcome (i.e., the answer was skillful) and the process of the event. In case of the former, a dimensional scale (along the dimension of sound volume, speed, etc.) would suffice, but for the latter, non-dimensional or evaluative meaning is involved, similar to non-dimensional adjectives. In short, manner is not uniform and simple, but instead involves complex relations whose meaning depends on the lexical semantics of each adverbs as well as context. Despite its simplicity, it is also unclear how the predicate analysis can correctly represent the meaning of subject-oriented adverbs such as *stupidly*. We need a way to distinguish between a manner reading (you embezzled in a stupid manner) and a subject/agent-oriented reading (it was stupid of you to embezzle). Reserving the intersective analysis to the former, we might treat the latter as a predicate modifier, as (73) presents. It is true just in case there was an event of the hearer embezzling and that event was stupid.

(73) a. $[\![\textit{stupidly}]\!] = \lambda P \lambda x \lambda e.\text{stupid}'(P)(x, e)$ $\langle\langle \textit{animate}, \langle \textit{event}, t\rangle\rangle, \langle \textit{animate}, \langle \textit{event}, t\rangle\rangle\rangle$
b. $[\![\textit{embezzled}]\!] = \lambda y \lambda e'.\text{embezzled}'(y, e')$ $\langle \textit{animate}, \langle \textit{event}, t\rangle\rangle$
c. $[\![\textit{stupidly}]\!]([\![\textit{embezzled}]\!]) = [\lambda P \lambda x \lambda e.\text{stupid}'(P)(x, e)](\lambda y \lambda e'.\text{embezzled}'(y, e'))$
$= \lambda x \lambda e.\text{stupid}'([\lambda y \lambda e'.\text{embezzled}'(y, e')](x, e)) = \lambda x \lambda e.\text{stupid}'(\text{embezzled}'(x, e))$ $\langle \textit{animate}, \langle \textit{event}, t\rangle\rangle$

On a predicate modifier approach, adverbs are functions that take verbs as arguments. This overlooks the basic fact that adverbs are optional. Furthermore, the logical translation does not capture the fact that what is described as being stupid is the subject, rather than the event of embezzlement. Moreover, by treating manner adverbs as simple properties and subject-oriented ones as properties of properties, we lose a unified semantic analysis of manner and subject-oriented adverbs, which are both VP modifiers.

A uniform analysis would be highly desirable since it avoids a lexical ambiguity for numerous adverbs that can have both manner and subject-oriented readings, an example of which is repeated in (74).

(74) a. Subject-oriented: Fido <u>rudely</u> departed.
b. Manner: Fido departed <u>rudely</u>.

McConnell-Ginet (1982) proposes to treat verbs taking manner adverbs as arguments for a unified analysis. She points out that some verbs indeed require an adverb, as in (75). If (75) tells something about the nature of adverb modification than merely an exceptional accident, then it opens up the possibility of treating verbs as arguments of the adverbs.

(75) a. Fido behaved *(badly).
b. Fido treated Garfield *(badly).
c. You worded the letter *(badly).
d. New York is situated *(on the Hudson).

We cannot postulate an argument position for adverbs for all verbs since in most cases adverbs are optional, and cases like (75) are rather exceptional. McConnell-Ginet (1982) proposes that adverbs become arguments after a verb has undergone a process of **augmentation** which gives verbs additional argument slots for adverbs to occupy. For example, *ran*, when modified by *quickly*, is augmented using an *aug-speed* shift and *quickly* itself denotes a property of rates of speed, as (76) shows. The sentence is true if and only if there was an event of Fido walking, and the speed of the event was quick.

(76) a. *Fido (aug-speed) ran quickly.*
a. $[\![\textit{aug-speed}]\!] = \lambda R \lambda P \lambda x \lambda e.R(x, e) \wedge P(\text{speed}'(e))$
b. $[\![\textit{aug-speed}]\!]([\![\textit{ran}]\!]) = [\lambda R \lambda P \lambda x \lambda e.R(x, e) \wedge P(\text{speed}'(e))](\lambda y \lambda e'.\text{ran}'(y, e'))$
$= \lambda P \lambda x \lambda e.[\lambda y \lambda e'.\text{ran}'(y, e')](x, e) \wedge P(\text{speed}'(e)) = \lambda P \lambda x \lambda e.\text{ran}'(x, e) \wedge P(\text{speed}'(e))$
c. $[\![\textit{quickly}]\!] = \lambda r.\text{quick}(r)\text{: is-a-speed(r)}$
d. $[\![(\textit{aug-speed})\ \textit{ran}]\!]([\![\textit{quickly}]\!]) = [\lambda P \lambda x \lambda e.\text{ran}'(x, e) \wedge P(\text{speed}'(e))](\lambda r.\text{quick}'(r)\text{: is-a-speed}'(\text{r})) = \lambda x \lambda e.\text{ran}'(x, e) \wedge \text{quick}'(\text{speed}'(e))$
f. $[\![(\textit{aug-speed})\ \textit{ran quickly}]\!]([\![\textit{Fido}]\!]) = [\lambda x \lambda e.\text{ran}'(x, e) \wedge \text{quick}'(\text{speed}'(e))](\text{f}) = \lambda e.\text{ran}'(\text{f}, e) \wedge \text{quick}'(\text{speed}'(e))$
g. $[\![\textit{Fido}\ (\textit{aug-speed})\ \textit{ran quickly}]\!] = \exists e.\text{ran}'(\text{f}, e) \wedge \text{quick}'(\text{speed}'(e))$

This treatment not only maintains the simple property analysis of manner adverbs but also better represent their meaning by focusing on the relevant aspect of the event described by the main verb. In the next section, we will observe that subject-oriented adverbs can be given a similar treatment as properties.

11.4.2 Subject-Oriented Readings

McConell-Ginet (1982) suggests that an agent-oriented reading of adverbs like *rudely* in (74a) also be treated as a manner adverb modifying an implicit higher verb *act*. The following near-equivalence provide evidence for her claim.

(77) Fido rudely departed ≈ Fido acted rudely to depart

If we adopt this approach, the argument structure of *act* can be extended to include an argument place for (compatible) manner adverbs. This allows us to avoid a lexical ambiguity analysis of numerous adverbs, but instead to maintain that almost all adverbs are manner adverbs. We can understand (77) as saying that some implicit action encoded by the *act* predicate, which was rude, caused the departing event. The compositional steps to derive (77) is given in (78) based on Morzycki's (2015) definition of *act*. The sentence is true if and only if Fido's action caused him to depart, and the causing action was rude.

(78) a. *Fido rudely (aug-manner) (act) departed.*
b. $[\![act]\!] = \lambda R \lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge R(x, e')$
c. $[\![act]\!]([\![departed]\!]) = [\lambda R \lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge R(x, e')](\lambda y \lambda e''.\text{departed}'(y, e'')) = \lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge [\lambda y \lambda e''.\text{departed}'(y, e'')](x, e') = \lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge \text{departed}'(x, e')$
d. $[\![aug\text{-}manner]\!] = \lambda R \lambda P \lambda x \lambda e''.R(x, e'') \wedge P(\text{manner}'(e''))$
e. $[\![aug\text{-}manner]\!]([\![(act)\ departed]\!] = [\lambda R \lambda P \lambda x \lambda e''.R(x, e'') \wedge P(\text{manner}'(e''))](\lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge \text{departed}'(x, e')) = \lambda P \lambda x \lambda e''.[\lambda x \lambda e \exists e'.\text{cause}'(e, e') \wedge agent(e) = x \wedge \text{departed}'(x, e')](x, e'') \wedge P(\text{manner}'(e'')) = \lambda P \lambda x \lambda e'' \exists e'.\text{cause}'(e'', e') \wedge agent(e'') = x \wedge \text{departed}'(x, e') \wedge P(\text{manner}'(e''))$
f. $[\![rudely]\!] = \lambda m.\text{rude}'(m)\text{: is-a-manner}'(m)$
g. $[\![(aug\text{-}manner\ act)\ departed]\!]([\![rudely]\!]) = [\lambda P \lambda x \lambda e'' \exists e'.\text{cause}'(e'', e') \wedge agent(e'') = x \wedge \text{departed}'(x, e') \wedge P(\text{manner}'(e''))](\lambda m.\text{rude}'(m)\text{: is-a-manner}'(m))$
$= \lambda x \lambda e'' \exists e'.\text{cause}'(e'', e') \wedge agent(e'') = x \wedge \text{departed}'(x, e') \wedge \text{rude}'(\text{manner}'(e''))$

h. $[\![$*rudely* (*aug-manner act*) *departed*$]\!]([\![$*Fido*$]\!])$
$= [\lambda x \lambda e'' \exists e'.\text{cause}'(e'', e') \wedge agent(e'') = x \wedge \text{rude}'(\text{manner}'(e''))](\text{f})$
$= \lambda e'' \exists e'.\text{cause}'(e'', e') \wedge agent(e'') = \text{f} \wedge \text{departed}'(\text{f}, e') \wedge \text{rude}'(\text{ma}$
$\text{nner}'(e''))$

We have now complicated our adverbial composition significantly by introducing abstract *act* and *aug-manner*. To offset, we gained a uniform analysis of VP modifying adverbs as simple properties, and a more natural interpretation of manner modification. Do we have empirical evidence for such an analysis or was it just for theoretical elegance? Abstract predicates like *act* are commonly employed as semantic primitive predicates in verb meaning (Dowty, 1979; Levin and Rappaport, 1998). Regarding manner, Landman and Morzycki (2003) and Anderson and Morzycki (2012) provide evidence from a systematic connection across several languages among manners, degrees and kinds. If kinds, degrees and manners are treated in systematically parallel ways in constructions across many languages, and if kinds and degrees are considered to be essential primitives in our semantic theorizing, it would be odd indeed if manners were not.

Reflection

- Why does a simple predicate modifier analysis of subject-oriented adverbs inadequate? Do you think using an implicit *act* predicate is plausible? Do the gains for doing so offset the complexity of the derivation? If we don't use *act*, how can we capture the agent-orientedness?
- What are motivations and evidence for the argument analysis of manner adverbs? What are some problems?
- According to Landman and Morzycki (2003) and Anderson and Morzycki (2015), a systematic connection exists across languages among manners, degrees and kinds. Since kinds and degrees are considered to be essential primitives in our semantic theorizing, do you think it's plausible to include manners as well?

11.5 Conclusion

This chapter examined various classes of adverbs, such as manner, subject-oriented, and speaker-oriented adverbs. We discussed different semantic theories of adverbs, the operator approach, the predicate approach and the argument approach, pointing out the merits and shortcomings of each approach. The operator analysis fits well with epistemic and evaluative adverbs but is inadequate as a theory for VP modifiers such as manner and subject-oriented adverbs. The predicate analysis relies on event semantics and treats adverbs as simple predicates. Despite its simplicity, it does not capture the fact that a manner modification is only about a certain aspect of the event. To remedy this, the argument analysis introduces an implicit augmentation operation that creates an argument position for adverbs. This is an ingenious account but less parsimonious as it introduces manner as a new ontological primitive.

Points to Remember

- Manner adverbs characterize the manner in which an event takes place. They are predicates over events.
- Subject-oriented adverbs, including mental-attitude adverbs and agent-oriented adverbs, are sensitive to properties of the subject and give rise to entailments involving it. They are also VP modifiers, on a par with manner adverbs.
- Speaker-oriented adverbs consist of evaluative adverbs that express the attitude of the speaker towards a proposition, epistemic adverbs that include various gradable modal adverbs and speech act adverbs that characterize the speech act itself.
- The operator analysis treats modal adverbs as quantifiers over possible worlds. A modal base and an ordering source are employed to explain the context sensitivity and gradable nature of modality.
- The predicate analysis treats manner adverbs as predicates over events. This analysis also provides a simple account of speech-act adverb with the help of the assertion operator.
- The argument analysis introduces an implicit augmentation operation that creates an argument position in the verb for adverbs. It introduces manner as a semantic primitive.

Technical Terms to Remember

1. **Adverbial:** A particular syntactic function, typically that of further specifying the circumstances of the situation described by the verb or the sentence.
2. **Predicational adverbs:** Adverbs that assign a (gradable) property to the meaning of the verb or the sentence they combine with, and commonly realized as deadjectival adverbs by adding -*ly* to an adjective stem.
3. **Manner adverbs:** Adverbs that specify the manner in which the described event is performed.

4. **Subject-oriented adverbs:** Adverbs that describe a property of the subject of the sentence.
5. **Speaker-oriented adverbs:** Adverbs that indicate the speaker's attitude toward the sentence or modify the speech act itself.
6. **Non-predicational/functional adverbials**: Adverbs that are not gradable or related to gradable predicates but typically quantificational.
7. **Mental attitude adverbs:** Adverbs that describe the attitude of the subject with regard to the action described by the verb.
8. **Agent-oriented adverbs:** Adverbs that attribute a property to the agentive subject based on the action described by the verb.
9. **Intensional adverbs:** Certain lexically specified mental attitude adverbs that create intensional contexts.
10. **Evaluative adverbs:** Adverbs that express the speaker's personal opinion about the proposition expressed by the modified sentence.
11. **Epistemic adverbs:** Adverbs that describe the degree of speaker's confidence about the proposition.
12. **Speech-act adverbs:** Adverbs that characterize the speaking event itself.
13. **Performative hypothesis:** The view that there is an underlying speech act verb in all sentences.
14. **Performative verbs:** Adverbs that make the sentence true simply by (an authoritative person) uttering it.
15. **Assertion operator:** An operator that applies to a proposition and return a property of an event of having asserted it.
16. **Conventional implicature:** Implicatures that derive from lexical meaning but do not directly contribute to the truth condition.
17. **Modal base:** Different conversational backgrounds for modal expressions.
18. **Epistemic modal base**: The modal base that is compatible with the speaker's knowledge and belief.
19. **Circumstantial modal base:** The modal base that is compatible with the way things are disposed to.
20. **Deontic modal base:** The modal base that is compatible with the way things should be.
21. **Ordering source:** A stereotypical or ideal conversational background that orders the propositions in a modal base.
22. **Augmentation:** Giving verbs additional argument slots for adverbs to occupy.

Suggested Reading

See Ernst (2002) for a more detailed discussion of adverb syntax and semantics. McNally and Kennedy (2008) contains a wide range of articles on adverb semantics by leading scholars.

Practice

1. Classify the following adverbs into manner, subject-oriented and speaker-oriented adverbs. For speaker-oriented adverbs, classify them further into evaluative, speech act and epistemic adverbs.
(a) _quickly_
manner

(b) _frankly_
(c) _unfortunately_
(d) _unwillingly_
(e) _completely_
(f) _surprisingly_
(g) _foolishly_
(h) _clearly_
(i) _confidentially_
(i) _softly_

2. Explain why the following sentences are infelicitous.
(a) *_She cleverly has obviously been studying hard._
speaker-oriented adverb (_obviously_) > subject-oriented adverb (_cleverly_)

(b) *_Certainly, he will unsurprisingly get fired._
(c) *_She quickly cleaned her room wisely._
(d) *_Fortunately, who rescued Fido?_
(e) *_I wondered whether, confidentially, you blew it._

3. What are the semantic types of the following adverbs? Which ones are predicate modifiers, which ones are properties, and which ones are proposition modifiers?
(a) _quickly_
properties $\langle e, t \rangle$

(b) _frankly_
(c) _unfortunately_
(d) _deliberately_
(e) _completely_
(f) _sadly_
(g) _briefly_
(h) _confidentially_
(i) _honestly_
(j) _clearly_

4. Some adverbs are polysemous. Explain the different readings and provide an explanation.

(a) a. *I spoke to you honestly.*
b. *Honestly, I spoke to you.*
c. *Honestly, I don't like you.*

***honestly* can be manner, subject-oriented or speaker-oriented**

(b) a. *Fido cleverly avoided the fight.*
b. *Fido avoided the fight cleverly.*

(c) a. *Disgustingly, I cleaned the fish in the sink.*
b. *I cleaned the fish in the sink disgustingly.*

(d) a. *I wisely voted.*
b. *I voted wisely.*

(e) a. *Happily, she ate her food.*
b. *She happily ate her food.*
c. *She ate her food happily.*

5. Are the entailment form (a) to (b) valid? Explain why.

(a) a. *Fido wisely avoided the fight.*
b. *Fido avoided the fight.*

***wisely* is veridical**

(b) a. *Fido wisely did not respond to the insult.*
b. *Fido did not respond to the insult.*

(c) a. *Oedipus intentionally married Jocasta.*
b. *Oedipus intentionally married his mother.*

(d) a. *Oedipus intentionally married Jocasta.*
b. *The son of Laius intentionally married Jocasta.*

(e) a. *Unfortunately, Fido lost his bone.*
b. *Fido lost his bone.*

6. Why is the responses inappropriate?

(a) A: *Fido unfortunately lost his bone.*
B: *That's not true, I think it is very good news. He should lose weight.*

speaker-oriented adverbs are not part of assertion

(b) A: *Frankly, you blew it.*
B: *That's not true. I blew it, but you weren't frank.*

7. Provide the denotations and the types of the following adverbs.

(a) *quickly*

$\boldsymbol{\lambda e.\mathbf{quick}'(e)\ \langle process, t\rangle}$

(b) *possibly*
(c) *deliberately*
(d) *quietly*
(e) *unfortunately*
(f) *wisely*
(g) *inevitably*

(h) *honestly*
(i) *cleverly*
(j) *mysteriously*

8. Provide compositional analyses of the following phrases with manner verbs using both intersective and verb augmentation analyses.

(a) *act stupidly*

a. $[\![\textit{stupidly}]\!] = \lambda e.\text{stupid}'(e)$
b. $[\![\textit{act}]\!] = \lambda x\lambda e.\text{act}'(x, e)$
c. $[\![\textit{act}]\!] \cap [\![\textit{stupidly}]\!] = \lambda x\lambda e.\text{act}'(x, e) \wedge \text{stupid}'(e)$

a. $[\![\textit{aug-manner}]\!]([\![\textit{act}]\!]) = [\lambda R\lambda P\lambda x\lambda e.R(x, e) \wedge P(\text{manner}'(e))](\lambda y\lambda e'.\text{act}'(y, e')) = \lambda P\lambda x\lambda e.[\lambda y\lambda e'.\text{act}'(y, e')](x, e) \wedge P(\text{manner}'(e)) = \lambda P\lambda x\lambda e.\text{act}'(x, e) \wedge P(\text{manner}'(e))$
b. $[\![\textit{stupidly}]\!] = \lambda m.\text{stupid}'(m)\text{: is-a-manner}'(m)$
c. $[\![(\textit{aug-manner})\ \textit{act}]\!]([\![\textit{stupidly}]\!]) = [\lambda P\lambda x\lambda e.\text{act}'(x, e) \wedge P(\text{manner}'(e))](\lambda m.\text{stupid}'(m)\text{: is-a-manner}'(m)) = \lambda x\lambda e.\text{act}'(x, e) \wedge \text{stupid}'(\text{manner}'(e))$

(d) *sing softly*
(c) *walk quickly*
(d) *speak loudly*
(e) *write beautifully*

9. Provide compositional analyses of the following phrases with subject-oriented adverbs using both predicate modifier analysis and the analysis involving an implicit *act* predicate.

(a) *stupidly fight*

a. $[\![\textit{stupidly}]\!] = \lambda P\lambda x\lambda e.\text{stupid}'(P)(x, e)$
b. $[\![\textit{fight}]\!] = \lambda y\lambda e'.\text{fight}'(y, e')$
c. $[\![\textit{stupidly fight}]\!] = [\lambda P\lambda x\lambda e.\text{stupid}'(P)(x, e)](\lambda y\lambda e'.\text{fight}(y, e')) = \lambda x\lambda e.\text{stupid}'([\lambda y\lambda e'.\text{fight}'(y, e')])(x, e)) = \lambda x\lambda e.\text{stupid}'(\text{fight}'(x, e))$

a. $[\![\textit{act}]\!] = \lambda R\lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \text{agent}'(e) = x \wedge R(x, e')$
b. $[\![\textit{act}]\!]([\![\textit{fight}]\!]) = [\lambda R\lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \textit{agent}(e) = x \wedge R(x, e')](\lambda y\lambda e''.\text{fight}'(y, e'')) = \lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \textit{agent}(e) = x \wedge [\lambda y\lambda e''.\text{fight}'(y, e'')](x, e') = \lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \textit{agent}(e) = x \wedge \text{fight}'(x, e')$
c. $[\![\textit{aug-manner}]\!] = \lambda R\lambda P\lambda x\lambda e''.R(x, e'') \wedge P(\text{manner}(e''))$
d. $[\![\textit{aug-manner}]\!]([\![(\textit{act})\ \textit{fight}]\!] = [\lambda R\lambda P\lambda x\lambda e''.R(x, e'') \wedge P(\text{manner}'(e''))](\lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \textit{agent}(e) = x \wedge \text{fight}'(x, e')) = \lambda P\lambda x\lambda e''.[\lambda x\lambda e\exists e'.\text{cause}'(e, e') \wedge \textit{agent}(e) = x \wedge \text{fight}'(x, e')](x, e'') \wedge P(\text{manner}(e'')) = \lambda P\lambda x\lambda e''\exists e'.\text{cause}'(e'', e') \wedge \textit{agent}(e'') = x \wedge \text{fight}'(x, e') \wedge P(\text{manner}'(e''))$
e. $[\![\textit{stupidly}]\!] = \lambda m.\text{stupid}'(m)\text{: is-a-manner}'(m)$
f. $[\![(\textit{aug-manner act})\ \textit{fight}]\!]([\![\textit{stupidly}]\!]) = [\lambda P\lambda x\lambda e''\exists e'.\text{cause}'(e'', e') \wedge \textit{agent}(e'') = x \wedge \text{fight}'(x, e') \wedge P(\text{manner}'(e''))]\ (\lambda m.\text{stupid}'(m)\text{: is-a-manner}'(m)) = \lambda x\lambda e''\exists e'.\text{cause}'(e'', e') \wedge \textit{agent}(e'') = x \wedge \text{fight}'(x, e') \wedge \text{stupid}'(\text{manner}'(e''))$

(b) *wisely vote*
(c) *anxiously wait*
(d) *arrogantly dismiss*
(e) *willingly leave*

10. Provide compositional analyses of the following sentences modified by speaker-oriented adverbs.
(a) *Unfortunately, Fido is lost.*
$[\![$*unfortunately*$]\!]$ = $\lambda p \lambda w'$.unfortunate′(p, w')
$[\![$*unfortunately*$]\!]$($[\![$*Fido is lost*$]\!]$) = [$\lambda p \lambda w'$.unfortunate′(p, w')]($\lambda w \exists e$.is-lost′(f, e, w))
= $\lambda w'$.unfortunate′([$\lambda w \exists e$.is-lost′(f, e, w)](w')) = $\lambda w'$.unfortunate′($\exists e$.is-lost′(f, e, w'))

(b) *Obligatorily, you go to prison.*
(c) *Frankly, you failed.*
(d) *Possibly, Fido is lost.*
(e) *Confidentially, I am fired.*

Notes

1 Maienborn and Schäfer (2011) add degree adverbs and so-called method-oriented adverbs to the category of VP-modifying verbs together with manner adverbs. The former describes the intensity or the extent to which an action is performed, as (ia) exemplifies, and the latter indicates a means or methods by which the action is carried out, as in (ib). We have discussed the degree modification of stative verbs in Chapter 5. Method-oriented adverbs can be analyzed as properties of events and combine intersectively with the verb because a linguistic analysis is also an analysis.

(i) a. Fido loved his master <u>very much/deeply</u>.
b. We analyzed the data <u>linguistically</u>.

2 If we do not treat adverbials as properties of events, the only other alternative is to combine them with the whole sentence. However, since combining an adverbial with a tense-less sentence necessarily produces an existentially closed formula, no additional adverbial can be added on to it, failing to explain a multiple adverbial modification. In addition, temporal adverbials like *today* or *on Sunday*, which are compatible with different tenses, must belong to multiple categories, which is not parsimonious. See Dowty (1979) for a discussion.

12 The Semantics of Prepositions

12.1 Typology of Prepositions

12.1.1 Do Prepositions Form a Lexical Category?

Whether prepositions are lexical or functional categories is controversial. They are considered to form a closed class because there are typically only a limited number of them in a language. Furthermore, in argument positions, they are usually meaningless syntactic markers. For example, *of* in *the king of France* is meaningless, where *of France* is an argument of the relational head noun *king*. In adjuncts, however, the interpretation of the prepositional phrase depends crucially on the inherent meaning of the preposition. That is, *from* in *the king from France* denotes a source, where *from France* is an adjunct of the head noun *king*. Adjuncts differ from arguments in that they can be iterated, as shown in (1a). By contrast, iteration of arguments results in ungrammaticality, as in (1b) (Pinker, 1989/2013).

(1) a. He is the king <u>from</u> France <u>next to</u> Germany <u>in</u> Europe.
    b. *He is the king <u>of</u> France <u>of</u> Germany.

Given that many prepositions have substantial semantic contents, we will explore their meaning in the last chapter of this book. Investigating the semantics of prepositions is important because they describe one of the most fundamental semantic domains of language, namely, space (Zwarts, 2017). Furthermore, numerous grammatical alternations we have discussed in this book, such as conative, dative, locative and benefactive alternations, involve prepositions. Therefore, the lexical semantic investigation would not be complete without a discussion of the meaning of prepositions. Keeping in line with the general logical methods adopted in this book, we will approach spatial semantics in terms of applied geometry, using elements and relations in mathematics. However, psychological factors involved in polysemy and metaphoric extensions will not be ignored.

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12.1.2 Locative and Directional Prepositions

Prepositions are broadly divided into locative and directional prepositions. *On, in, at, over, under, in front of, behind*, etc., are **locative prepositions**, and *onto, from, to, toward, across*, *beyond and through*, etc. are **directional prepositions**. The former locates an object relative to a reference object, as in (2a), where *Garfield* is the located object (called **figure**) and *the mat* is the reference object (called **ground**). The latter describe a dynamic change in location with respect to the reference object, typically occurring with a verb expressing motion and direction, as in (2b).

(2) a. Garfield is <u>on</u> the mat.
b. Garfield jumped <u>onto</u> the mat.

Locative prepositions are fine in the predicative construction, as in (2a), but directional prepositions are not, as shown in (3b).

(3) a. Fido ran <u>to the park</u>.
b. *Fido is <u>to the park</u>.

Locative prepositions are further divided into **topological (non-projective) prepositions** (*in, on, at, out*) and **projective prepositions** (e.g., *above, below, in front of, behind, beside*) (Herskovits, 1986). While topological prepositions involve knowledge about the locations of the two objects, projective prepositions require additional knowledge about the direction from the ground (Zwarts and Winter, 2000). Note that these two major types of locative prepositions are truth-conditionally distinct; (4a) is true if and only if there is a contact between figure and ground, whereas (4b) does not require a contact.

(4) a. Garfield is <u>on</u> the mat.
b. Garfield is <u>above</u> the mat.

Although places are regions in three-dimensional space, which can be mathematically represented as sets of points, many scholars treat them as primitives (Bierwisch, 1989; Coventry and Garrod, 2004; Nam, 1995). For example, notions such as "contiguity/contact" and "inclusion/enclosure" have been used to represent many prepositions, including *on, in* and *above*. The concept of static space can explain the basic topological prepositions, but we need dynamic/relational notions of distance and direction for the semantics of projective prepositions. This can be achieved in region-based approaches by introducing more complex relations such as "near" and "between" (Nam, 1995). Such treatment parallels the approaches to verbal and nominal semantics where events and sums are taken as primitives. An alternative approach begins with distance and direction, combined in the notion of a "vector" (Zwarts, 1997; Zwarts and Winter, 2000). In the vector-based approach, three-place relations *near* and *between* are comprehended in terms of a comparison of the length and direction of vectors. We will discuss the vector space semantics in detail in Section 12.2. It suffices for now to see that *on the mat* in (4a) is a function from the region of the mat to the set of regions that are externally connected to it, and *above the mat* in (4b) is the set of all vectors that point upward from the mat.

Directional prepositions involve the path domain, which is closely related to the motion verb semantics. Depending on what part of the path is related to the ground, directional prepositions can be further subdivided into **source** (*from, out of, off*), **goal** (*to, into, onto*) and **route prepositions** (*through, over, along, across, around*) (Cinque and Rizzi, 2010; Jackendoff, 1983; Pantcheva, 2010). For example, *onto* in (5a) denotes the set of paths whose final position is on the ground, *from* in (5b) denotes the set of paths whose initial position is on the ground. The route preposition involves an intermediate part of the ground, as in (5c), or the whole path, as in (5d).

(5) a. Garfield jumped <u>onto</u> the mat.
b. Fido ran <u>from</u> the house.
c. Fido ran <u>past</u> the tree.
d. Fido ran <u>along</u> the river.

Table 12.1 summarizes the typology of prepositions. The topological prepositions are morphologically simpler than directional ones, and they tend to be expressed as cases in languages with case marking. The projective prepositions are usually heavier than topological ones, and they are often derived from nouns in many languages (Zwarts, 2017).

12.1.3 Algebra of Path

The notion of path is part of a formal algebra, which allows more precise typological classifications. Concatenating paths makes it possible to classify the PPs on the basis of the algebraic properties of their denotations. A notion of **cumulativity** can be defined for directional PPs. A cumulative PP is closed

Table 12.1 Typology of prepositions

Locative		*Directional*		
Topological	*Projective*	*Source*	*Route*	*Goal*
at, in, on, inside, outside, near, between	*above, below, in front of, behind, over, under, next to, besides, left/right of*	*from, out of, off, away from*	*along, past, over, across, through, around*	*to, into, onto, toward*

under concatenation, whereas a noncumulative PP is not. The notion of cumulativity defined in (6a) for directional PPs is conceptually very similar to the notion of cumulativity (unboundedness) for plural and mass nouns and atelic verb phrases (Krifka, 1998). It also explains why certain prepositions (those not closed under concatenation, that is, noncumulative) lead to telic aspect (*walk to/past the store*), and other prepositions (the cumulative ones) lead to atelic aspect (*walk towards/along the river*).

(6) a. A set of paths X is cumulative iff. (i) there are p, $q \in$ X such that p + q exist and (ii) for all p, $q \in$ X, if $p + q$ exists, then $p + q \in$ X.
b. A set of paths X is divisive (or homogeneous) iff. for all p, $q \in$ X, if $q < p$, then $q \in$ P.
c. A set of paths X is telic iff. for all p, $q \in$ X, if $p \leq q$, then $p(0) = q(0)$ and $p(1) = q(1)$.
d. A set of paths X is quantized iff. for all p, $q \in$ X, not $p < q$.

On the other hand, divisivity, telicity and quantization defined in (6b-d) (Krifka, 1998; Nam, 1995) are not the properties that can distinguish between bounded and unbounded PPs (Zwarts, 2005). The unbounded PP *toward the park*, for example, does not observe divisivity when the path is curved, and some sub-paths are pointing away from the park. Quantization is also not adequate because paths in the bounded PP denotation can have sub-paths in the same denotation. For example, sub-paths that are smaller but whose final point is at the park are also in ⟦*to the park*⟧. Telicity does not give us much more than quantization. Therefore, the relevant property is cumulative reference: A PP is unbounded if and only if it has cumulative reference, and a PP is bounded if and only if it does not have cumulative reference. That is, the aspect of directional PPs is represented in terms of closure under concatenations (cumulativity). The notion of **reversibility** adds a further refinement to the PP typology. If a PP is cumulative and reversible, it describes **continuations** (*along, through, around, round*). If a cumulative PP is nonreversible, it describes **progression** (*toward, away from*). If a PP is noncumulative and reversible, it describes **cycles** (*past, through, all the way*

Table 12.2 Types of directional prepositions

	Nonreversible	*Reversible*
Noncumulative (not closed under concatenation)	Transitions (*from, to*)	Cycles (*past, through, all the way around*)
Cumulative (closed under concatenation	Progressions (*towards, away from*)	Continuations (*along, through, around and around*)

round). If a noncumulative PP is nonreversible, it describes **transitions** (*from, to*). Table 12.2 presents the typology of directional prepositions in terms of cumulativity and reversibility (Zwarts, 2017).

We will discuss these formal properties in more detail in the following sections.

Reflection

- Are prepositions a lexical or a grammatical category? Why do we discuss semantics of prepositions in a lexical semantics book?
- What are the differences between locative and directional prepositions? What are the differences between projective and non-projective locative prepositions?
- Among cumulativity, divisivity, telicity and quantization, which distinguishes between bounded and unbounded PPs? Why?

12.2 Vector Space Semantics

12.2.1 Problems with the Point Ontology

When we try to provide a semantics for locative or directional prepositions, an idea that immediately comes to mind is to treat places or regions as a set of points in space that is existentially quantified, as in (7), in which *p* is a variable for points. (7a) states that there is a place on the mat where Garfield is, and (7b) asserts that there is a path onto the mat that Garfield is following.

(7) a. $[\![\textit{Garfield is on the mat}]\!] = \exists p.p \in [\![\textit{on the mat}]\!] \land \text{be}'(\text{g}, p)$
b. $[\![\textit{Garfield jumped onto the mat}]\!] = \exists p.p \in [\![\textit{onto the mat}]\!] \land \text{jump}'(\text{g}, p)$

However, this initially plausible idea that prepositions denote points in space leads to problems, calling for the notion of **vectors**. Vectors are simply directed line segments between points in space, rather than a set of points or mereological portions of space. Vector space semantics is motivated by the desire to compositionally obtain meanings of prepositions modified by an adverb or a measure phrase. Consider (8).

(8) a. The picture is <u>right/straight</u> above the door.
b. The picture is <u>high</u> above the door.

Assuming that *above the door* denotes a set of points in the region, *straight* maps the set of points to a set of points, which are subsets, as represented in (9).

(9) a. $[\![$*straight above the door*$]\!] = \{p \in [\![$*above the door*$]\!] \mid p$ is straight$\}$
b. $[\![$*high above the door*$]\!] = \{p \in [\![$*above the door*$]\!] \mid p$ is high$\}$

The problem with (9a) is that points cannot be straight (or direct, right or 10 centimeters). A seemingly more plausible (9b) is also problematic because a point can be high only with respect to another point. In (9b), the reference point is the door, unlike (9a), whose reference point is the ground or the speaker. In other words, PP modifiers describe distance or direction between the theme object and the reference object. Let us make this relative meaning explicit by making the modifier as a relation between the point and the reference object encoded by the NP, as in (10).

(10) a. $[\![$*straight above the door*$]\!] = \{p \in [\![$*above the door*$]\!] \mid$ straight$(p, [\![$*the door*$]\!]\}$
b. $[\![$*high above the door*$]\!] = \{p \in [\![$*above the door*$]\!] \mid$ high$(p, [\![$*the door*$]\!])\}$

(10), however, cannot be compositionally obtained because the meaning of the modified PPs cannot be derived by the meaning of the modifier and the PP, but instead must access the complement NP. This raises doubt in the assumption that PP modifiers refer to positions denoted by the PP. It appears instead that they refer to distances and directions with respect to the reference object. This in turn means that PPs must directly encode direction to and distance from an implicit reference object, rather than denoting simple positions. The notion of vectors, therefore, becomes necessary for the interpretation of locative prepositions. In addition to solving the composition problem in examples like (8) above, performing the usual algebraic operations on vectors allows us to investigate the denotations of PPs systematically and to discover logical properties that characterize major subclasses of locative PPs.

12.2.2 Vector Ontology

In vector space semantics, a region is a set of vectors, rather than a set of points (Zwarts, 1997; Zwarts and Winter, 2000). The meaning of a PP denotes a general region of space that stands in a particular relation to the reference object, rather than absolute positions. In other words, the PP denotes a set of vectors whose origin is invariably located at the reference object of the PP. We add to our ontology a set of vectors which provide for each pair of points p and p', a vector v pointing from p to p' and a vector v' pointing from p' to p. The set of vectors is the union of an infinite set of vector spaces. Assuming that *outside the house* denotes a set of vectors pointing outward from the boundary of the house, a modifier inside of a PP denotes a vector that is intersected with the P denotation. The intersection of the measure phrase *ten meters* with a set of vectors V is a subset of V containing only vectors that are ten meters long, i.e., $\{v \in V: |v| = 10m\}$. *Ten meters outside the house* then denotes a set of vectors pointing outward from the boundary of the house that are 10 meters long. In general, a locative preposition denotes a function that applies to a set of points where the reference object is located and returns a set of vectors.

An important insight we gain from vector space semantics is that its algebraic structure renders a systematic classification of logical types of prepositions, as well as a formulation of certain universal constraints on preposition meaning. The set of all vectors with the same origin form a vector space defined in (11).

(11) A vector space V over the set of real numbers R is a set that is closed under two operations:

a. **Vector addition**
For every pair $u, v \in V$ there is exactly one $u + v \in V$, the vector sum of u and v.

b. **Scalar multiplication**
For every $v \in V$ and $c \in R$ there is exactly one $cv \in V$, the scalar product of v by scalar c.

A vector space has the following properties.

(12) a. For all u and $v \in V$, $u + v = v + u$
b. For all u, v and $w \in V$, $(u + v) + w = u + (v + w)$
c. There is an element $0 \in V$, the **zero vector**, such that $v + 0 = 0 + v = v$ for all $v \in V$
d. For every $v \in V$ there is a $-v \in$ V, the **inverse** of v, such that $v + (-v) = 0$
e. For all u and $v \in V$ and every $c \in R$, $c(u + v) = cu + cv$
f. For every $v \in V$ and a and $b \in R$, $(a + b)v = av + bv$ and $(ab)v = a(bv)$
g. For every $v \in V$, $1v = v$

A vector can be lengthened or shortened. If we lengthen a vector in a certain denotation of P and if it still remains in that denotation, we say that it is monotone-increasing or **upward monotone**. Prepositions such as *above* or *outside* are upward monotone. If Fido is outside the house, he is still outside even if we lengthen the relevant vectors. If we shorten a vector in a certain denotation of P and if it still denotes P, then we call it monotone-decreasing or **downward monotone**. Prepositions like *near* are downward monotone. Only upward monotone prepositions can be modified by a measure phrase, e.g., *three feet outside* vs. **three feet near.* It is proposed that simple prepositions are universally required to be downward monotone (Zwarts, 1997; Zwarts and Winter, 2000).

12.2.3 Topological Prepositions in Vector Space Semantics

Having discussed the basic tenets and mechanisms of the vector space semantics, we are ready to analyze individual prepositions using the tool. Let us begin with simple locative prepositions. The non-projective prepositions in (13a) denote basic topological notions like inclusion, contact and environment. The projective prepositions in (13b) express a particular direction typically determined by an axis.

(13) a. *in, inside, on, outside, near*
b. *in front of, behind, above, below, over, under, left, right, next to/besides*

To determine the location of the reference object, we introduce the function ***loc*** from the set of entities in D_e to their location in space (type $\langle e, \langle p, t\rangle\rangle$ where p is point). The whole PP, which denotes a set of vectors, needs to be turned into ordinary predicates by applying the inverse of *loc*, which gives an object located at the region determined by the set of vectors, defined in (14). *loc*— maps any set of vectors V to the set of entities whose location is contained in the set of V's end-points.

(14) $loc\text{—} = \lambda V \lambda x \forall p \in loc(x).\exists v \in V(e\text{-}point(v) = p)$

The proposition (15) states that every point in the tree is an end point of a 10m long vector starting on the house and pointing outside.

(15) The tree is ten meters outside the house.
$loc\text{—}[[\![ten\ meters]\!] \cap ([\![outside]\!](loc([\![the\ house]\!])))]([\![the\ tree]\!]) \Leftrightarrow$
$\forall p \in loc([\![the\ tree]\!]).\exists v \in [\![outside]\!](loc([\![the\ house]\!]))(e\text{-}point(v) = p \wedge$
$|v| = 10m)$

Let us unpack (15) to show how it is compositionally obtained. Special interest is in defining the function denoted by the preposition (type $\langle p, \langle v, t\rangle\rangle$) that observes basic inference patterns in natural language. To distinguish between *in* and *out*, let us first define **boundary vectors** in (16a). The minimality condition imposed on vectors in (16b) ensures that measure phrases refer to the shortest vector connecting the reference object and the located object; we can say *the tree is ten meters outside the house* only if the shortest vector connecting the tree to the house is ten meters long.

(16) a. A vector v is a **boundary vector** for a set of points A, boundary(v, A), if and only if s-points(v) is in b(A), the boundary of A.
b. A boundary vector v is a **closest vector** to A, closest(v, A), if and only if for every vector $w \in Dv$ that is a boundary vector of A such that e-point(v) = e-point(w): $|v| \leq |w|$.
c. If e-point(v) $\in A$, v is internally closest to A, int(v, A). Otherwise, v is externally closest to A, ext(v, A).

The prepositions *in*/*inside* and *outside* map a set of points to a set of its internally/externally closest vectors, respectively.

(17) a. $[\![inside]\!] = \lambda A \lambda v.\mathrm{int}(v, A)$
b. $[\![outside]\!] = \lambda A \lambda v.\mathrm{ext}(v, A)$

Let us define *on, at* and *near*. *On* and *at* require almost zero distance between the objects, and *near* requires the vector's length smaller than some contextually determined number.

(18) a. $[\![on]\!]/[\![at]\!] = \lambda A \lambda v.\mathrm{ext}(v, A) \wedge |v| \prec r_0$ (where $r_0 \approx 0$)
b. $[\![near]\!] = \lambda A \lambda v.\mathrm{ext}(v, A) \wedge |v| \prec r_1$ (where r_1 is a pragmatically determined number)

Preposition modifiers can be given their own denotations in terms of vectors. The length of the vector is specified in absolute terms by a measure phrase, as in (19a). The adjectives *far* and *close* specify the length of the vector in relative terms, by comparing it with a contextually given norm *r*, as in (19b) and (19c). Adverbs like *right, directly* and *just* express that the length is almost zero, as in (19d).

(19) a. $[\![3\ meters]\!] = \{v \,||v| = 3\mathrm{m}\}$
b. $[\![far]\!] = \{v \,||v| \succ r\}$, where *r* is a contextually specified "large" amount.
c. $[\![close]\!] = \{v \,||v| \prec r\}$
d. $[\![right/directly/just]\!] = \{v||v| \approx 0\}$

This lets us deal with modified PPs in terms of regular set intersection. (15) above is compositionally obtained as follows.

(20) a. The tree is ten meters outside the house.
b. $[\![outside]\!] = \lambda A \lambda v.\mathrm{ext}(v, A)$
c. $[\![outside]\!]([\![the\ house]\!]) = [\lambda A \lambda v.\mathrm{ext}(v, A)](loc(\mathrm{h})) = \lambda v.\mathrm{ext}(v, loc(\mathrm{h}))$
d. $[\![ten\ meters]\!] = \lambda v.|v| = 10m$
e. $[\![ten\ meters]\!] \cap [\![outside]\!]([\![the\ house]\!]) = \lambda v.\mathrm{ext}(v, loc(\mathrm{h})) \wedge |v| = 10m$
f. loc—$[[\![ten\ meters]\!] \cap ([\![outside]\!]([\![the\ house]\!]))]([\![the\ tree]\!])$
$= \forall p \in loc(\mathrm{t}).\exists v.\mathrm{ext}(v, loc(\mathrm{h})(\text{e-point}(v) = p \wedge |v| = 10m)$

12.2.4 Projective Prepositions in Vector Space Semantics

To handle projective prepositions, we add the **axis functions *vert, front, lat*** and their inverses (−*vert*, etc.), as well as their orthogonal complements (⊥*vert*, etc.). The vertical up-down axis is determined by gravitation. The horizontal front-back axis can be intrinsic to the reference object or determined deictically (with respect to the position of the speaker). The lateral left-right axis is perpendicular to the *vert* and *front*. *Vert* is the set of vectors pointing upward, *front* is the set of vectors pointing forward, and *lat* is the set of vectors pointing rightward or leftward. They correspond to the prepositions *above, in front of* and *next to*, respectively. Their antonym pairs, *below* and *behind*, are captured by the **inverses** of the axis, the set of vectors pointing toward the opposite direction. **Orthogonal complement** is the set of vectors orthogonal to the vectors in an axis or plane. For example, the orthogonal complement $\perp vert$ of the upward vertical axis *vert* is the set of horizontal vectors. These are formally defined in (21).

(21) a. $vert = \{v \mid \text{upward}(v)\}$
b. $front = \{v \mid \text{forward}(v)\}$
c. $lat = \{v \mid \text{right/leftward}(v)\}$
d. The inverse of an axis A is $-A = \{v \mid -v \in A\}$
e. The orthogonal complement of A is $\perp A = \{v \mid \forall w \in A\ [v \perp w]\}$

Equipped with these notions, we can define the meanings of projective prepositions. *Above* denotes the vectors that make an acute angle with the $vert(x)$ axis, allowing only vectors whose vertical component is larger than their projection on the orthogonal component $\perp vert$ (the horizontal plane). The denotation of *above* is given in (22a), and *below* and *under* are defined in (22b).

(22) a. $[\![above]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{vert}| > v_{\perp vert}|$
b. $[\![below]\!]/[\![under]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{-vert}| > v_{\perp -vert}|$

The definition of *in front of* and *behind* involves the *front* axis, as in (23).

(23) a. $[\![in\ front\ of]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{front}| > |v_{\perp front}|$
b. $[\![behind]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{-front}| > |v_{\perp -front}|$

Lastly, *beside* or *next to* can be defined in terms of the *lat* axis, given in (24).

(24) $[\![beside]\!]/[\![next\ to]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{lat}| > |v_{\perp lat}|$

(25) shows a compositional analysis of a sentence containing a projective preposition.

(25) a. The picture is ten inches above the fireplace.
b. $[\![above]\!] = \lambda A \lambda v.\text{ext}(v, A) \wedge |v_{vert}| > |v_{\perp vert}|$
c. $[\![above]\!]([\![the\ fireplace]\!]) = [\lambda A \lambda v.\text{ext}(v, A) \wedge |v_{vert}| > |v_{\perp vert}|](loc(\text{f}))$
$= \lambda v.\text{ext}(v, loc(\text{f})) \wedge |v_{vert}| > |v_{\perp vert}\ |$
d. $[\![ten\ inches]\!] = \lambda v.|v| = \text{10-inch}$

e. $[\![\textit{ten inches}]\!] \cap [\![\textit{above the fireplace}]\!]$
$= \lambda v.\text{ext}(v, loc(\text{f})) \wedge |v_{vert}| > |v_{\perp vert}| \wedge |v| = \text{10-inch}$
f. $loc—[[\![\textit{ten inches}]\!] \cap ([\![\textit{above the fireplace}]\!])]([\![\textit{the picture}]\!])$
$= \forall p \in loc(\text{p}) \exists v.\text{ext}(v, loc(\text{f})) \wedge |v_{vert}| > |v_{\perp vert}|(\text{e-point}(v) = p \wedge$
$|v| = \text{10-inch})$

Reflection

- What is the vector space semantics? Why do we need vectors? Why isn't the point ontology sufficient for the analyses of prepositions?
- What are *loc* and *loc*— functions, *axis* vectors, inverses and orthogonal complements? Why do we need these concepts and operations?
- What are upward- and downward-monotone prepositions? Why do you think simple prepositions are universally required to be downward monotone?

12.3 Directional Prepositions

12.3.1 Path

As previously mentioned, unlike locative prepositions describing a static position of the located object with respect to some reference object, directional prepositions like *to, onto, from* and *across* describe a change in location of an object in relation to the reference object. Can we use vectors directly to represent the meaning of directional prepositions? For instance, (26a) would be interpreted in terms of a vector that has some arbitrary beginning point and the end point pointing to the garage. Such treatment, however, is inadequate because directional prepositions do not invariably denote a linear path like a vector, e.g., *around* in (26b).

(26) a. The car drove <u>to</u> the garage.
b. The car drove <u>around</u> the garage.

Furthermore, using vectors for directional prepositions would sacrifice the unified account of the role of the reference object in PPs. The reference object is always the origin of the vectors in the P denotation. However, vectors will have to have their endpoint at the reference object in (26a), and neither the starting point nor the end point with prepositions like *through*. The denotation of directional prepositions involves a more complex object called a **path** (Bennett, 1975; Cresswell, 1978; Gawron, 2006; Jackendoff, 1983; Zwarts, 2005). A path is a function $\boldsymbol{\Theta}$ from the real interval $[0, 1] \subset R$ to vectors, basically a set of sequences of vectors where each sequence determines a potential change in position of the located object (type $\langle i, v\rangle$ where the [0, 1] interval is a domain D*i* of type *i*).[1] The source prepositions like *from, out of, off* specify where the path starts and thus puts a condition on $\mathbf{\Theta}(0)$. The goal prepositions like *to, into, onto* determine the last vector $\mathbf{\Theta}(1)$ of the path. The route prepositions like *through, across, along, around, over* require that the path contains some vector $\mathbf{\Theta}(x)$ that has certain properties in relation to the reference object. Directional prepositions are related to locative prepositions in a systematic way, making the entailments in (27) valid. In (27a), the initial vector in the relevant path must overlap an internal point of the reference object (the house). In (27b), the final vector must overlap an internal point of the reference object. In (27c), an intermediary vector does. In (27d), the over path must overlap an intermediary vector whose endpoint is above the reference object (the fence).

(27) a. The dog went <u>out of</u> the house. ⇒ The dog was <u>in</u> the house.
b. The dog went <u>into</u> the house. ⇒ The dog was <u>in</u> the house.
c. The dog went <u>through</u> the tunnel. ⇒ The dog was <u>in</u> the tunnel.
d. The dog jumped <u>over</u> the fence. ⇒ The dog was <u>above</u> the fence.

Directional prepositions map the reference object to a set of paths, indicating a potential change in position of the reference object. The PP *onto the mat*, for example, denotes the set of paths that have their final position on the mat, that is, $\mathbf{\Theta}(1) \in$ *on*(the mat). The goal or cofinal operator *to* can be defined as a general function from a set of places P to the set of paths that end at those places, that is, *to*(P) = $\{\mathbf{\Theta}: \mathbf{\Theta}(1) \in \mathrm{P}\}$. The source or coinitial operator *from* has 0 instead of 1. Therefore, source and goal paths are each other's reversals, like *onto* and *off*. The route prepositions apply the locative condition either to one intermediate part of the path (e.g., *go past the tree*, transitive) or to the whole path (e.g., *go along the river*, prolative). Most route prepositions show mixed behavior in this respect (e.g., *through the woods*). We will provide formal definitions in the next sub-section.

12.3.2 Analyses of Directional Prepositions

For the analyses of directional prepositions, let us define the **closest path** on the basis of the closest vector.

(28) A path $\mathbf{\Theta} \in D_i$ is a closest path to a set of points $A \subseteq D_p$ and denotes closest($\mathbf{\Theta}$, A) if and only if for every $x \in D_i$: $\mathbf{\Theta}(x)$ is a closest vector to A.

The mapping between a locative preposition and the corresponding directional preposition is defined in (29) using a function ***dir*** that for any locative preposition function P and a subset of the interval D_i yields a directional preposition function. $dir(\mathrm{I})(P)$ maps any set of points A to the set of closest paths to A whose value on some member of I is in $P(A)$.

(29) $dir(\mathrm{I})(P) = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, A) \wedge \exists x \in \mathrm{I}.P(A)(\boldsymbol{\Theta}(x))$

We use the abbreviations dir^0 for source, dir^1 for goal, and $dir^{\exists}$ for route directional prepositions derived from locative prepositions (Zwarts and Winter, 2000). Using these operators, we can represent the directional preposition functions in terms of their corresponding locative preposition functions in Table 12.3. Note that only locative prepositions *at, on* and *in* have a full pattern of source and goal prepositions, indicating that these prepositions have a special, more basic status.

⟦*from*⟧ is defined as a function that maps any set of points A to the path satisfying $[\![at]\!](\boldsymbol{\Theta}(0), A)$, i.e., $[\![from]\!] = dir^0([\![at]\!])$.

(30) a. $[\![from]\!] = dir^0([\![at]\!]) = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, A) \wedge at(\boldsymbol{\Theta}(0), A)$
b. $[\![from]\!]([\![the\ house]\!]) = [\boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, A) \wedge at(\boldsymbol{\Theta}(0), A)](loc(\mathrm{h}))$
$= \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, loc(\mathrm{h})) \wedge at(\boldsymbol{\Theta}(0), loc(\mathrm{h}))$

⟦*to*⟧ is defined as a function that maps any set of points A to the path satisfying $[\![at]\!](\boldsymbol{\Theta}(1), A)$, i.e., $[\![to]\!] = dir^1([\![at]\!])$.

(31) a. $[\![to]\!] = dir^1([\![at]\!]) = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, A) \wedge at(\boldsymbol{\Theta}(1), A)$
b. $[\![to]\!]([\![the\ park]\!]) = [\boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, A) \wedge at(\boldsymbol{\Theta}(1), A)](loc(\mathrm{p}))$
$= \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, loc(\mathrm{p})) \wedge at(\boldsymbol{\Theta}(1), loc(\mathrm{p}))$

⟦*over*⟧ is defined as a function that maps any set of points A to the path satisfying $[\![above]\!](\boldsymbol{\Theta}(\mathrm{x}), A)$, i.e., $[\![over]\!] = dir^{\exists}([\![above]\!])$.

(32) a. $[\![over]\!] = dir^{\exists}([\![above]\!]) = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, \mathrm{A}) \wedge \mathrm{above}(\boldsymbol{\Theta}(\mathrm{x}), \mathrm{A})$
b. $[\![over]\!]([\![the\ fence]\!]) = [\boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, \mathrm{A}) \wedge above(\boldsymbol{\Theta}(\mathrm{x}), A)](loc(\mathrm{f}))$
$= \boldsymbol{\lambda\Theta}.\mathrm{closest}(\boldsymbol{\Theta}, loc(\mathrm{f})) \wedge above(\boldsymbol{\Theta}(\mathrm{x}), loc(\mathrm{f}))$

While *over* is a lexicalized directional preposition *above*, *under* has the same form for location and direction in English, as in (33). We assume that the $dir^{\exists}$ operator is applied in (33b).

Table 12.3 Directional preposition functions from location preposition functions

$[\![from]\!] = dir^0([\![at]\!])$	$[\![off]\!] = dir^0([\![on]\!])$	$[\![out\ of]\!] = dir^0([\![in]\!])$
$[\![to]\!] = dir^1([\![at]\!])$	$[\![onto]\!] = dir^1([\![on]\!])$	$[\![into]\!] = dir^1([\![in]\!])$
$[\![via]\!] = dir^{\exists}([\![at]\!])$	$[\![across]\!] = dir^{\exists}([\![on]\!])$	$[\![through]\!] = dir^{\exists}([\![in]\!])$

(33) a. The dog is under the bridge.
b. The dog ran under the bridge.

Directional prepositions like *toward*, *away from* and *around* cannot be defined in terms of the *dir* operator and locative prepositions, as they require certain relations among vectors in the path. For example, *toward* and *away from* require that the endpoint of the final vector in the path is closer to and further from the reference object than the endpoint of the initial vector, respectively. Let us represent their meanings in terms of ***dist***, a function that measures the distance between points, in (34).

(34) a. $[\![\textit{toward}]\!] = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\text{closest}(\boldsymbol{\Theta}, A) \wedge \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(1)), A) < \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(0), A))$
b. $[\![\textit{away from}]\!] = \boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\text{closest}(\boldsymbol{\Theta}, A) \wedge \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(1)), A) > \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(0), A))$

Toward the garage denotes a set of paths with the following properties; the distance between their end points and the location of the garage in the beginning of the paths is smaller than the distance between their end points and the location of the garage at the end of the paths.

(35) $[\![\textit{towards}]\!]([\![\textit{the garage}]\!])$
$= [\boldsymbol{\lambda} A \boldsymbol{\lambda\Theta}.\text{closest}(\boldsymbol{\Theta}, A) \wedge \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(1)), A) < \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(0), A))](\textit{loc}(\text{g})$
$= \boldsymbol{\lambda\Theta}.\text{closest}(\boldsymbol{\Theta}, \textit{loc}(\text{g})) \wedge \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(1)), \textit{loc}(\text{g})) < \textit{dist}(\text{e-point}(\boldsymbol{\Theta}(0), \textit{loc}(\text{g})))$

12.3.3 Aspectual Properties

Directional prepositions contribute to the aspectual properties of a sentence in different ways. Manner of motion verbs like *walk, run* and *drive* are atelic process verbs. However, combining these verbs with directional PPs leads to different results: The prepositions *onto* and *out of* lead to telic aspect, as in (35a). As in (35b), prepositions like *toward* and *along* make the sentence atelic. Some prepositions are ambiguous, like *around* and *through* in (35c), allowing either a telic (*in one hour*) or atelic (*for one hour*) interpretation (Zwarts, 2005).

(36) a. She walked onto the platform/out of the hotel (in/*for ten minutes).
b. She drove toward the mountains/along the river (*in/for a day).
c. She ran around the lake/through the grass (in/for one hour).

How can we explain how the cumulative PP results in telic sentences? Following the approaches in Verkuyl (1993), Jackendoff (1996a), Krifka (1998) and Zwarts (2010), we assume that aspectual properties are transferred from the PP denotation to the verbal denotation by a thematic role with homomorphism properties. The basic link between verbs and directional PPs is performed by a thematic function ***trace*** that maps events to their spatial trace. If e is a motion event, then $trace(e)$ is the path followed by the theme of e. *Trace* is a function over the set of motion events, because every motion event has a unique path.

(37) $[\![V\ PP]\!] = \{e \in [\![V]\!]: trace(e) \in [\![PP]\!]\}$

The PP restricts the denotation of the verb (a set of events) to those events that have paths in the PP denotation as their trace.

(38) a. $[\![run]\!]([\![to]\!]([\![the\ park]\!])) = \{e \in [\![run]\!]: trace(e) \in [\![to\ the\ park]\!]\}$
$= \{e \in [\![run]\!]: trace(e) \in \{\boldsymbol{\Theta}: \boldsymbol{\Theta}(1) \text{ is at the park}\}\}$
b. $[\![run]\!]([\![toward]\!]([\![the\ park]\!])) = \{e \in [\![run]\!]: trace(e) \in [\![toward\ the\ park]\!]\}$
$= \{e \in [\![run]\!]: trace(e) \in \{\boldsymbol{\Theta}: \text{there is a } \boldsymbol{\Theta}' \in [\![to\ the\ park]\!] \text{ such that } \boldsymbol{\Theta} \leq \boldsymbol{\Theta}' \text{ and } \boldsymbol{\Theta}(0) = \boldsymbol{\Theta}'(0)\}\}$

Given the two structures of events and paths, *trace* can be characterized as a homomorphism from events to paths. It is a homomorphism because it is structure-preserving: $e < e'$ implies $trace(e) < trace(e')$ and $trace(e + e')$ implies $trace(e) + trace(e')$ if $e + e'$ is defined. For example, if a walking event e is a subevent of a walking event e', then the path of e is a sub-path of the path of e' and the trace of two events is the concatenation of the traces of the individual events. Verbs like *walk, drive, swim* and *push* invariably have cumulative reference. The VP that results from combining such a verb with a noncumulative PP like *to the house* is noncumulative because *trace* requires every event in the VP mapped to a path in the PP denotation. If e and e' are in $[\![run]\!]$ so is their concatenation $e + e'$ if it exists. If their path $trace(e')$ are in $[\![to\ the\ park]\!]$, their concatenation will never be, because $trace(e + e')$, which is identical to $trace(e) + trace(e')$, is not in the noncumulative $[\![in\ the\ park]\!]$. This is different with a cumulative PP like *along the river*: *Walk along the river* is cumulative because the cumulativity of *along the river* ensures that if two walking events have a trace along the river, then their concatenation, if defined, has a trace along the river.

> **Reflection**
>
> - What are the logical properties of paths?
> - How can we analyze different directional prepositions? How are the notions of the path and the closest path used?
> - How does aspectual properties derive from the preposition meaning? What does *trace* function do? Why do we need this?

12.4 Pragmatics of Prepositions

12.4.1 Functional Aspects

We have so far defined the meaning of prepositions in logical terms using points, regions and vectors. However, geometric semantics alone is not sufficient to describe all prepositions, but functional aspects like "support" or "attachment" are also crucial in defining their meanings. Prepositions are also highly polysemous, and subject to substantial cross-linguistic variations, which is unexpected if their meanings are universally determined by geometry with well-defined mathematical properties. For example, (39) violates the geometric conditions of inclusion and contact for *in* and *on*, respectively.

(39) a. The flower is <u>in</u> the vase.
b. The cup is <u>on</u> the table. (when the cup is on top of a book on the table)

In addition to the geometric conditions of inclusion and contact, *in* and *on* also require that the reference object is a container (in case of *in*) or a supporting surface (in case of *on*). If a container is upside down, or there is no supporting relation but only touching, *in* and *on* cannot be used; instead *under* might be more appropriate (Herskovits, 1986). Experimental studies found a robust influence of functions in preposition interpretations. For example, when the reference object is a container (e.g., bowl), speakers tend to choose *in* rather than *on*, which is preferred when the ground object is called *plate*, which is a supporter (Feist and Gentner, 2003). Not only simple topological prepositions but also projective prepositions like *over* and *above* are subject to the influence of function (Coventry et al., 2001; Logan and Sadler, 1996). Speakers use these prepositions when the figure object is close to the ground in the straight axis. Although directional prepositions are affected by function to a lesser degree, it has been shown that source and goal paths are asymmetric in that speakers are biased toward the goal, encoding it more often than the source in movement descriptions (Lakusta and Landau, 2005). This cannot be explained by their formal path properties alone.

Zwarts (2017) proposes to reconcile the geometric semantics and functional effects in terms of the distinction between truth-conditional semantics and Gricean pragmatics. As argued by Coventry and Garrod (2004), functional factors are highly context-dependent, but geometry still plays a determining role when the context does not provide enough information about the function. In neo-Gricean pragmatics, a **Q-implicature** licenses an inference from a lower value on a pragmatic scale to the negation of a higher value, and an **I-implicature** licenses an inference to richer information that is prototypical (Levinson, 2000). Assuming that <*on*, *near*> form a scale where *on* entails *near*, the use of *near* implicates that the figure is not on the ground based on the Q-implicature. *On* is strengthened to a stereotypical spatial relation where a contact occurs with the upper surface of something instead of just touching anywhere, explaining the support relation. In addition to pragmatic inferences, spatial ontology itself can be enriched. For example, the notion of force-dynamics (Talmy, 1988) can help explain the functional relations such as containment, support and attachment since these involve forces that the ground exerts on the figure, only differ in spatial directions. For example, if a cup is on the table, then the table causes the cup not to fall. Forces have been formalized, refining the basic spatial relations with force vectors (Goldschmidt and Zwarts, 2016; Wolff, 2007; Zwarts 2010). Pustejovsky's (1995) dot objects and telic roles offer another way to make the spatial ontology richer. A location (e.g., school) can be viewed as a dot object, a combination of spatial location and the abstract institution. Spatial prepositions can be made sensitive to such complex ontological types, explaining their functional properties.

12.4.2 Polysemy

The polysemy of prepositions is well known and has been much discussed (see Tyler and Evans, 2003, and references therein for *over* and Zwarts, 2004, for the polysemy of *around*). For example, *around* can describe configurations depending on the shape of the path and its relation to the ground. (40a) describes an encircling motion, (40b) does not require an encircling but only evading, etc. It can also denote extension (40f), location (40g) or rotation (40h).

(40)
a. She walked around the table.
b. She drove around the pothole.
c. She disappeared around the corner.
d. She ran around the track.
e. She walked around the house.
f. People gathered around the piano.
g. She lives around the corner.
h. She turned around.

Lakoff (1987) argues that such prepositional clusters can be organized as radial networks: there is one central, prototypical meaning, from which other meanings are derived in various ways. Contrary to Lakoff (1987), however, it is not necessary to invoke the problematic notion of prototypes and family resemblance in place of classical geometric definition of *around*. Although it may not be possible to provide a single classical definition for the prepositional interpretation as a whole, we can still define types of spatial situations and their relations. If so, the distinct, but related meanings of the same preposition can be subsumed under a class of related semantic types (Zwarts, 2017). For example, the simple notion of inclusion for *in* can be enriched by tightly related notions, like connection and the convex hull of a ground region, which is the smallest region of which the ground is a part (Garrod et al., 1999).

(41) a. Total topological enclosure, e.g., jam in a closed jar, an insect in amber.
b. Partial geometric enclosure, e.g., a flower in a vase.
c. Scattered geometric enclosure, e.g., a bird in a tree, an island in an archipelago.

After geometrically defining each of these different sub-types, we can position them in a continuity network which connects the types that are closest to each other. Psychological reality of such network has been demonstrated by experimental works. Speakers tend to use similar names for coherent areas in the network (Egenhofer and Mark, 1995). This is also in line with systematic cross-linguistic variations. "Languages may differ in the way they divide up a 'space' of meanings. The underlying space may then be assumed to be universal, but there are language-specific 'tessellations' of this space." (Zwarts, 2017, p. 15). For example, the *on-in* variation across languages is constrained in such a way that a preposition always covers neighboring relations in the continuum (Bowerman and Choi, 2003).

12.4.3 Metaphoric Extensions

In addition to being highly polysemous, prepositions easily render themselves to metaphoric extensions. For instance, we often use the same preposition for both spatial locations for objects and temporal locations for events.

(42) a. Fido is standing at the corner.
b. Fido ate at 1.

Historically, spatial expressions develop into analogous temporal ones (Bybee et al., 1994). A "time is space" metaphor is often invoked to explain the space-time parallelism; we are cognitively predisposed to understand

and describe temporal concepts in terms of more concrete spatial schemas. Space and time, however, are built on quite different ontologies. Experimental works show that it is questionable whether such metaphor is still active in contemporary reasoning of prepositional meanings. Kemmerer (2005) found dissociation between the spatial and temporal meanings of prepositions in brain-damaged speakers, suggesting an independent process of the two meanings of prepositions. Furthermore, while space involves vectors in space, times are typically represented in a linear one-directional line of dense order. Instead of vectors, temporal instants and intervals, as well as events, are taken as primitives in temporal semantics.[2]

Prepositions are also frequently used for abstract relationships, as in (43) (Jamrozik and Gentner. 2014). *In* in (43a) relates Garfield and his state of mind, rather than his physical location. This idea is also related to work on "control" in metaphorical extensions of other prepositions, such as *over* in (43b) (Tyler and Evans, 2003).

(43) a. Garfield is <u>in</u> a frenzy.
     b. Fido has a strange power <u>over</u> Garfield.

It has been proposed that the difference between *on* and *in* resides in the relative control; *on* is associated with greater figure control, and *in* conveys greater ground control. Such difference is argued to be extended and transferred to abstract uses of prepositions and even to novel words (Feist and Gentner, 2003; Jamrozik and Gentner, 2004). Like spatial uses, conventional abstract uses of *on* (e.g., *on a roll*) convey greater figure control than uses of *in* (e.g., *in a hurry*), and matched figure-ground pairs (e.g., *in time* vs. *on time*).

12.4.4 Primacy of Spatial Relations

It is a common practice in semantics to employ different ontological objects for different domains, e.g., sets of spatial points or vectors for spatial prepositions, times and events for temporal adverbs, and degrees for gradable adjectives. However, it seems clear that these domains exhibit similar structures. Zwarts (2003) suggests that postulating different ontological categories or primitives for places, sizes, orientations, shapes or spatial parts might not be necessary. For example, the following paraphrases show that adjectives like *long* and *shor*t can be represented using vectors.

(44) a. x is long = one end of x is far from the other end
     b. x is short = one end of x is close to the other end

We may explore the possibility that the spatial relations in the semantics of prepositions are in fact basic, and the gradable meaning of the other lexical categories expressing movement, size, orientation and parts can all be interpreted with respect to the same spatial structure of vector space semantics (Faller, 2000; Winter, 2001; Zwarts, 2003, 2005). Zwarts (2003) defines adjectives *long* and *short* in (45), where *r* is a context-dependent average for vector length.

(45) a. *x* is short: there is a *v* such that *axis*(*x*, *v*) and $|v| < r$
b. *x* is long: there is a *v* such that *axis(x*, *v*) and $|v| > r$

This analysis, however, does not capture the markedness properties of gradable adjectives (e.g., the difference in bias between *how far/ long* vs. *how close/ short*) (Kennedy, 2012).

Reflection

- Why do you think the actual uses of prepositions do not always conform to their logical denotations but are often influenced by function and convention?
- How can preposition polysemy be analyzed?
- Can vector space semantics apply to other lexical items? Do you think it's desirable for all lexical categories to have the common ontology of vectors?

12.5 Conclusion

The last chapter of the book has dealt with prepositions. We first classified prepositions broadly into locative and directional prepositions. We introduced vector space semantics, which employs directed line segments between points in space. We further introduced the concept of path for directional prepositions. We then explored the polysemy and metaphoric extensions to temporal and abstract meanings and context-dependency of prepositions.

Points to Remember

- Prepositions are divided broadly into locative and directional prepositions.
- The locative prepositions are further divided into projective (e.g., *above, below, in front of, behind, beside*) and non-projective prepositions (*in, on, at, out*)
- The directional prepositions are further divided into source (*from, out of, off*), goal (*to, into, onto*) and route prepositions (*through, over, along, across, around*).
- We need vectors, directed line segments between points in space, instead of points or places for the semantics of prepositions

because their meaning denotes a general region of space that stands in a particular relation to the reference object, rather than absolute positions.

- We can represent projective locative prepositions using the axis functions *vert, front, dext*, their inverses (-*vert*, etc.) and their orthogonal complements (⊥*vert*, etc.).
- The denotation of directional prepositions involves a more complex object called a path, which is a function from the real interval to vectors, a set of sequences of vectors where each sequence determines a potential change in position of the located object.
- The geometric semantics and functional effects can be reconciled in terms of the distinction between truth-conditional semantics and Gricean pragmatics.
- It has been suggested that postulating different ontological categories or primitives for places, sizes, orientations, shapes or spatial parts might not be necessary.

Technical Terms to Remember

1. **Locative prepositions:** Prepositions that locate an object relative to a reference object.
2. **Directional prepositions:** Prepositions that express a dynamic change in location with respect to the reference object.
3. **Figure:** The located object.
4. **Ground:** The reference object.
5. **Topological prepositions:** Prepositions that involve knowledge about the locations of the two objects.
6. **Projective prepositions:** Prepositions that require additional knowledge about the direction from the ground.
7. **Source:** The set of paths whose final position is on the ground.
8. **Goal:** The set of paths whose initial position is on the ground.
9. **Route prepositions:** Prepositions denoting an intermediate part of the ground.
10. **Cumulativity:** A cumulative PP is closed under concatenation.
11. **Reversibility:** A reversible PP describes a backward movement on a path.
12. **Continuations:** Cumulative and reversible directional PPs.
13. **Progression:** Cumulative and nonreversible directional PPs.
14. **Cycles:** Noncumulative and reversible directional PPs.
15. **Transitions:** Noncumulative and nonreversible directional PPs.
16. **Vectors:** Directed line segments between points in space.

17. **Vector addition:** For every pair u, $v \in V$ there is exactly one $u + v \in V$, the vector sum of u and v.
18. **Scalar multiplication:** For every $v \in V$ and $c \in R$ there is exactly one $cv \in V$, the scalar product of v by scalar c.
19. **Zero vector:** An element $0 \in V$ such that $v + 0 = 0 + v = v$ for all $v \in V$.
20. **Inverse:** For every $v \in V$ there is a $-v \in V$ such that $v + (-v) = 0$.
21. **Upward monotone:** If we lengthen a vector in a certain denotation of P and if it still remains in that denotation.
22. **Downward monotone:** If we shorten a vector in a certain denotation of P and if it still denotes P.
23. ***Loc*:** The function from the set of entities in *De* to their location in space.
24. **Boundary vector:** For a set of points A, boundary(v, A), if and only if s-points(v) is in b(A), the boundary of A.
25. **Closest vector:** A boundary vector v is a closest vector to A if and only if for every vector $w \in Dv$ that is a boundary vector of A such that e-point(v) = e-point(w): $|v| \leq |w|$.
26. **int(v, A)**: If e-point(v) $\in A$, v is internally closest to A.
27. **ext(v, A)**: If e-point(v) $\notin A$, v is externally closest to A.
28. ***Vert*:** The up–down axis function that is determined by gravitation, i.e., the set of vectors pointing upward.
29. ***Front*:** The horizontal front–back axis can be intrinsic to the reference object or determined deictically (with respect to the position of the speaker), i.e., the set of vectors pointing forward.
30. ***Lat*:** The lateral left–right axis is perpendicular to the *vert* and *front*, i.e., the set of vectors pointing rightward or leftward.
31. **Inverses:** The set of vectors pointing toward the opposite direction.
32. **Orthogonal complement:** The set of vectors orthogonal to the vectors in an axis or plane.
33. **Path:** A function $\mathbf{\Theta}$ from the real interval $[0, 1] \subset R$ to vectors, i.e., a set of sequences of vectors where each sequence determines a potential change in position of the located object.
34. **Closest path:** A path $\mathbf{\Theta} \in Di$ is a to a set of points $A \subseteq Dp$ and denotes closest($\mathbf{\Theta}$, A) if and only if for every $x \in Di$: $\mathbf{\Theta}(x)$ is a closest vector to A.
35. ***Dir*:** A function that for any locative preposition function P and a subset of the interval *Di* yields a directional preposition function.
36. ***Dist*:** A function that measures the distance between points.
37. ***Trace*:** A thematic function that maps events to their spatial trace.
38. **Q-implicature:** Implicature that licenses an inference from a lower value on a pragmatic scale to the negation of a higher value.
39. **I-implicature:** Implicature that licenses an inference to richer information that is prototypical.

Suggested Reading

See Jackendoff and Landau (1991) for a more extensive list of prepositions. See Zwarts and Winter (2000) for a more through exposition of vector space semantics. See Zwarts (2017) for cognitive aspects of prepositions.

Practice

1. Classify the prepositions into locative and directional prepositions.
(a) *under*
locative

(b) *to*
(c) *toward*
(d) *on*
(e) *in*
(f) *onto*
(g) *into*
(h) *in front of*
(i) *beyond*
(j) *through*

2. Classify the locative prepositions into projective and non-projective prepositions.
(a) *behind*
projective

(b) *above*
(c) *beside*
(d) *below*
(e) *in*
(f) *on*
(g) *at*
(h) *in front of*
(i) *out*
(j) *inside*

3. Classify the directional prepositions into source, goal and route prepositions.
(a) *through*
route

(b) *from*
(c) *to*
(d) *past*
(e) *across*
(f) *out of*
(g) *onto*

(h) *into*
(i) *toward*
(j) *along*

4. Provide the semantics of the following prepositional phrases in terms of sets of points and explain why such treatment is inadequate.
(a) *ten meters outside the building*
$\mathbf{= \{}\boldsymbol{p} \in [\![\boldsymbol{outside\ the\ building}]\!]\ \mathbf{|\ ten\ meters(}\boldsymbol{p}, [\![\boldsymbol{the\ house}]\!]\mathbf{\}}$

(b) *straight above the fireplace*
(c) *right behind the door*

5. Describe the following inferences using the monotonicity of prepositions.
(a) *The building is in New York.* ⇒ *The building is in America.*
***in* is monotone increasing**

(b) *The building is outside New York.* ⇒ *The building is outside America.*
(c) *The building is near New York.* X⇒ *The building is near America.*

6. Provide compositional vector space semantics analyses of the non-projective prepositional phrases and paraphrase their meanings.
(a) *in the house*
$\mathbf{[\lambda \boldsymbol{A} \lambda \boldsymbol{v}.int(\boldsymbol{v}, \boldsymbol{A})](\boldsymbol{loc}([\![\boldsymbol{the\ house}]\!])) = \lambda \boldsymbol{v}.int(\boldsymbol{v}, \boldsymbol{loc}(h))}$
denotes a set of vectors internally closest to the house

(b) *out of the house*
(c) *on the table*
(d) *at the store*
(e) *near the river*

7. Provide compositional vector space semantic analyses of the projective prepositional phrases and paraphrase their meanings.
(a) *above the fireplace*
$\mathbf{[\lambda \boldsymbol{A} \lambda \boldsymbol{v}.ext(\boldsymbol{v}, \boldsymbol{A}) \wedge |\boldsymbol{v}_{\boldsymbol{vert}}| > |\boldsymbol{v}_{\perp \boldsymbol{vert}}|](\boldsymbol{loc}([\![\boldsymbol{the\ fireplace}]\!])}$
$\mathbf{= \lambda \boldsymbol{v}.ext(\boldsymbol{v}, \boldsymbol{loc}(f) \wedge |\boldsymbol{v}_{\boldsymbol{vert}}| > |\boldsymbol{v}_{\perp vert}\ |}$
denotes a set of vectors externally closest to the fireplace and whose upward vertical component is larger than their projection on the orthogonal component (the horizontal plane)

(b) *below the table*
(c) *in front of the house*
(d) *behind the door*
(e) *next to the store*

8. Provide compositional vector space semantics analyses of the following modified locative prepositional phrases and paraphrase their meanings.
(a) *right outside the window*
$\mathbf{[\lambda \boldsymbol{A} \lambda \boldsymbol{v}.ext(\boldsymbol{v}, \boldsymbol{A}) \wedge |\boldsymbol{v}| \approx 0](\boldsymbol{loc}([\![\boldsymbol{the\ window}]\!])) = \lambda \boldsymbol{v}.ext(\boldsymbol{v}, \boldsymbol{loc}(h)) \wedge |\boldsymbol{v}| \approx 0}$
denotes a set of vectors externally closest to the house that are close to zero

(b) *two yards outside the building*
(c) *deep inside the woods*
(d) *ten inches inside the fence*
(e) *far above the roof*
(f) *two meters below the bridge*
(g) *right in front of the house*
(h) *three miles in front of the store*
(i) *two yards behind the tree*
(j) *right next to the picture*

9. Provide compositional vector space semantics analyses of the directional prepositional phrases and paraphrase their meanings.

(a) *from the mountain*

$\boldsymbol{[\![\textit{from}]\!] = \textit{dir}^0([\![\textit{at}]\!]) = \lambda A\lambda\Theta.\text{closest}(\Theta, A) \wedge \textit{at}(\Theta(0), A)}$

$\boldsymbol{[\![\textit{from}]\!]([\![\textit{the mountain}]\!]) = [\lambda A\lambda\Theta.\ \text{closest}(\Theta, A) \wedge \textit{at}(\Theta(0), A)](\textit{loc}(\text{m}))}$

$\boldsymbol{= \lambda\Theta.\text{closest}(\Theta, \textit{loc}(\text{m})) \wedge \textit{at}(\Theta(0), \textit{loc}(\text{m}))}$

(b) *off the mat*
(c) *to the park*
(d) *across the street*
(e) *out of the room*
(f) *through the wood*
(g) *onto the train*
(h) *over the roof*
(i) *under the bridge*
(j) *into the house*

10. Explain the interaction between the verbal aspect and prepositional aspect and provide a compositional analysis of the sentences.

(a) *Fido walked to the house in ten minutes.*

***walk to* is noncumulative**

$\boldsymbol{= \{e \in [\![\textit{walk}]\!]: \textit{trace}(e) \in \{\Theta: \Theta(1) \text{ is at the house}\}\}}$

(b) *Fido walked toward the house for ten minutes.*

Notes

1 The path does not invariably involve movement but used in locating plural or elongated objects or the direction of a person's gaze, as demonstrated by examples in (i) (Jackendoff, 1983). Hence, it is a function from a non-temporal interval into space.

(i) a. The trees are standing <u>along</u> the river.
b. This road leads <u>to</u> the city.
c. She looked <u>through</u> the window.

Alternatively, paths can be introduced simply as primitives, as in Jackendoff (1996b) and Krifka (1998), together with a system of axioms that describe their properties.

2 Abundant literature exists for tense and temporal adverbials, which belong to the subject matters of compositional semantics.

Epilogue

Lexical semantics has arisen as a major research field in formal semantics, but few theoretical lexical semantics textbooks for advanced undergraduate and graduate students exist in the market. Most books only deal with individual lexical categories, and those books that provide a comprehensive discussion of lexical semantics are either too basic/largely descriptive, or too technical. Although there is a copious amount of good introductory formal semantics textbooks, they discuss lexical semantics in a chapter or two since their focus is not on word meaning but on compositional semantics. I wrote this book to fill the lacuna in the pedagogical literature.

This book provided a coherent theoretical framework for lexical semantics, analyzing major lexical categories using a formal semantic tool in a step-by-step manner. The first two chapters were foundational. In Chapter 1, we first defined lexeme and word and then identified our object of inquiry in lexical semantics. After briefly surveying approaches from the meaning-to-form perspective, such as the semantic field theory, componential analyses and the prototype theory, we discussed approaches from the form-to-meaning perspective that focus on polysemy, metonymy, metaphor and coercion. Chapter 2 introduced a logical language called many-sorted typed lambda calculus to represent and analyze word meaning systematically and precisely. The logical tool has an explanatory power to elucidate why the composition fails when the type match requirement is not satisfied, and why certain groups of words behave similarly in terms of their grammatical distributions.

For the remainder of the book, we explored specifics concerning the individual lexical categories. The major categories of verbs, nouns and adjectives were given more attention, but adverbs and prepositions, which are more controversial categories, were each assigned a chapter. These chapters were designed to help readers to understand the important issues that have been debated in the field, and also to acquire the skills needed to apply logical tools in order to analyze the meaning of various lexical items in each category. Summaries and practice exercises were provided at the end of each chapter for solidifying the theoretical concepts, developing an ability to think critically and to solve problems using the theoretical tools.

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Chapter 3 began investigating the core constituent of a sentence, the verb, introducing three commonly used verb classifications; thematic roles, aspectual classes and event templatic structures. In Chapter 4, after identifying a set of logical distinctions in the verb meaning in terms of the types of changes they describe, we analyzed major semantic types of verbs, such as process, incremental change, instantaneous change, bounded and unbounded event verbs. In Chapter 5, we investigated logical polysemy and type coercion. A mechanical function application between arguments and functions does not yield the correct interpretation when the predicate selects only particular aspects of its argument or when the argument introduces new information beyond what it contributes as an argument to the function within the phrase. This observation led to a new view of semantic composition called co-compositionality.

Chapter 6 began exploring the semantics of the noun, the other major constituent of a sentence that occupies the argument positions selected by the verb, such as subjects and objects. This chapter introduced important concepts and influential theories of noun interpretations, such as sense and reference, theories of names, kinds and objects, the qualia structure and complex objects whose different dimensions can be selectively predicated. In Chapter 7, we provided a more fine-grained ontology of the domain of things, and analyzed various classes of nouns, those naming atomic objects, non-atomic substances, natural kinds, artifacts, eventualities and mental/emotional states. In Chapter 8, we discussed reference extensions involved in metonymy and metaphor, which exploit a contextually given relation between the actual denotation and the related denotation, whether it is a part-of relation, a resemblance relation or a more open-ended relation that requires encyclopedic knowledge. After presenting contrasting views of metonymy and metaphor, we offered formal semantic analyses of them.

The topic of Chapters 9 and 10 was the meaning of adjectives, which serve as noun modifiers or occur in stative predicates. In Chapter 9, we classified attributive adjectives based on their relationship with the nouns that they modify into intersective, subsective and intensional adjectives, as well as based on their own meanings in terms of scalarity into dimensional and non-dimensional/evaluative adjectives. The order of attributive adjectives was discussed, as well. Different theories of adjectives were presented in Chapter 10, focusing on the debate about whether a unified semantics for all adjectives is possible. We then examined various theories of vagueness, such as fuzzy-logic theories, inherent vagueness theories and degree-based theories. Lastly, we explored the semantics of evaluative adjectives, focusing on the predicates of personal taste, comparing truth relativist approaches and contextualist approaches.

Verbal modifiers, commonly known as adverbs, was dealt with in Chapter 11. We first examined various types of adverbs, such as manner, subject-oriented and speaker-oriented adverbs. We showed that subject-oriented adverbs are also VP modifiers, on a par with manner adverbs, based on the behavior of intensional adverbs. Analyses of speaker-oriented adverbs called for an assertion operator and conventional implicature, which do not directly contribute to the truth condition but express the speaker's subjective meaning. We introduced different semantic theories of adverbs, the operator approach, the predicate approach and the argument approach, pointing out the merits and shortcomings of each approach.

Chapter 12 was about prepositions. We first classified them broadly into locative and directional prepositions; the former was further divided into projective and non-projective prepositions, while the latter was classified into source, goal and route prepositions. We introduced vector space semantics, which employs directed line segments between points in space, and analyzed various prepositions using this tool. We then explored the polysemy, metonymic and metaphoric extensions to temporal and abstract meanings, and context-dependency of prepositions. Finally, we discussed whether the spatial relations in the semantics of prepositions are in fact more basic, and the gradable meaning of the other lexical categories expressing path, movement, size, orientation and parts can all be interpreted with respect to the same spatial structure of vector space semantics.

The broader aim of this book has been to teach students how to use empirical methods in lexical semantics and to make logical tools more accessible. As previously mentioned, word meaning has been viewed as an idiosyncratic component of grammar that defies systematic formal accounts by traditional linguistics influenced by American structuralism. It has been until recently a common attitude among formal semanticists that word meaning is not so much linguistic matter as psychological or ontological matter. Throughout the book, however, we saw that mathematical notions of sets, relations, functions, orders, part–whole relations and vectors, which have been fruitfully applied to compositional semantics, form the bases of numerous word meanings in all categories. This allowed us to study word meaning scientifically with precision. Due to the nature of the book, however, some formalizations were simplified, reflecting the spirit of the original works more than their rigorous details.

This book took a logical, classic and universalist approach to lexical semantics and used English as an object language and a meta language. As such, it is intended to be complemented by higher-order pragmatic theories to explain functional factors and by cross-linguistic data to account for language variations. We discussed research along these lines when we introduced Zwarts's (2017) work. The trend in linguistics in general and (lexical) semantics in particular is to use naturally occurring corpus examples or experimental data, instead of solely relying on native speakers' intuitions, and use sophisticated computational methods to analyze them. Whenever possible, I mentioned psycholinguistic literature that bear on the semantic issues to provide a more real account of word meaning. Existing large corpora, such as Corpus of Contemporary American English (COCA) and British National Corpus (BNC), structured electronic dictionaries such as WordNet as well as experimental methods developed in psycholinguistics can be fruitfully applied to lexical semantics investigation for creating more empirically sound models. As briefly mentioned in the Introduction, Baroni (2013) discusses a relationship between formal and Distributional Semantic Models (DSM). DSM automatically extract word meaning from large corpora on the basis of closeness in meaning measured by their distributions. It represents a word meaning with a vector that encodes the number of times the word occurs in different contexts, enabling quantification of semantic similarities between words. Jackendoff (2011), however, criticizes DSMs for their focus on individual words and their lack of compositional calculation of phrases and sentences. To respond to such criticism, Compositional DSMs have been developed, but they are better suited to represent generic sentences rather than episodic sentences with indexical reference, capturing better or worse paraphrases, and commonsense aspects of entailments. Distributional methods supplement the logical methods pursued in this book, rather than replacing them.

I thank my students in my lexical semantics classes for their helpful comments on the previous versions of the book. For any mistakes, deficiencies and omissions, I am solely responsible. I hope this book will be a positive step toward stimulating and reviving lexical semantics, providing a text comparable to the many successful formal/compositional semantics textbooks.

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