Grammar and Meaning

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1   Introduction

The study of linguistic meaning is normally divided into three fields: lexical semantics, compositional semantics,[1] and pragmatics. Lexical semantics studies the meanings of words and relations between these meanings, as well as how these meanings are realized grammatically (i.e., morphosyntactically). Compositional semantics studies how the meanings of larger grammatical units — phrases, sentences, discourses — are built out of the meanings of their parts. Pragmatics studies how speakers enrich meanings contextually and the relation between context and meaning. Each of these aspects of meaning is related to grammatical aspects of linguistic structure (morphology, syntax, prosody), although pragmatics generally displays weaker strictly grammatical effects than the other two aspects of meaning, for which the relationship with grammar is intrinsic. In this paper, I understand *grammar* to be a productive system that characterizes the well-formed (potentially) meaningful units of a language. I do not take a crucial stance on what the minimal meaningful units are or what the precise relationship is between morphology and syntax, but I will tacitly assume a form of *strong lexicalism* (Lapointe 1980), such that the minimal units of syntax are words.

The terms 'grammar' and 'meaning' are themselves open to a variety of interpretations, but a thoroughgoing consideration is not possible in this paper. I assume here that 'grammar' refers to syntax and that 'meaning' refers, on the one hand, to a truth-conditional conception of compositional and lexical semantics and, on the other hand, to how meanings produced by the linguistic system (syntax and semantics) are enriched contextually with knowledge from outside the linguistic system by speakers and hearers (pragmatics). The distinction between these two different aspects of meaning should be obvious in what follows.

These decisions reflect my own background and competence, but also the currently predominant viewpoint in theoretical linguistics (see, e.g., Partee 1995 for a lucid introductory presentation of this view of grammar and meaning from first principles). As such, this seems like a natural starting point for students and researchers wishing to find an overview and an entry point into the literature. Nevertheless, this means that various other perspectives are not represented here. For example, I do not review morphological contributions to lexical and compositional semantics (see, e.g., Hewson 1972, Bolinger 1977, Leech 2004). Nor do I review theories of lexical semantics and its interaction with compositional semantics which emphasize the cognitive/conceptual underpinnings of meaning, most prominently Cognitive Grammar (Langacker 1987, 1991, 1999, 2008, Taylor, this volume). I similarly focus on a particular view of the relationship between lexicon and grammar that has received wide currency in various linguistic theories, but set aside other views (see, e.g., Duffley 2014, Jaszczolt 2016).

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[1]Compositional semantics is often merely called 'semantics', but I use the term 'compositional' to contrast this aspect of semantics with lexical semantics.

2 Lexical Semantics[2]

In his recent overview, Geeraerts (2010) lists quite a few kinds of theories of lexical semantics, but I do not seek to endorse any particular one of them here. In section 2.1, I review two key truth-conditional relations between lexical items. In section 2.2, I briefly review some central aspects of the relationship between lexical meaning and grammar.[3]

2.1 Lexical Relations

In this section, I review two fundamental lexical relations: *synonymy* and *antonymy*.

2.1.1 Synonymy

A standard definition of synonymy is that two lexical items are synonymous if and only if substitution of one for the other in any sentence necessarily preserves truth (Cruse 1986: 88). In other words, for any sentence in which the first lexical item occurs, substitution with the second lexical item necessarily results in a sentence with the same truth conditions. This is a truth-conditional definition of synonymy, which Cruse (1986) calls *propositional synonymy*, since it depends on truth-conditional equivalence between propositions modulo substitution of corresponding lexical items. Propositional synonymy can also standardly be understood as mutual entailment: Two lexical items α and β are synonymous if and only if every sentence φ which contains α entails and is mutually entailed by the sentence φ' with β substituted for α (where φ' is identical to φ except for the substitution of β for α). For example, *violin* and *fiddle* are synonyms, according to Cruse (1986: 88), because "these are incapable of yielding sentences with different truth values".

Unfortunately, this is isn't quite true, for a number of reasons. First, the substitution cannot occur in any of the standard contexts where substitution breaks down (so-called *intensional* or *opaque* contexts; Frege 1892, Carnap 1947, Quine 1956, 1960, Montague 1973), such as clauses embedded under propositional attitude verbs. For example, it is possible for the sentence *Kim believes Sandy owns a violin* to be true while the sentence *Kim believes Sandy owns a fiddle* is false, if Kim doesn't realize that fiddles are violins. Second, substitution can fail in collocations. For example, *Kim plays first fiddle in the orchestra* sounds decidedly odd, because the position is called *first violin*. Third, otherwise synonymous words may have different connotations (Geeraerts 2010: 38) or may differ in sentiment or *expressivity* (Potts 2007b). For example, *prostitute* and *whore* (on one usage) are arguably synonyms, but the latter expresses more negativity than the former. It may therefore be preferable to adopt a slightly different definition of synonymy that builds on notions of model-theoretic interpretation (see section 3.1 below) but eschews substitution in sentences. For example, *violin* and *fiddle* are synonymous in our world because the set of violins is the same as the set of fiddles (nothing is in one set but not the other). This doesn't capture the complexities of collocations and connotation,

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but it provides a minimal notion of synonymy which can then be accommodated in theories of those phenomena.

2.1.2 Antonymy

Speakers often have strong and consistent intuitions about oppositeness and even quite young children grasp lexical opposition. In ordinary language, the term *antonym* is often used very generally for all lexical opposition. But opposition in lexical semantics is normally considered a more general concept than antonymy; three entire chapters of Cruse (1986) are dedicated to 'opposites' but only a fraction of this is specifically about antonymy.

One possible definition of antonymy could treat it as the opposite of synonymy (building on the ordinary intuition that *antonym* and *synonym* are antonyms) and we could similarly define the relation in terms of entailment, based on the notion of contradiction, where two propositions are contradictory if and only if whenever the first is true the second is false and vice versa. This very strict definition of antonymy could then be given as follows: Two lexical items α and β are antonymous if and only if every sentence φ which contains α contradicts the sentence φ' with β substituted for α, where φ' is identical to φ except for the substitution of β for α. But this is far too strict. Only opposites like *dead* and *alive* or *true* and *false* would thereby count as antonyms, but surely we want many other contrary but not strictly contradictory words to count as antonyms, such as *good/bad*, *long/short*, *fast/slow* and *hot/cold*.

Cruse (1986: 198–204) therefore reserves the term *complementaries* for strictly contradictory pairs and follows Lyons (1968: 463–464) in defining antonymy in terms of the following properties (Cruse 1986: 204) :

1. Antonyms are gradable. For example, something can be *very long* or *not very long*.

2. The members of an antonymic pair denote degrees of a scalar property, e.g. in the examples above: goodness,[4] length, speed, temperature.

3. Intensification of the members of an antonymic pair moves them further apart on the scale. For example, *very hot* and *very cold* are further apart on the scale of temperature than the unmodified adjectives.

4. The members of an antonymic pair do not bisect their domain. For example, it is not a contradiction to say *Kim is neither tall nor short*.

Property 4 goes hand in glove with the following additional property (also see footnote 3 above):

5. There is no definite transition point on the scale such that the opposing member then strictly applies. In other words, antonyms are *vague*. For example, there is no specific point on the scale of human height that we would say separates tall people from short people (except by arbitrary decree).

Thus, gradable, scalar, vague adjectives are paradigmatic antonyms.

These semantic properties interact with other aspects of grammar, such as the structure of comparatives and superlatives and adverbial modification of adjectives. There has been considerable work on this since the pioneering modern work of Kennedy (1999, 2007), which itself builds on prior work by Klein (1980, 1982, 1991) and others. As an illustration of the interaction with adverbial modification, consider the following typology of scales and accompanying examples from Kennedy and McNally (2005: 354–355); the judgements are theirs:

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[4]This illustrates that the property in question does not have to be easily definable independently or even be strictly measurable.

(1)

A typology of scale structure		
Scale structure	**Picture**	**Examples**
(Totally) open	$\longleftrightarrow$	*tall/short*, *deep/shallow*, *eager/uneager*
Lower closed	$\longrightarrow$	*bent/straight*, *loud/quiet*, *famous/unknown*
Upper closed	$\longleftarrow$	*certain/uncertain*, *pure/impure*, *safe/dangerous*
(Totally) closed	$\blacksquare\!\!\!-$	*full/empty*, *open/closed*, *visible/invisible*

(2)   Open scale pattern

    a.   Her brother is completely ??tall/??short.

(3)   Lower closed scale pattern

    a.   The pipe is perfectly ??bent/✓ straight.

(4)   Upper closed scale pattern

    a.   This product is 100% ✓ pure/??impure.

(5)   Closed scale pattern

    a.   The room was completely ✓ full/✓ empty.

In all of these, the middle of the scale is indeterminate, though, and context is important in reducing or eliminating the indeterminacy. Thus, scalar adjectives also interact with pragmatics; for further discussion, see Barker (1992), Kennedy (1999, 2007), and Kennedy and McNally (2005).

2.2   Argument Structure: The Lexicon–Grammar Interface

There are both intra-language and inter-language (typological) generalizations about how lexical meanings correspond to elements in the grammar. For example, if a predicate has two arguments, such that one of them is the entity that is the actor in the action that the verb denotes and the other is the entity acted upon (cf. the *macroroles* of *actor* and *undergoer* in Role and Reference Grammar; Foley and Van Valin 1984, Van Valin 2005), then in an active sentence we see the following correspondence between these arguments of the predicate and syntactic arguments:[5]

(6)   *predicate*   ⟨   *actor*   *undergoer*   ⟩

                           | |

              subject   **object**

A theory of argument structure thus minimally requires three parts:

1. Some representation of the semantic roles of the arguments of a predicate (*actor* and *undergoer* above)

2. Some representation of syntactic grammatical functions (**subject** and **object** above)

3. Some representation of the mapping between elements of 1 and elements of 2 (the lines above)

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[5]This representation bears a passing resemblance to representations in the Mapping Theory of Lexical-Functional Grammar (for discussion and further references, see Bresnan et al. 2016: Chapter 14), but it is intended entirely pre-theoretically.

Different theories make different choices about these parts. For example, in many theories the elements of 1 are *thematic roles* (Gruber 1965, Fillmore 1968, Jackendoff 1972) like *agent* and *patient*. However, Dowty (1991) has argued that thematic roles are actually cluster concepts (*proto-roles*), not unitary elements. Turning to the elements of 2, theories make different choices here, too. For example, Lexical-Functional Grammar (LFG) directly represents grammatical functions like SUBJECT and OBJECT in the syntactic level of *functional structure* (Bresnan et al. 2016), Head-Driven Phrase Structure Grammar (HPSG) represents grammatical functions positionally in one or more lists that represent syntactic subcategorization, and so-called *Mainstream Generative Grammar* (Culicover and Jackendoff 2005), i.e. Principles & Parameters Theory and its direct ancestors and descendants (e.g., Chomsky 1965, 1981, 1995), represents grammatical functions positionally in a syntactic tree. Lastly, the mapping itself can be represented in different ways. For example, in LFG the mapping is a correspondence between separate elements of a predicate–argument structure and a functional structure, whereas in HPSG the mapping is represented as structure-sharing of elements of an ARG(UMENT)-ST(RUCTURE) list and elements of SUBCAT(EGORIZATION) lists (where this was a single list in earlier versions of the theory and two separate lists in later versions).

There are far too many interesting aspects of the lexicon–grammar interface to adequately consider here; see Schönefeld in this volume and Wechsler (2015) for recent authoritative overviews. However, a central question about the relationship between grammar and meaning that arises in this context is the following:

(7)		Does lexical meaning determine grammatical structure or does grammatical structure determine (apparent) lexical meaning?

In other words, is it theoretically correct 1) to predict structure from lexically stored meanings or 2) to construct the meanings of potentially radically underspecified lexical elements (often called *roots* in recent versions of the relevant kind of theory) from the structure in which they are instantiated? On the former sort of view, the lexicon is a rich generative component in its own right (among many others, Bresnan 1978, Dowty 1979, Kaplan and Bresnan 1982, Pollard and Sag 1987, Jackendoff 1990, Pustejovsky 1995); the latter are often called *lexicalist* theories. On the latter sort of view, the lexicon, to the extent there is one, consists of syntactically and semantically underspecified elements, which are inserted into highly articulated syntactic structures (e.g., Hale and Keyser 1993, 2002, Borer 1994, 2005a,b, 2013, Ramchand 2008, Lohndal 2014) or *constructions* (syntactic templates; e.g., Fillmore et al. 1988, Kay and Fillmore 1999, Goldberg 1995, 2006, Goldberg and Jackendoff 2004, Jackendoff 2002, 2007); these are often called *phrasal* or *constructional* theories and are, to some extent, updates of certain key ideas of Generative Semantics (Lakoff 1965, McCawley 1968a,b). See Spencer (this volume) for an overview of morphological approaches. See Rauh (2010) for a recent discussion of, and further references to, the relationship between meaning and syntactic subcategorization and see Müller and Wechsler (2014, 2015) and Bruening (2018) (as well as the accompanying replies and author's reply) for further discussion of and further references to lexicalist versus constructional/phrasal theories; also see Hilpert (this volume) and Lohndal and Haegeman (this volume).

A hybrid sort of theory is offered by Asudeh et al. (2013), using the formal notion of *templates* from recent work in Lexical-Functional Grammar (Dalrymple et al. 2004, Asudeh 2012).[6] A template is just a named bundle of grammatical information and wherever the template is invoked, the grammatical information is substituted for the template. For example, we could define an English agreement template 3SG which states that the subject's person is 3rd and the subject's number is singular. The lexical entries for, e.g., *smiles* and *smile* would both invoke this template, but respectively as @3SG and ¬@3SG, which captures the fact that the former is a third-person singular form, whereas the latter is incompatible with precisely this cell of the relevant agreement paradigm.

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[6]Müller and Wechsler (2014) lump the Asudeh, Dalrymple, and Toivonen approach with phrasal/constructional approaches, but this is a mistake (Asudeh and Toivonen 2014). Unfortunately, we have not been clear enough in explaining our hybrid theory, because some misunderstandings persist (Müller 2016).

Templates thus do not increase the power of the grammar but allow cross-lexical generalizations to be captured, somewhat similarly to types in HPSG (although see Asudeh et al. 2013 on important distinctions between templates and types). Crucially, as argued by Asudeh et al. (2013) and Asudeh and Toivonen (2014), the same templatic information could in principle be associated with a word or a phrase, thus allowing some of the insights of constructional approaches to be captured, but without admitting constructions *per se* into the theory. For example, building on work by Dalrymple (2001), Asudeh and Toivonen (2014) show how a single template can be defined for English to capture the modificational semantics of relativization and that this template can be associated both with relative pronouns in non-reduced relative clauses (e.g., *who* in *the person who she met*) and with the reduced relative clause structure itself (e.g., *the person she met*), thus allowing the commonalities between the two realizations to be captured without positing either a null relative pronoun or a specific construction for reduced relatives. The templatic approach has been explicitly incorporated into work on argument structure in Asudeh and Giorgolo (2012), Asudeh et al. (2014), and Findlay (2014, 2016).

3   Compositional Semantics[7]

The semantic counterpart to syntactic *productivity/creativity* is compositionality, which is a general semantic procedure for assigning interpretations to novel linguistic expressions that have no upper bound on their length.[8] That is, given a syntactic mechanism for modelling the natural language property of productivity, there must be a semantic correlate for assigning interpretations. This is typically enshrined in the principle of compositionality, often attributed to Frege (perhaps incorrectly; see Janssen 1997):

(8)   **Principle of Compositionality**
        The meaning of a linguistic expression is determined by the meaning of its parts and their
        arrangement (syntax).

The principle, stated as such, does not place substantive constraints on exactly how it should be realized. In practice, there are two principal ways in which it is deployed. Either syntax feeds semantics, i.e. semantics interprets the output of syntax in a systematic fashion, or syntax and semantics are built up together. The former kind of theory is often called 'Logical Form Semantics' and is typically the default kind of theory assumed by semanticists who are influenced by Chomsky's theory of generative grammar, narrowly construed (e.g., Government and Binding Theory, Principles and Parameters Theory, the Minimalist Program; Chomsky 1981, 1986, 1995). I will call this kind of theory *Interpretive Composition*.

   The other kind of theory is more typically associated with semanticists who have sought to further develop the ideas in Montague's seminal works on formal semantics (Montague 1974) and/or have

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[7] There are many textbooks and overviews of compositional semantics. For excellent introductory overviews, see Kearns (2011) and Elbourne (2011). Heim and Kratzer (1998) is very influential, but more advanced. Dowty et al. (1981) is the classic advanced introduction to Montague Semantics. Gamut (1991a) is also an influential advanced introduction to Montague Semantics and its formal prerequisites, as well as to subsequent *dynamic semantic* approaches, which are discussed briefly in section 5.4. For readers particularly interested in dynamic semantics, Kamp and Reyle (1993) remains a key text. Partee et al. (1993) is a comprehensive introduction to the formal tools of compositional semantics. Gamut (1991b) is also an excellent introduction that focuses especially on the logical tools used in formal semantics. Allwood et al. (1977) is a considerably gentler but less comprehensive introduction to logic. Other more advanced introductions to formal semantics include Carpenter (1997), Chierchia and McConnell-Ginet (2000), and Jacobson (2014). Handbooks on semantics include Maienborn et al. (2011a,b, 2012), Hinzen et al. (2012), Lappin and Fox (2015), and Aloni and Dekker (2016). Other handbooks contain considerable relevant material, including van Benthem and ter Meulen (1997, 2011), Ramchand and Reiss (2007), and Heine and Narrog (2015). Portner and Partee (2002) and Davis and Gillon (2004) collect many classic papers in formal semantics and philosophy of language.

[8] A common theoretical approach to capturing productivity is *recursion*, but really it is the empirical phenomenon of grammatical productivity that is strictly relevant here, not how it is formally captured. See Thomas (this volume) and Taylor (this volume) for some further discussion of recursion.

been influenced by the logical work of Ajdukiewicz (1935), Bar-Hillel (1953), and Lambek (1958). There are various modern manifestations of this thread, but a particularly prominent one is typically referred to broadly as Categorial Grammar, of which there are two main varieties: Combinatory Categorial Grammar (e.g., Ades and Steedman 1982, Steedman 1996, 2000, 2012, Jacobson 1999) and Type-Logical Grammar (Morrill 1994, 2011, Carpenter 1997).[9] However, we also see reflexes of the key idea that syntax and semantics are built in tandem in other approaches to the syntax–semantics interface, such as that of Head-Driven Phrase Structure Grammar (Pollard and Sag 1994, Copestake et al. 2005) and Glue Semantics (Dalrymple 1999). This kind of theory is often referred to as 'rule-to-rule composition', in reference to the 'rule-to-rule hypothesis' (Bach 1976), because in Montague's original treatment each syntactic rule of structure building was paired with a semantic rule of interpretation. However, this term is now inaccurate, due to generalizations in the field that removed these pairings of individual rules, particularly the *type-driven translation* of Klein and Sag (1985). I will therefore call this kind of theory *Parallel Composition*. Jacobson (2014) is a (somewhat higher level) introduction to semantics that explicitly compares interpretive and parallel composition.

Interpretive composition and parallel composition are introduced briefly in sections 3.3 and 3.4, but first I will introduce some very basic model theory (section 3.1) and type theory (section 3.2), which are the two principal formal foundations of compositional semantics. I will use some of the concepts introduced in sections 3.1 and 3.2 in what follows those sections.

3.1 Model Theory

Much of modern compositional semantics is model-theoretic. To say that a semantic theory is model-theoretic is to say that statements in the object language (the language being interpreted) are verified against mathematical models that are meant to be representations of the entities and relations that expressions in the object language denote. In other words, if we are interested in truth or falsity of sentences of some natural language, we interpret these sentences, and the expressions which make them up, relative to a model.

In his seminal work on model-theoretic semantics, Montague experimented with two kinds of model-theoretic interpretation: direct interpretation (Montague 1970) and indirect interpretation (Montague 1973), which can be schematized as follows:

(9)   **Direct interpretation**
        Language $\Rightarrow_{interpretation}$ Model

(10)   **Indirect interpretation**
        Language $\Rightarrow_{translation}$ Meaning Representation $\Rightarrow_{interpretation}$ Model

There have occasionally been attempts in the literature to argue for one mode of interpretation over the other, typically direct interpretation over indirect interpretation,[10] essentially based on the observation that the translation mapping itself may be poorly understood. But the truth of the matter is that indirect interpretation is prevalent, because it is normally more expedient to reason about the intervening meaning representation, which is typically formalized in some appropriate logical language[11] than it is to reason about a direct relation between language and a model. Also, for those semanticists who are primarily concerned with the foundational issue of compositionality, the formal meaning representation typically offers a better testing ground for theories.

Partee et al. (1993: 200ff.) offer a detailed and formally precise overview of model theory for formal semantics, but here I will present only the very basics. Minimally, a model M for a language

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[9]Wood (1993) is a good introductory overview of Categorial Grammar.

[10]For example, this seems to be part of the argument in Jacobson (2002).

[11]Montague himself used *intensional logic* (Fitting 2015).

is an ordered pair of some domain, D, and a valuation function, V, that assigns semantic values to the basic expressions of the language:[12]

(11) $M = \langle D, V \rangle$

The fundamental domain D is the domain of individuals/entities. The values of complex expressions all boil down to functions from the domain of entities to the domain of truth values, $\{0, 1\}$ — where 1 is True and 0 is False — and functions on such functions, as well as functions from entities to entities and truth values to truth values.[13]

Once we move into model-theoretic interpretation, the notion of truth of a sentence S, or more generally interpretation of an expression α, is always with respect to a model M. This can be represented in various ways. The standard notation from Montague Semantics is:

(12)   For any expression α, $[\![\alpha]\!]^M$ is the semantic value of α in model M; i.e. $[\![\alpha]\!]^M = V(\alpha)$.

The brackets, $[\![\ ]\!]$, represent the interpretation function on expressions in the object language (the language being interpreted). V is the valuation function for basic expressions from (11) above. So for basic expressions, the interpretation function simply returns whatever V does. The kind of model-theoretic interpretation discussed so far is very impoverished, because it has no way of interpreting variables. Therefore, it is typical to see interpretation relative to an *assignment function*: $[\![\alpha]\!]^{M,g}$ is the denotation of an expression α relative to a model M and an assignment function g that assigns values to variables. The model's valuation function, V, provides the interpretation of constants, whereas the assignment function, g, provides the interpretation of variables.

3.2   Type Theory

Type theory essentially offers a way to capture semantic well-formedness according to some syntactic calculus over a vocabulary of types. In other words, types are semantic categories and the type system is meant to guarantee that well-defined combinations of types are always semantically well-defined. Since the foundational work of Montague (1973), type theory has often been adopted for natural language semantics due to the fact that it is more expressive than other natural options, such as first-order predicate logic. In standard (first-order) predicate logic, we can only talk about individuals (e.g., *Robin*), properties of individuals (e.g., *sleeps*), and relations between individuals (e.g., *loves*). But natural language abounds in expressions that are more complex than this. For example to say that *Robin is similar to Sandy* minimally requires that they have some property in common, but first-order predicate logic does not allow us to quantify over properties ("some property"), only over individuals/entities (Gamut 1991a: 75–77).

The minimal type theory that is typically favoured for simple extensional natural language semantics is as follows (Gamut 1991a: 79; Partee et al. 1993: 339–340):[14,15]

(13)   *Syntax of the type theory*
          The set of types T is the smallest set such that:

          a. e is a type in T

          b. t is a type in T

          c.   If a and b are types in T, then $\langle a, b \rangle$ is a type in T

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[12]Different presentations might name the parts of the model differently, but the basic idea is the same. For example, Dowty et al. (1981: 46) use A for what I have called D and F for what I have called V.

[13]Note that this is a minimal, extensional model theory. In order to capture intensional phenomena, such as modality and propositional attitudes, a common move is to add a set of possible worlds, W, to the model.

[14]The type e is the type for entities and the type t is the type for truth values.

[15]In order to handle intensions, it is common to include a type w for possible worlds (see footnote 13). In Montague's foundational treatment, the type s is used to create intensional types; e.g., $\langle s, \langle e, t \rangle \rangle$ is the intensional type for properties. However, the type s is only introduced by Montague in a complex type definition similar to clause (13c) below; s is not a base type in the system of Montague (1973).

(14)   *Semantics of the type theory*
        Let D be a given domain of individuals/entities. Then

      a. $\text{Domain}_e = D$

      b. $\text{Domain}_t = \{0, 1\}$, the set of truth values

      c. $\text{Domain}_{\langle a,b \rangle} =$ the set of functions from Domain_a to Domain_b

We thus see that the types and their interpretations are related to elements of the models introduced in section 3.1. In order to pump intuitions about what types are, it may be useful to think of complex types as "input–output devices". A complex type $\langle a, b \rangle$ basically says, "If you give me a thing of type a, I'll give you a thing of type b".[16] This intuition forms the basis of thinking about types both as functions and as the basis for computation. (A computer is also an input–output device!).

3.3   Interpretive Composition

Interpretive composition theories assume that semantics interprets the output of syntax. A central exemplar of such a theory is the one developed by Heim and Kratzer (1998) in their influential textbook. In the remainder of this section, I present an example of interpretive semantic composition, adapted from Heim and Kratzer (1998: 15–26). First we need an inventory of possible denotations. This will be as defined in sections 3.1 and 3.2: the domain of individuals/entities, the domain of truth values, and functions on these domains. We also need denotations for all our lexical items, the basic elements of composition:[17]

(15)   **Lexicon**

      a. $[\![\textbf{Kim}]\!] = \text{Kim}$
           etc. for other proper names

      b. $[\![\textbf{smokes}]\!] =$
           The function f of type $\langle e, t \rangle$ from entities to truth values such that for all x in Domain_e,
           f(x) = 1 if and only if x smokes.
           etc. for other intransitive verbs

Lastly, we need rules for interpreting syntactic structures, which we assume are generated by an independent syntactic component:

(16)   **Rules for syntactic structures**

    S1.   If α has the form $\underset{\beta \quad \gamma}{\overset{X}{\wedge}}$ then $[\![\alpha]\!] = [\![\gamma]\!]([\![\beta]\!])$ or $[\![\alpha]\!] = [\![\beta]\!]([\![\gamma]\!])$, as appropriate.[18]

    S2.   If α has the form $\underset{\beta}{\overset{X}{|}}$ then $[\![\alpha]\!] = [\![\beta]\!]$.

The compositional semantics works as follows for a simple example (based on Heim and Kratzer 1998: 16–20):

(17)   Kim smokes.

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[16]Consequently, complex types are often alternatively represented as $(a \rightarrow b)$, with outer parentheses typically left out. This makes the computational (input/output) nature of types more evident, but is somewhat more cumbersome for larger types.

[17]Heim and Kratzer (1998) adopt the convention that expressions of the object language are written in bold.

[18]In other words, as determined by the semantic types of β and γ; this is the notion of type-driven translation referred to above (Klein and Sag 1985).

1. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right]$

2. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right] = \left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad \textbf{smokes} \\ \textbf{Kim} \end{array} \right]\!\!\right]$ by S2

3. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right] = \left[\!\!\left[\begin{array}{c} \text{S} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right]$ by three further applications of S2 ($[_{\text{VP}}$ **smokes**], $[_{\text{N}}$ **Kim**], $[_{\text{NP}}$ N])

4. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right] = [\![\, \textbf{smokes} \,]\!]([\![\, \textbf{Kim} \,]\!])$ by S1

5. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right] = \left[\begin{array}{l} \text{The function f of type } \langle e, t \rangle \text{ from entities to truth} \\ \text{values such that for all x in Domain}_e, \text{ f(x)} = 1 \text{ if} \\ \text{and only if x smokes.} \end{array} \right] (\text{Kim})$

   from Lexicon

6. $\left[\!\!\left[\begin{array}{c} \text{S} \\ \text{NP} \quad \text{VP} \\ \text{N} \quad\quad \text{V} \\ \textbf{Kim} \quad \textbf{smokes} \end{array} \right]\!\!\right] = 1 \text{ iff Kim smokes}$ by Functional Application

Functional application is the fundamental rule by which the function that is the denotation of *smokes* is *applied to* (i.e., combines with) its argument, the individual that is the denotation of *Kim*, which gives the right truth conditions for the sentence *Kim smokes*.

In order to know the actual truth *value* of *Kim smokes*, we have to know the denotation of **smokes** in our model. This is a function that can be represented in any number of standard ways (Partee et al. 1993), such as:

(18)   a. $[\![\textbf{smokes}]\!] = \{\langle \text{Kim},1\rangle, \langle \text{Robin},1\rangle, \langle \text{Sandy},0\rangle\}$
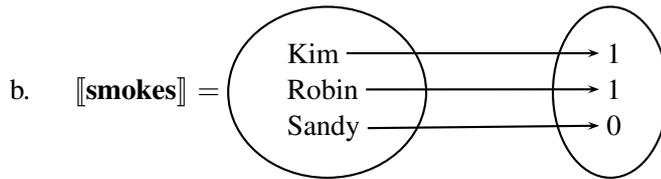
    b. $[\![\textbf{smokes}]\!] =$

    c. $[\![\textbf{smokes}]\!] = \begin{bmatrix} \text{Kim} & \to & 1 \\ \text{Robin} & \to & 1 \\ \text{Sandy} & \to & 0 \end{bmatrix}$

In (18a), the function is represented as a set of pairs. In (18b), it is represented in a standard graphical format. In (18c), we have a *tabular function*, which is a good compromise between the set notation and the graphical notation.

3.4   Parallel Composition

Categorial Grammar and other parallel composition theories assume that 1) each lexical item pairs its syntactic category with a semantic interpretation and 2) each syntactic operation is paired with a semantic operation. Therefore, once the syntax is built, the semantics has also been determined, rather than semantics interpreting the output of syntax. The presentation of Categorial Grammar is often quite different from the presentation of Logical Form Semantics in Heim and Kratzer (1998). However, I will try to maintain as much similarity as possible between the presentation in this section and the presentation in the previous section, in order to maximize comparability. We therefore continue to adopt the same notational choices as in (15). We also continue to assume the same denotations for **Kim** and **smokes**.

   The lexicon is presented slightly differently in Categorial Grammar, because the whole point of the parallel composition enterprise is to associate syntactic categories directly with their semantic types and interpretations. We follow the presentation of Steedman (1996), except for the notational choices mentioned above:

(19)   **Lexicon**

    a.   **Kim** $:= NP : [\![\textbf{Kim}]\!]$
    b.   **smokes** $:= S\backslash NP : [\![\textbf{smokes}]\!]$

The slash means that **smokes** is a complex category: The backward slash indicates that **smokes** takes an argument to its left, an NP, and the result is an S. On the semantic side, the function $[\![\textbf{smoke}]\!]$ applies to the argument $[\![\textbf{Kim}]\!]$.

   This application is captured in the following combinatory rule:

(20)   **Functional application**

    a. $X/Y : f \qquad Y : a \;\Rightarrow\; X : f(a)$
    b. $Y : a \qquad X\backslash Y : f \;\Rightarrow\; X : f(a)$

The rules in (20) have two elements on the left-hand side of the arrow and one on the right-hand side. The *forward slash* rule in (20a) states that a complex category X/Y can be combined with a category Y to its right (hence *forward* slash) to yield the result X. Similarly, the *backward slash* rule in (20b) states that a complex category $X\backslash Y$ can be combined with a category Y to its left (hence *backward* slash) to yield the result X. In each case, the complex category on the left-hand side of the rule is twinned with an interpretation f, a function, and the result of combining the complex category with the category Y is to apply this function to the interpretation of Y; i.e. f is applied to a, yielding

$f(a)$. For example, in English, the combination of a transitive verb with its object would involve the forward slash rule (20a) (because transitive verbs precede their objects), whereas the combination of a subject with its predicate would involve the backward slash rule (20b) (because predicates follow their subjects).

We can then construct the following derivation:

(21)

$$\frac{\overline{\textbf{Kim}} \qquad \overline{\textbf{smokes}}}{NP : [\![\textbf{Kim}]\!] \quad S \backslash NP : [\![\textbf{smokes}]\!]}$$
$$S : [\![\textbf{smokes}]\!]\,([\![\textbf{Kim}]\!])$$

The result is interpreted as before: It is true if and only if the function that is the denotation of **smokes** maps the individual that is the denotation of **Kim** to 1. In other words, if Kim indeed smokes, $[\![\textbf{smoke}]\!]([\![\textbf{Kim}]\!])$ yields 1 (True); otherwise it yields 0 (False).

As mentioned above, the key idea in parallel composition is that syntax and semantics are built up together, rather than semantics interpreting the output of semantics. This does not mean that different choices cannot be made about the syntax, though. We have seen a simple example from Categorial Grammar in (21), but a different kind of parallel composition theory — Glue Semantics (Dalrymple et al. 1993, Dalrymple 1999, 2001, Asudeh 2004, 2005a,b, 2006, 2012, Lev 2007, Kokkonidis 2008, Andrews 2010, Bary and Haug 2011, Lowe 2015a,b, Findlay 2016) — makes a different assumption about the connection between syntax and semantics.[19] The crucial difference is that Categorial Grammar assumes that syntax/grammar is directly responsible for semantic composition, which is a traditional strong assumption derived from Montague Grammar (Jacobson 1999, 2002, Barker and Jacobson 2007). In other words, Categorial Grammar assumes that the syntax of the compositional semantic derivation (proof) is isomorphic to the syntax that generates all and only the well-formed strings of the language (i.e., the syntax of the object language, in the standard sense intended by circumlocutions like "the syntax of English"). In contrast, Glue Semantics assumes that terms in the compositional semantics are instantiated by the syntax, but that semantic composition is handled by a separate "glue logic" (a fragment of *linear logic*; Girard 1987) which "sticks" meanings together (i.e., composes them). This allows semantic composition in Glue Semantics to be *commutative* (i.e, order-insensitive), whereas composition in Categorial Grammar is normally non-commutative (since syntax is by definition order-sensitive). Commutative composition arguably more accurately and purely captures the nature of functional application, the key operation of semantic composition (for further discussion, see Asudeh 2012: Chapter 5).

4 Pragmatics[20]

Pragmatics concerns the information conveyed by *utterances* — that is, particular *tokens* or *uses* of a given abstract sentence *type* (Korta and Perry 2015). For example, consider the following sentence:

(22)   Kim is allergic to peanuts.

This sentence potentially conveys very different information before and after Kim has been served and partaken of pad thai (a dish that typically contains peanuts). If the sentence is uttered beforehand, it may convey the information that Kim should be served something else, or function as a warning to the host, or constitute a conspiratorial suggestion that this may be an effective way to dispatch Kim.

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[19]See Asudeh (2006) for a discussion of Glue Semantics versus Logical Form Semantics and Categorial Semantics in light of questions of compositionality.

[20]The classic overview is Levinson (1983). A somewhat gentler but correspondingly less comprehensive introduction is Chapman (2011). Handbooks on pragmatics include Horn and Ward (2004), Huang (2013), Allan and Jaszczolt (2015) and Östman and Verschueren (2016). Davis (1991) is an excellent collection of original papers in pragmatics. Kasher (1998) is a mammoth multi-volume collection of papers and offers a very catholic selection. The classical works of Austin (1975) and Grice (1989) are deep, but not inaccessible.

If the sentence is uttered afterwards, it may function as an admonishment to the host or convey the information that an ambulance should be called immediately. Yet, the compositional meaning of the sentence surely has not changed and remains constant whether the sentence is uttered before or after Kim eats the pad thai. This highlights another way of looking at pragmatics: It is the study of the effects of context on meaning.

The twin pillars of "classical pragmatics" (Chapman 2011, Korta and Perry 2015) in this sense are Austin's theory of *speech acts* (Austin 1975) and Grice's theory of *implicature* (Grice 1989).[21] These will be discussed in the following two sections. Certain more recent developments in pragmatic theory will be discussed in section 5 below.

4.1 Speech Acts

The title of Austin's book, *How to do things with words*, gets across very well the central idea behind speech act theory: In communicating propositions, we also perform actions; what these actions are depends in part on lexical choices in the utterance, but also on the speaker's intentions and on social and cultural factors. We have already seen some examples of speech acts in the introduction to section 4, when I wrote that (22) could function as a warning or admonishment, given contextual knowledge.

Austin originally made a binary distinction between *performatives* and *constatives*. The latter convey propositions (i.e., a declarative statement that is capable of being true or false), whereas the former constitute actions, such as promising, warning, declaring, commanding, apologizing, baptising, sentencing, etc. The last two examples illustrate that certain performatives depend on cultural or legal authority under an institutional aegis. Only an ordained priest can perform a baptism, and even then only in certain circumstances. And only a judge may pass a sentence and only in a court of law. Thus, Austinian pragmatics places a special emphasis on language in its sociocultural setting.

Whereas a constative can be false, Austin held that a failed performative was instead *infelicitous* and proposed *felicity conditions* for the successful execution of performatives. He divided infelicities into two major classes (Austin 1975: Lecture II): *abuses* ("act professed but hollow") and *misfires* ("act purported but void"). For example, if a speaker utters *I promise to come to the party* without any intention of upholding their promise, then this would count as an abuse for Austin. An example of a misfire would be a wager made but not taken up: If I say *I bet you £100 that the United Kingdom does not leave the European Union* but you make no acknowledgement of accepting the wager, then a wager has not successfully been made.

In the latter part of *How to do things with words*, Austin abandons the performative/constative dichotomy and instead develops a more general theory of speech acts in terms of three kinds of communicative forces that all utterances have. This is essentially motivated by the fact that an apparently constative sentence can have a performative function, as we have already seen with example (22). On the revised view, an utterance consists of a *locutionary* act, an *illocutionary* act, and a *perlocutionary* act. The locutionary act is the act of uttering a sentence as a form–meaning mapping with some structure mediating the mapping; in other words, the locutionary act consists of a tripartite activity of uttering a sentence of some language, with its proper phonetics–phonology (the part of the locutionary act termed the *phonetic* act), syntax over some lexicon (the *phatic* act), and semantics (the *rhetic* act). The illocutionary act is the act of doing something through the utterance of the sentence with the *force* of a statement, warning, promise, etc; thus, the illocutionary act is the closest correspondent of the prior performative category and is at the heart of the part of speech act theory that concerns a speaker's communicative intentions. This act is complemented by the perlocutionary act, which is the uptake of the communicative intentions by the addressee(s).

For example, consider an utterance of the following example:

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[21]The dates on these publications belie the much earlier genesis (in the nineteen forties and fifties) and circulation (most notably in prominent lectures in the nineteen fifties and sixties) of these ideas,

(23)   I have a gun.

The locutionary act is the uttering of the sentence (23). The illocutionary force depends on the speaker's intentions: Is it a threat, a warning, or a mere statement of fact? Suppose, the speaker means the latter. Depending on the circumstances, the perlocutionary force may nevertheless be a threat, if the addressee feels threatened by the utterance.

Speech act theory was subsequently further developed by Searle, who proposed a set of rules or schemas for capturing speech acts (Searle 1969) and a resulting putatively exhaustive taxonomy of speech acts (Searle 1975), which revised Austin's own proposed taxonomy. Searle's rules are however not predictive or generative, merely classificatory, and the taxonomy is based only on English and its attendant sociocultural norms, rather than a broader typological survey of languages. Both of these factors could be considered shortcomings from the perspective of linguistic theory.

Nevertheless, Austin and Searle's work on speech acts excited some interest among grammarians, particularly among the Generative Semanticists (Newmeyer 1980, Lakoff 1989, Harris 1993), who argued that speech acts were actually syntactically encoded (see, e.g., Lakoff 1970b, Ross 1970, Sadock 1974), in what Levinson (1983: 247–263) has called the *performative hypothesis*. At the heart of the performative hypothesis is the claim that every sentence has as part of its underlying structure a highest performative clause, yielding a frame like the following (Levinson 1983: 244):

(24)   I hereby $V_{performative}$ (to) you (that) . . .

In an explicit performative the performative verb and possibly other aspects of the structure are overtly realized, but even an utterance of, e.g., (23) is an implicit performative, more or less equivalent to:

(25)   I hereby tell you that I have a gun.

Proponents of this syntactic account of performatives adduced evidence for their position from anaphora, adverbial modification, and other phenomena that, at least at the time, were seen to favour an underlying structure like (24). In sum, the performative hypothesis suggests a very tight relationship between grammar and the aspect of broader, pragmatic meaning captured by speech acts.

However, it was pointed out early on that this does not seem to give a particularly satisfying truth-conditional semantics for declarative sentences,[22] since it would seem to predict that (26) and (27) are equivalent, contrary to fact (Lewis 1970):

(26)   The world is flat.

(27)   I state to you that the world is flat.

My merely uttering (27) renders it true, but not so with (26). Lakoff (1975) responded to these criticisms, but Levinson (1983: 253–254) argues that the overall resulting conception of meaning remains unsatisfactory. The performative hypothesis has largely been abandoned as a claim about syntax. However, a related, subtler claim has been offered more recently, starting in work by Krifka (1999, 2001), that there are (typically non-explicit) speech act operators in the compositional semantics.

4.2   Implicature

In the introduction to section 4, I suggested that an utterance of (22) (*Kim is allergic to peanuts*) could convey the information that Kim should be served something other than pad thai or could convey the information that an ambulance should be called. However, it is clear that (22) does not have as its semantic interpretation either of these propositions. Rather, these propositions are (potentially)

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[22]In fact, Austin (1975: Lecture V) himself seems to express wariness about any attempt to codify performatives in a grammatical form and consequently does not formulate anything like the performative hypothesis explicitly.

implied by the speaker, under certain conditions, and normally inferred by the hearer, given the same conditions. These extra propositions are what Grice (1975, 1989) called *implicatures*.[23]

Grice divided implicatures into two main classes: *conventional implicature* and *conversational implicature*. The latter was further subdivided into *particularized* and *generalized* conversational implicature. Given the focus in this section on the role of pragmatics in the relationship between grammar and meaning, it is the conventional implicatures and generalized conversational implicatures that are of key interest. But in order to see why, it is useful to first consider conversational implicatures more broadly, which also serves as a broad introduction to Grice's theory.

Grice was interested in rational action and construed conversation as a particular, linguistic instance of such activity. He therefore proposed the following 'rough general principle' (Grice 1975: 26) that participants in conversation observe and expect each other to observe.

(28)   **The Cooperative Principle (CP)**
         Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.

It is important to realize that this is offered as a *characterization* of rational conversation, not as a *prescription* for rational conversation (Chapman 2011: 74).

Grice proposed that there are four conversational maxims. These maxims, together with the CP, yield implicatures.

1. **Quality**[24]

   (a) Do not say what you believe to be false.

   (b) Do not say that for which you lack adequate evidence.

2. **Quantity**

   (a) Make your contribution as informative as is required (for the current purposes of the exchange).

   (b) Do not make your contribution more informative than is required.

3. **Relation**[25]
   Be relevant.

4. **Manner**
   Be perspicuous.

   (a) Avoid obscurity of expression.

   (b) Avoid ambiguity.

   (c) Be brief.

   (d) Be orderly.

Again, despite the imperative mood, these are offered as characteristics, not as prescriptive instructions.

Let us look at one of Grice's examples:

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[23]Implicatures are distinct from entailments, because the latter necessarily follow from the truth of a proposition, whereas implicatures are merely implied through the use of a proposition by a speaker. For example, implicatures can be cancelled felicitously, but cancelling an entailment leads to contradiction.

[24]Grice (1975: 27) also proposes a Quality 'supermaxim': 'Try to make your contribution one that is true'.

[25]This maxim is also often called *Relevance*. Although it is the inspiration for Relevance Theory (Sperber and Wilson 1986, Wilson and Sperber 2012), the notion of relevance in the two theories should not be conflated.

(29)   A: I am out of petrol.
          B: There is a garage round the corner.

If B is following the CP and the maxims, then they must assume that their reply is relevant. Their reply is only relevant if they believe the garage is possibly open and willing to sell A petrol. So, given the first submaxim of Quality, B's utterance in (29) implicates or conveys the proposition φ that the garage round the corner is (possibly) open and (possibly) sells petrol. However, this is not what B literally said and if φ turns out to be false, A could not accuse B of having lied (only if in fact there is no garage round the corner).

This implicature is an example of a particularized conversational implicature (PCI), because φ arises only in the context of what A said. If A had said, for example, *I have a puncture*, then B's utterance would not implicate φ, but rather φ': The garage round the corner is (possibly) open and (possibly) fixes punctures. This property of contextual variance means that particularized conversational implicatures cannot easily be claimed to be grammatically encoded. That would be tantamount to claiming that B's utterance is generally ambiguous between having the implicatures φ and φ', but it is clearly not: In one context it implicates φ and not φ' and in another context it implicates φ' and not φ. This is further underscored by the property of *nondetachability* of conversational implicatures: Any other way of expressing the information expressed by B in (29) implicates the same proposition, given the same context (Grice 1989, Levinson 1983). For example, if B's reply to A's utterance in (29) had been *See that corner? If you turn there, you'll find a garage*, B would still implicate φ. But if this is so, particularized conversational implicature cannot have much to do with grammatical encoding, as not even the most fanciful syntactician would attempt to derive *See that corner? If you turn there, you'll find a garage* from *There is a garage round the corner*, or vice versa.

In contrast to PCIs, generalized conversational implicatures (GCIs) arise *unless* there is specific contextual knowledge to the contrary (Levinson 2000: 16) and can thus be thought of as default, defeasible propositions (Levinson 2000: 42ff.). Moreover, GCIs are often associated with specific lexical items and specific logical meanings. For example, the following example leads naturally to a reading of temporal order between the conjuncts, such that the event described by the first preceded that described by the second:

(30)   The cowboy leapt onto his horse and rode off into the sunset.

This seems to follow by the fourth Manner submaxim ('Be orderly') (see Grice 1989: Chapter 4 and Levinson 2000: Chapter 1).

The GCI is so strong that if we reverse the conjuncts, we nevertheless infer that the cowboy rode off into the sunset (on something other than his horse) and then leapt onto his horse:

(31)   The cowboy rode off into the sunset and leapt onto his horse.

But the GCI is also partly predictable from grammatically encoded aspects of the semantics, in particular that we have a conjunction of two phrases headed by non-stative verbs. If we conjoin two stative phrases, the two orderings are not distinct — there is no GCI of temporal order:

(32)   Ottawa is the capital of Canada and Canberra is the capital of Australia.

(33)   Canberra is the capital of Australia and Ottawa is the capital of Canada.

Thus GCIs seem to be at least in part grammatically encoded; e.g., they are predictable from the lexical meaning of the conjunction *and* and the grammatical features of the conjuncts.

It is conventional implicature (CI) that most strongly demonstrates a connection between grammar and implicature, because grammatical encoding is a definitional aspect of CIs.[26] Let us first consider two of Grice's examples (without endorsing their implicatures):

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[26]I follow Potts (2005) and much subsequent literature in using 'CI(s)' as the abbreviation for 'conventional implicature(s)', despite the unfortunate fact that it would equally well abbreviate 'conversational implicature(s)'.

(34)   She is poor but honest.

(35)   He is English. He is therefore brave.

An utterance of (34) conveys the information φ that the speaker believes there to be a contrast between poverty and honesty (or, that the latter is unexpected given the former). An utterance of (35) conveys the information ψ that the speaker believes that bravery is a consequence of Englishness.

Grice (1975, 1989) contended that these are implicatures that arise from the conventional meanings of *but* and *therefore* — i.e., what in modern terms we might call some aspect of their lexical meaning. However, he contended that these aspects of the meaning of these words, although always associated with the words, are not part of what is said, i.e. part of their semantics. Rather they are implicatures, but conventional ones that are always associated with these words rather than conversational ones subject to contextual variation. That this distinction is at least broadly correct can be demonstrated by considering the interaction of (34) with negation:

(36)   It's not the case that she is poor but honest.

A speaker cannot utter (36) to deny that there is a contrast between poverty and honesty, but rather only to deny the truth of one or both conjuncts. Thus, the contribution to compositional semantics of *but* seems to be just that of *and*. However, it also conventionally implicates contrast.

Conventional implicature and generalized conversational implicature can thus be seen as part of Grice's larger program of preserving the underlying logicality of the natural language correlates of the logical connectives. The GCI account of temporal or causal readings of *and* sentences mitigates the need, at least from these sorts of examples, for positing an ambiguity in the meaning of *and* such that there is a non-truth-functional lexical meaning of *and* in addition to the logical, truth-functional meaning (Carston 2002). Similarly, the conventional implicature treatment of *but* apparently accounts for its lack of interaction with the logical operation of negation.

This feature of conventional implicature would also be explained if CIs were presuppositions (see section 5.1) and there have been prominent attempts to unify the two phenomena (e.g., Karttunen and Peters 1979). However, Potts (2005, 2007a) has argued persuasively, in a pioneering formalization of CIs, that presupposition and conventional implicature are distinct. The essential reasoning is not hard to grasp: While presuppositions are taken for granted by the speaker — i.e., are a kind of backgrounded information — conventional implicatures are not taken for granted but are rather some kind of assertion, albeit a side assertion — i.e., CIs are not a kind of backgrounded information (Potts 2015). I return to presupposition in section 5.1.

Potts himself avoids some of the controversy surrounding Grice's own examples of CIs by focusing instead on cases like appositives (37) and expressive adjectives (38):

(37)   a.   Donald Trump, who is a narcissist, was elected President in 2016.

         b.   Donald Trump, a narcissist, was elected President in 2016.

(38)   That damn knife is very sharp.

In uttering either of (37), the speaker makes the side comment that Trump is a narcissist. In uttering (38), the speaker expresses an attitude about the knife or its sharpness. For Potts, (37) and (38) are thus paradigmatic examples of CIs.

Crucially, once again we see that conventional implicatures are at least partially grammatically encoded. Appositives require a specific kind of intonational off-setting (represented orthographically with a comma, hence Potts's term 'comma intonation'). And expressive adjectives are positionally restricted to attributive, nominal-internal position and cannot function predicatively:

(39)   *That very sharp knife is damn.

This contrast is demonstrated nicely in French, which normally has postnominal attributive adjectives (40a), but requires expressive adjectives to be prenominal (40b):

(40) a. Cette maison maudite est effrayante.
          This house cursed is scary
          'This cursed (*lit.*) house is scary.'

      b. Cette maudite maison est effrayante.
          This damn   house is scary
          'This damn house is scary.'

The adjective *maudite* when used postnominally only has its literal meaning of 'cursed', but when used prenominally has an expressive meaning similar to English expressive *damn*. In sum, conventional implicature is another example of pragmatic meaning that is grammatically encoded.

5   Boundary Issues

The relationship between grammar and meaning is essential and undeniable, but this does not mean that the boundary between grammatically encoded/conventionalized meaning and non-encoded/unconventionalized meaning is sharp (Szabó 2005). In this section, I review three phenomena whose boundaries have been contested. In doing so, I hope to illustrate the sorts of issues that render the relationship between grammar and meaning a rich and fruitful topic of continuing investigation. The section concludes with a brief consideration of *dynamic semantics*, which yields a somewhat different perspective on some of these issues.

5.1   Presupposition

In making an utterance, a speaker invariably takes some information for granted, either because the information has already been established between the speaker and their addressee(s) (it is part of the *common ground*) or the speaker believes that it can be *accommodated* by their addressee(s) (added to the common ground). This assumed information can be characterized as a set of propositions which are the *presuppositions* of the speaker's utterance. Presupposition is intimately tied to the context of the speaker's utterance, but it is also conventionalized in that there are a large number of presupposition *triggers* that invariably give rise to predictable presuppositions as part of their conventional meaning. Presupposition thus seems to straddle the boundary between pragmatics (*pragmatic presuppositions*) and semantics (*semantic presuppositions*).[27]

Consider an utterance of the following example without any prior relevant context:

(41)   Kim stopped breastfeeding Saint.

Among the presuppositions of this utterance are:

1. The addressee understands English.

2. The addressee knows who the relevant Kim and Saint are.

3. Kim used to breastfeed Saint.

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[27]Presupposition is a huge topic in its own right. Overview articles on the topic include Beaver (1997), Beaver and Geurts (2014), Atlas (2004), Simons (2006), and Potts (2015).

Presuppositions 1 and 2 are pragmatic presuppositions:[28] They are general assumptions the speaker is making about the conversation.[29] In contrast, presupposition 3 is a semantic presupposition specifically triggered by the aspectual verb *stop*. It is part of the conventional meaning of *stop*. If we change the example by replacing *stopped* with *started*, presupposition 3 goes away (and is replaced by a presupposition that Kim did not use to breastfeed Saint, since *start* is also an aspectual verb and presupposition trigger). However, the pragmatic presuppositions 1 and 2 persist.

How do we know that presupposition 3 is indeed a presupposition and not just a logical entailment of (41)? First, if the presupposition is false — i.e., it is known that Kim did not use to breastfeed Saint — example (41) is not true, but nor does it seem to be strictly speaking false (Strawson 1950, Heim and Kratzer 1998: Chapter 4). Rather, it seems meaningless. In contrast, if an entailment of (41) is false, (41) itself is necessarily false. For example, if it's the case that Kim still breastfeeds Saint, then (41) is not true, because (41) entails that Kim does not breastfeed Saint. Second, the presupposition survives certain embeddings that logical entailments do not, e.g. negation:

(42)   It's not the case that Kim stopped breastfeeding Saint.

The entailment that Kim does not breastfeed Saint no longer holds, but the presupposition that Kim used to breastfeed Saint still does. This is called presupposition *projection* or *inheritance* and raises the following issue in the study of the interaction of presupposition with grammar: Is it possible to fully characterize and explain the environments from which presuppositions do and do not project? The so-called *projection problem* was recognized early in the history of generative grammar (Morgan 1969, Langendoen and Savin 1971, Karttunen 1973), but has continued to be of central interest (for an influential recent investigation and further references, see Tonhauser et al. 2013, 2018).

5.2   Free Enrichment and Implicit Variables

Another debate on whether aspects of meaning are grammatically encoded has centered around examples like the following (see, e.g., Stanley and Szabó 2000, Carston 2004):

(43)   Every bottle is empty.

(44)   It's raining.

If a speaker utters (43), it is probable that they wish to communicate, and succeed in communicating, that every bottle from some contextually restricted class of bottles is empty, not that every bottle in the universe is empty. In other words, in order to know whether (43) is true *in the intended sense*, the hearer needs to know which bottles are contextually relevant. Stanley and Szabó (2000) call this *the problem of quantifier domain restriction* (von Fintel 1994), and point out that it is an instance of the broader *problem of context dependence*, which is how context together with grammar determines the proposition conveyed by an utterance.

Example (44) demonstrates another instance of the problem. In order to know whether (44) is true (in the relevant sense), the hearer seems to minimally need to know when and where it was uttered. But things are not quite this straightforward (Carston 2004: 817–818). Suppose Matt and Elinor live within an hour's drive of each other and have decided to play tennis near Elinor's in the afternoon, but only if it hasn't rained recently. Right before Matt is to leave, they skype[30] to make

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[28]A reviewer points out that presupposition 2 could equally be considered a semantic presupposition triggered by the proper names, but knowing *which Kim and Saint are relevant* strikes me as more than is strictly warranted by the normal existential presupposition triggered by proper names, which in this case would merely be that Kim and Saint exist. Therefore, as presented, it seems fair to characterize 2 as a pragmatic presupposition. But this discussion, if nothing else, is further evidence that presupposition is a challenging boundary phenomenon between semantics and pragmatics!

[29]Indeed, it could be argued that Grice's Cooperative Principle is itself a pragmatic presupposition, to the extent that a speaker assumes that the addressee would normally assume that the speaker is following the CP.

[30]Other video chat tools are available.

final arrangements. Elinor is facing away from the window behind her and has not yet realized that it's started to pour, but this is visible to Matt in the video. It's not raining where Matt is. Elinor asks, "Are we set to play?" and Matt replies, "It's raining." Clearly, Matt, the speaker, does not mean that it's raining where he is, the location of the utterance — this is neither true nor relevant — but rather that it's raining where Elinor is.

The question, then, is how context and grammar together determine what proposition has been communicated. This problem was already evident in the semantics of *indexicals* (like *I*, *you*, *here*, *now*) and *deictics* (like *this* and *that*), as in influential work by Kaplan (1989a) and Stalnaker (1970).[31] However, Stanley (2000: 411ff.) has argued that the relevant reading of, e.g., (44) cannot simply be due to a hidden indexical, because the implicit location in examples like the following seems to be bound by the quantificational operator, which Stanley (2000) claims indexicals resist (Stanley 2000: 415):

(45)   Every time John lights a cigarette, it rains.

The relevant reading that Stanley (2000) argues cannot arise from an indexical is one in which the "the location of the rain co-varies with the location of the cigarette-lighting" (Hall 2008: 429), i.e. *Every time John lights a cigarette, it rains at the location and time where he lights the cigarette.*[32]

Stanley and Szabó (2000) and Stanley (2000) argue that resolving the problem of context requires a semantic solution such that there are implicit variables (and binders) in the semantic representation[33] rather than eschewing grammatical encoding in favour of a purely pragmatic resolution. A purely pragmatic account proposes that, for example, the propositional interpretation of (43) requires what are sometimes called *unarticulated constituents*[34] (Perry 1986), meaning material that is not present in the grammatical encoding of the sentence (its syntax or semantics) but is rather supplied purely pragmatically. It would be as if *every bottle* in sentences like (43) is always understood as *every relevant bottle* (but without the word *relevant* being present in the structure).

It is unsurprising, then, that early focus on the pragmatic solution to the problem came from Relevance Theory (Sperber and Wilson 1986) and its notion of the *propositional form* of the utterance, which is now more commonly discussed under the rubrics of *free enrichment* and *explicature* (Carston 1988, 2002, 2004), although the term *free enrichment* is sometimes confusingly also used as a general descriptive term for solutions to the problem of context dependence, whether semantic or pragmatic (e.g., Stanley 2002: 163, fn.16). Free enrichment/explicature is quite similar to the notion of *impliciture* (Bach 1994), but see Bach (2010) on distinctions between the two. The basic idea of free enrichment/explicature is that sentences need to be fleshed out pragmatically (with contextually provided unarticulated constituents) before they can have propositional force. It thus constitutes one sort of pragmatic solution to the problem of context dependence.

Stanley (2000) develops the binding argument discussed with respect to (45) above in his argument against pragmatic free enrichment. The basic idea is that if a variable can be operator-bound it is necessarily present in the semantics, i.e. grammatically encoded. This conclusion has been denied by proponents of free enrichment — see, e.g., Bach (2000), Carston (2002, 2004), Recanati (2002),[35]

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[31]The publication dates are misleading: Kaplan's work was more or less contemporaneous with Stalnaker's.

[32]It could be pointed out that the following sentence with an overt location indexical seems to allow a reading either identical to or very similar to the bound reading:

(i)   Every time John lights a cigarette, it rains there.

This seems to cast some doubt on Stanley's argument, but mainly highlights the need for independent linguistic evidence/motivation for the presence of a phonologically null operator that binds a location variable.

[33]Stanley and Szabó (2000: 231ff.) also consider, but reject, syntactic solutions, in which there is more than just a variable in the linguistic structure, but rather elided lexical material, as in e.g. *Every bottle* [that I just bought] *is empty*.

[34]This is a truly unfortunate choice of terminology, since it could easily be mistaken for a constituent that is present in the syntax but unpronounced (i.e. what is often called *syntactic ellipsis*, routinely posited in certain theories), which is the very thing that the term seeks to avoid; see footnote 33.

[35]Martí (2006) offers a counter-argument to Recanati (2002), claiming that a different formal treatment of variables

and Hall (2008), among others. Hall (2008: 430) even contends that, 'A serious weakness in the binding argument, though, is that it relies on the stipulation that bound variables cannot be supplied pragmatically, but must be present in logical form.' However, it must be said that from the perspective of formal semantics it is not clear what it would mean for a bound variable to 'be supplied pragmatically', since operator-binding is fundamentally considered a part of compositional semantics (Lewis 1970, Montague 1974), indeed as Stanley contends. That is, if we grant Hall her premise, we are fundamentally obliterating the semantics–pragmatics boundary, so nobody interested in maintaining this traditional boundary, as Grice (1989) did, would grant this.

Hall's remark highlights how this entire debate has been undermined by a lack of independent linguistic evidence and formal rigour. The proponents of free enrichment have little to gain from proposing an adequate formalization, since they are after all arguing that compositional semantics is not responsible for the phenomenon. But the proponents of the semantic account do owe a full formalization, but offer only a sketch (Stanley 2000, Stanley and Szabó 2000), which undermines the proposal and leaves room for formal doubts (Neale 2000). This is allayed by Elbourne (2016), who is concerned with incomplete definite descriptions, like *the table* (Strawson 1950), which raise the same issues as quantifier domain restriction (Neale 1990), since the uniqueness of the incomplete definite description is satisfied contextually (i.e., it need not be the case that there is a unique table in the universe for the incomplete description to be used successfully). Elbourne (2016) provides an explicit formal syntax and semantics and an analysis of a fragment of English. Moreover, he provides independent linguistic evidence from ellipsis that he argues shows that the implicit variable is a variable over situations, rather than the kind of variable proposed by Stanley and Szabó (2000).

5.3   Scalar Implicature

Another recent boundary conflict has arisen around the phenomenon of *scalar implicature*, with some claiming that it is grammatically encoded rather than a result of purely pragmatic reasoning. A scalar implicature results when a speaker fails to make an alternative, intuitively stronger assertion, and thereby implicates that the stronger alternative is false. For example, an utterance of (46) results in the scalar implicature in (47):

(46)   Some students protested.

(47)   Not all students protested.

The speaker could have uttered (46) with *all* substituted for *some*, but chose not to. They thereby implicate (47). Scalar implicatures are so-called because they seem to crucially involve a scale, ordered by informativeness/entailment; e.g., $\langle all, most, some \rangle$ (Horn 1972, Levinson 1983, Hirschberg 1985). On Gricean reasoning, this is a kind of Quantity implicature (see Potts 2015 for a carefully worked-through example) and some see scalar implicatures as paradigmatic cases of generalized conversational implicatures (Levinson 2000).

The alternative, grammatical view of scalar implicature holds that they are in fact part of the semantic meaning of relevant lexical items and are compositionally derived, typically through interaction with a covert *exhaustification operator* (essentially a covert correlate of *only*). Consider the following example from Chierchia (2013: 97):[36]

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renders free enrichment unnecessary. However, this argument seems to be a kind of parsimony argument that rests on understanding free enrichment as an additional process. It is unlikely that proponents of free enrichment would grant that premise, since they would contend that their overall approach is more parsimonious in positing less syntactic and semantic machinery. Even Stanley and Szabó, who seek to reject the pragmatic solution to the problem of quantifier domain restriction, i.e. free enrichment, grant that 'The obvious advantage [of the pragmatic approach] is that one can propose a syntax and semantics for sentences containing quantifiers that is extremely simple and does not involve covert expressions or covert semantic values.' (Stanley and Szabó 2000).

[36]It is useful for what follows to bear in mind the distinction between *inclusive* and *exclusive or*. ϕ *or* ψ, where *or* is interpreted *inclusively*, is true if and only if ϕ is true or ψ is true, including the case where they are both true. ϕ *or* ψ, where

(48)   If you assign a problem set or an experiment, students will love it. But if you assign a
        problem set *and* an experiment, they will hate it.

If the *or* in the first sentence is interpreted inclusively (i.e., such that ϕ *or* ψ is true if both ϕ and ψ are true), then the second sentence would result in a contradiction. The fact that it doesn't is taken by proponents of the grammatical view of scalar implicature to show that there is an embedded, or local, scalar implicature in the first sentence, arising from a covert exhaustification operator, which we mark as O following Chierchia (2013); this renders the disjunction exclusive:

(49)   If you assign O[a problem set or an experiment], students will love it.

The meaning of (48), given the exhaustivity operator, is thus equivalent to that of (50), which is not contradictory.

(50)   If you assign a problem set or an experiment but not both, students will love it. But if you
        assign a problem set *and* an experiment, they will hate it.

Proponents of the grammatical view have argued that these effects are, in essence, too systematic and predictable, given other features of the grammar, to be the result of standard Gricean reasoning (see, e.g., Chierchia 2004, 2013, Chierchia et al. 2012). But the theory remains controversial and others have argued that the effects can be explained through more standard pragmatic reasoning (see, e.g., Russell 2006, Geurts 2009, Geurts and van Tiel 2013, Franke 2011). The debate has also resulted in an interesting series of psycholinguistic studies, and commentary on these studies, that seek to empirically bolster either the grammatical explanation (among others, Chemla 2009, Chemla and Spector 2011, Crnič et al. 2015, Singh et al. 2016) or the standard pragmatic explanation (among others, Geurts and Pouscoulous 2009, Sauerland 2010, van Tiel et al. 2016).

5.4   Dynamic Semantics

Another perspective on these boundary issues comes from *dynamic semantics* (Kamp 1981, Heim 1983, Groenendijk and Stokhof 1991, Kamp and Reyle 1993), an umbrella term for semantic theories that take the fundamental role of meaning to be information growth (Nouwen et al. 2016). In the dynamic approach, the meaning of a proposition is its capacity to update a context, which is in turn a representation of the entities under discussion and the information that has thus far been accumulated about them. These contrast with the kinds of theories sketched above, which are static: they concern truth relative to some given situation and do not model information growth. However, truth-conditional semantics can be recovered from dynamic semantics, so the two approaches are not fundamentally oppositional, although their understanding of compositionality is distinct (Nouwen et al. 2016). Dynamic semantics grew out of the recognition that there are linguistic conditions on the introduction of and subsequent reference to entities in a discourse (Karttunen 1973, 1974). In particular, indefinite and definite noun phrases behave broadly differently: A key role of indefinites is to introduce entities to the discourse (*discourse referents*), whereas a key role of definites is to refer to already established discourse referents (Kamp 1981, Heim 1982). In this respect, definites behave similarly to pronouns.[37] This also suggests a new way to think about presuppositions associated with definite descriptions as conditions on the discourse referents that the definites bind to. This in turn

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or is interpreted *exclusively*, is true if and only if ϕ is true and ψ is false or else ϕ is false and ψ is true, thus excluding the case where they are both true.

[37]Caution should be taken here. Similarity of behaviour does not necessarily entail that pronouns in fact *are* (hidden) definite descriptions. The latter view, though still controversial and far from universal, is indeed a long-standing and well-defended view in the philosophy of language and linguistics, but is a stronger claim than the mere observation of similarities of behaviour. See Elbourne (2005) for a thorough defence of the stronger claim and further references. See Nouwen (forthcoming) for further discussion and a dynamic semantics defence of the weaker, non-conflationory claim that pronouns can behave like definite description without literally being disguised descriptions.

suggests that presuppositions may also somehow have to bind to discourse referents and are at least partly anaphoric in nature (van der Sandt 1992).

This means that, from the dynamic perspective, there may be distinct connections between the three aspects of meaning that we have focused on (lexical, compositional, pragmatic) and therefore distinct boundaries and boundary issues. In particular, 1) the boundary issues of presupposition and free enrichment discussed above are potentially closely connected in dynamic semantics and 2) the implicit variable-binding on one view of the free enrichment issue may in fact be most profitably understood as a kind of dynamic variable binding (Groenendijk and Stokhof 1991, Heim 1990).[38] However, notice that adopting the dynamic perspective does not dispel the issue: If there is some discourse variable that permits dynamic binding, then there is some structural element (implicitly) present, which is still a version of the implicit variable approach and still goes against the free enrichment view. More generally, it is fruitful to think of dynamic semantics as a kind of augmentation of static semantics rather than as a radical alternative (Nouwen et al. 2016). But this cuts both ways: It is unlikely that dynamic semantics could give solutions that are fundamentally distinct from static semantics if the issue is at heart one of allegedly otiose representations. Nevertheless, if seen through the distinct lens of dynamic semantics, there is no doubt that the phenomena and problems discussed above would look different and suggest substantively different analyses and solutions.

6 Conclusion

This paper has surveyed the three key areas of the linguistic study of meaning: lexical semantics, compositional semantics, and pragmatics. All three of these aspects of meaning interact with grammar, the first two uncontroversially so. The third, pragmatics, was classically viewed as primarily post-grammatical, operating on the output of semantics. However, this view has been facing challenges for quite some time and continues to do so. The challenges have been mounted both by those who view pragmatics as a crucial part of identifying the proposition expressed, i.e. those who advocate a greater role for pragmatics as inferential reasoning from world knowledge and context, and by those who would not necessarily accept this notion but view certain problems that have historically received pragmatic solutions as instead requiring grammatical solutions, i.e. those who advocate a lesser role for pragmatics.

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[38] A reviewer suggests that the implicit variable in (45) above (*Every time John lights a cigarette, it rains*) is a kind of *donkey pronoun*, which have received a lot of attention in both dynamic and non-dynamic semantics (Geach 1962, Groenendijk and Stokhof 1991, Heim 1990, Elbourne 2005):

(i)   Every farmer who owns a donkey feeds <u>it</u>.

Here the interaction between the indefinite (*a donkey*) and the pronoun (*it*) is such that it has universal force, despite appearances (i.e., the sentence is true if and only if the relevant farmers all feed *all* their donkeys). It may well be that the mechanism involved on the implicit variable-binding view is whatever mechanism is involved in interpreting donkey pronouns (see Elbourne 2005 for a thorough overview and references and Nouwen, forthcoming, for a recent reappraisal). But notice that the essential problem remains how *a cigarette* binds a *locational* variable, which it could not otherwise do. This is quite distinct from what is happening in (i), where we have exceptional binding of a pronoun *it* which *could* otherwise corefer to or be bound by *a donkey*.

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