Word Classes in Formal Semantics[1]

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Formal semantics of natural language grew out of works that assume a strong relationship between syntactic categories and semantic types (Lewis, 1970; Montague, 1973). In its strictest formulation, this assumption entails that any two words of the same category must have the same type of meaning. Thus, by learning the morpho-syntactic category of a word, you learn some of its most important semantic aspects. This idea is theoretically appealing but it comes with a heavy toll. A too restrictive matching between syntactic categories and semantic types is descriptively untenable. In many languages, one and the same word class may systematically correspond to more than one semantic type, or contribute to sentence meaning in ways that are not easy to describe using types alone. Much of the progress in formal semantics since the 1970s has been achieved by articulating a richer palette of semantic objects suitable for describing meanings of the major word classes in Germanic and Romance languages. This has been accompanied by a principled relaxation of the matching between categories and types. Starting from the mid-1990s, much research in formal semantics has been devoted to less well-studied languages (Von Fintel and Matthewson, 2008), with a more recent keen interest in the cross-linguistic analysis of categories in formal semantics (Francez and Koontz-Garboden, 2017).

One of the assets of formal semantics is its explicitness regarding processes of nominal quantification and anaphora. This has led to a focus on the semantics of nouns and its extensions to other categories. The semantic connections between nouns and other word classes are also the main topic of this paper. To review this state of the art, section 1 starts out by introducing the classical notion of types in formal semantics, which describe function-argument relations like those that appear between verbs and their arguments, or between determiners and nouns. We illustrate this 'extrinsic' use of types in analyses of English and of Warlpiri, whose word order is freer and case system is richer than most European languages. Extrinsic typing does not distinguish nouns from verbs, adjectives and prepositions. These word classes are distinguished by their phrase-internal semantic arguments, which play a central role in modification. This is the topic of section 2. The analysis of phrasal modifiers allows us to characterize category-specific arguments for meanings of verbs (states and events), gradable adjectives (degrees) and locative prepositions (spatial objects). Unlike these other word classes, nouns are assumed not to have intrinsic semantic arguments, and their extrinsic entity argument is directly targeted by phrase-internal modifiers. Section 3 addresses another property that distinguishes nouns from other categories: their ability to restrict the domain of quantification. This property of *N-conservative* quantification, together with phrase-internal modification, are illustrated by analyzing the semantic disambiguation of N/V-like words in Hebrew. Section 4 addresses another characteristic of nouns: their ability to introduce identity criteria, as proposed in the philosophical work of Geach (1962).

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We discuss challenges for linguistic works that rely on Geach's proposal, and review part of the controversy surrounding on-going attempts to adapt Geach's ideas to formal semantic frameworks. Section 5 addresses some major issues in the semantics of nouns in relation to their ability to refer to *kinds* and *mass* substances. Adding another dimension to classifications of semantic restrictions on word classes, this discussion also shows the intimate relation between mass terms and property expressions, which affects the choices that languages make when manifesting certain property meaning as nominal or adjectival.

1 Extrinsic types of words and function-argument relationships

Different word classes contribute differently to sentential meaning. Formal semantics encodes this fact using different *types* that are associated with different word classes. This section concentrates on standard semantic types that describe a word class's contribution to relations between functions and arguments in a sentence's meaning. To distinguish them from other aspects of word meaning in formal semantics, we refer to these types as *extrinsic*. After describing some elements of the theory of extrinsic types, we illustrate their application to configurational and non-configurational analyses of English and Warlpiri.

1.1 Extrinsic types and function application

All languages have ways of referring to entities and propositions, whose types are denoted using the labels 'e' and 't', respectively. Proper names and definite noun phrases refer to (concrete or abstract) entities, whereas declarative sentences refer to propositions. The notation 't' for the propositional type reflects the analysis of propositions as having *truth-values* relative to given situations (Frege, 1892).

In principle, any mathematical function that operates on entities and propositions is a legitimate candidate for being the meaning of linguistic expressions. Accordingly, types of different word classes are described using the basic types e and t and their combinations. One-place predicates are viewed as functions from entities to propositions, whose type is denoted $\langle e, t\rangle$. Such meanings are assigned to intransitive verbs (V), common nouns (N) and adjectives (A). Transitive verbs, as well as most prepositions and relational nouns (*brother of*) and adjectives (*fond of*), are viewed as functions from *pairs* of entities to truth-values. The type $\langle e \bullet e, t\rangle$ is used for describing such *two-place predicates*.[2] Functional categories like articles, demonstratives, conjunctions, determiners and comparatives are assigned more complex types, which are nonetheless mathematically straightforward. Let us exemplify this using the English definite article. In the noun phrase *the flutist*, the article combines with a noun of type $\langle e, t\rangle$ to yield an entity. Accordingly, English articles and demonstratives receive the following type:

$\langle\langle e, t\rangle, e\rangle$: functions from one-place predicates to entities

By assigning types like $\langle e, t\rangle$, $\langle e \bullet e, t\rangle$ or $\langle\langle e, t\rangle, e\rangle$ to an expression, we describe its 'extrinsic' semantic interactions with other expressions in terms of function-argument relations. Some conventional assignments of extrinsic types to categories are summarized in Table 1.

[2] An equivalent way of treating two-place predicates is as functions from entities to one-place predicates, whose type is $\langle e, \langle e, t\rangle\rangle$. This 'Curried' type is often useful in compositional semantic analysis (Winter, 2016, 52-59).

		Extrinsic type	**Intrinsic argument** (section 2)		
PN	proper name	e	-		
N	noun	$\langle e,t\rangle$	-		
V	verb (in.)	$\langle e,t\rangle$	E	event	for eventive and stative verbs
	(tr.)	$\langle e\bullet e,t\rangle$	E		
A	adjective	$\langle e,t\rangle$	d	degree	for gradable adjectives
P	preposition	$\langle e\bullet e,t\rangle$	r	region	for locative prepositions
ADV	adverb	$\langle e,t\rangle$	d	degree	for manner and degree adverbs
ART	article	$\langle\langle e,t\rangle,e\rangle$	-		

Table 1: different categories with their extrinsic types and intrinsic arguments

Extrinsic types help to explain how words from different word classes support the assignment of meaning to complex expressions, including full sentences. A central mode of meaning composition is *Function Application* (FA). This rule describes situations where an expression of a function type combines with its argument. For instance, when the function denoted by the intransitive verb *runs* combines with the entity meaning of the name *Ben*, the result is the propositional meaning of the sentence *Ben runs*, of type t. We describe this function application as follows:

$$\langle e,t\rangle + e \xrightarrow{\textbf{FA}} t$$

Function application is treated as a commutative operation. Thus, when writing "$\langle e,t\rangle + e$" we refer to both VS and SV constructions. Another example for the operation of FA is the meaning composition between determiners and nouns. For example, the noun phrase *the flutist* involves the following type transition, from the typed meanings of the article and the noun to the entity denotation of the noun phrase:

$$\langle\langle e,t\rangle,e\rangle + \langle e,t\rangle \xrightarrow{\textbf{FA}} e$$

As we saw, the article *the* is assigned the type $\langle\langle e,t\rangle,e\rangle$ that describes a function from one-place predicates to entities. When this meaning is combined using function application to the one-place predicate denoted by the noun *flutist*, the result is an entity-denoting noun phrase, of type e.

A two-place predicate like the transitive verb *see* combines with an entity argument to form a one-place predicate like the verb phrase *see Ben*. This is described using the following rule:

$$\langle e\bullet e,t\rangle + e \xrightarrow{\textbf{FA}} \langle e,t\rangle$$

1.2 Extrinsic types in configurational and non-configurational analysis

Assigning types to categories as in Table 1 is suitable for analyzing meaning in different languages, and does not depend on a specific syntactic theory. Rather, it applies type theory to generalize insights which are common in the typological literature (Croft, 1991; Hengeveld, 1992), and is applicable to languages whose word order is freer and whose case system is richer than English and other European languages. Here we illustrate this point

by comparing the semantic analysis of simple sentences in English and Warlpiri.[3]

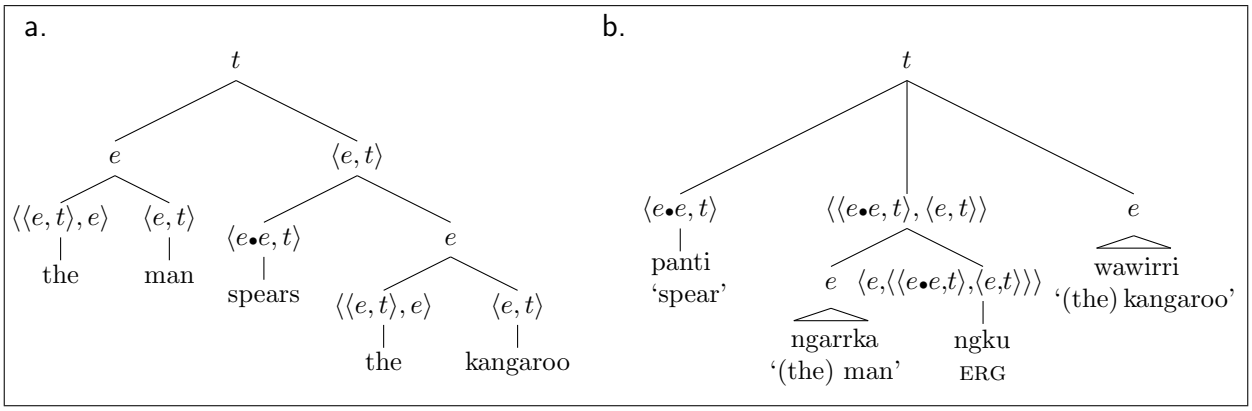


Figure 1: **English vs. Warlpiri**. *Arguments are identified in English using a configurational analysis; in Warlpiri that is achieved by case marking with Hale's non-configurational analysis and Keenan's semantics. For presentational reasons, Figure 1b suppresses the non-past suffix* rni *and the auxiliary* ka *in (1). The one-place predicate denotations of the bare nouns* ngarrka *('man') and* wawirri *('kangaroo') are assumed to be mapped to single entities using a morphologically covert definite article (sections 1.2 and 5.1).*

In Figure 1a, the three cases of function application that are illustrated above are applied to a configurational analysis of a simple English sentence. In this analysis, the expression that combines first with the transitive verb *spear* is the patient *the kangaroo*. When describing the semantics of this composition, the two-place predicate that is denoted by the verb *spear* is assumed to have the patient as its first argument. This is described as follows:

$$\textit{spear} \;=\; \text{the 2-place predicate holding of the pairs } \langle x, y\rangle \text{ where } x \text{ is the patient and } y \text{ is the agent (“}y \text{ spears } x\text{”)}$$

Thus, we obtain the following one-place predicate as the meaning of the verb phrase:

$$\textit{spear the kangaroo} \;=\; \text{the 1-place predicate holding of the entities } y \text{ such that } \langle \textit{the\_kangaroo}, y\rangle \text{ is a pair in the 2-place predicate } \textit{spear}$$

This semantic analysis is suitable for configurational accounts of SVO languages like English, but it is also suitable for languages where configurational assumptions have been contended. To consider one such case, let us look at the following Warlpiri example from (Hale, 1983):

(1) panti-rni ka ngarrka-ngku wawirri (Warlpiri)
spear-NONPAST AUX man-ERG kangaroo

"The man is spearing the kangaroo"

Word order in Warlpiri is famous for being much more permissive than in English. The semantic role of Warlpiri arguments is identified using case markers and not necessarily by their position in the sentence. Hale (1983) and others propose to deal with that using a 'non-configurational' analysis, where a transitive verb, subject and object (essentially) form

[3]For further details on case in formal semantics, see the review in (De Hoop and Zwarts, 2008).

a trinary sentential structure. To interpret such structures, we must analyze the semantic contribution of case markers. For instance, without a semantic interpretation of the marker *ngku*, we would have no way to identify the noun *ngarrka* ('man') as the agent of the action in (1), for the same case marked noun may appear in different positions while retaining its agentive meaning.[4] Such a move is not necessary for 'configurational' languages like English, where case markers are less operational.

In Keenan (1989), case markers like *ngku* in (1) are analyzed as 'arity reducers': functions that map an *n*-ary predicate to an (*n-1*)-predicate by specifying one of its *n* arguments as a target for reduction. In our present terms, the ergative case marker *ngku* in (1) is assigned the following type:

$$\langle e, \langle \langle e_\bullet e, t\rangle, \langle e, t\rangle\rangle\rangle$$

The noun *ngarrka* is analyzed as denoting an entity ('the man') using an implicit process interpreting it as a definite.[5] This entity combines with the meaning of the case marker *ngku* by function application. Consequently, the noun phrase *ngarrka-ngku* ('the man'-ERG) gets the type $\langle \langle e_\bullet e, t\rangle, \langle e, t\rangle\rangle$: an arity reducing function from two-place predicates to one-place predicates. Keenan assumes that the marker *ngku* has a 'nominative' meaning, which leads to the following analysis of the noun phrase:

ngarrka-ngku = the function mapping any 2-place predicate P to the 1-place predicate holding of the entities x such that $\langle x, the\_man\rangle$ is in P

This semantic analysis of the case marker makes sure that the noun *ngarrka* ('man') is identified as the verb's agent. It allows identifying the nominative argument semantically in a flat structure like Hale's, which uninterpreted case does not. In Keenan's analysis, unlike the configurational analysis of the English phrase *spear the kangaroo*, it is the meaning of the overt case marker (rather than syntactic adjacency) that determines the meaning composition.[6] This analysis of sentence (1) is summarized in Figure 1b, ignoring the auxiliary and the tense suffix. Note that unlike the English sentence, analyzing the Warlpiri example does not require assumptions about binary configurations, and not even common categories. The key to the semantic analysis of Warlpiri in Figure 1b is the type and meaning assumed for the case marker, and the process of function application.

2 Intrinsic meanings of different word classes – intersective modification

The extrinsic types that were introduced above account for function-argument relations, which are relevant for all word classes in all phrases and expressions. However, extrinsic types do not cover more specialized aspects of meaning that characterize specific word classes. For instance, intransitive nouns, verbs and adjectives are all assigned the extrinsic type $\langle e, t\rangle$, with no regard to more specific aspects of word meaning that distinguish these

[4]Hale mentions that the orders *ngarrka-ngku ka wawirri panti-rni* and *wawirri ka panti-rni ngarrka-ngku* are also possible, among others.

[5]The introduction of silent definite articles as in Figure 1b is not special to the semantic analysis of Warlpiri, and is used for many other languages with bare nominal arguments (see section 5.1).

[6]Warlpiri case has further functions. Croft (2001, p.186) mentions that the ergative case can establish a connection between a noun and an attributive adjective at a distance. This does not rule out Keenan's analysis, but it requires a more careful formulation than what is given here.

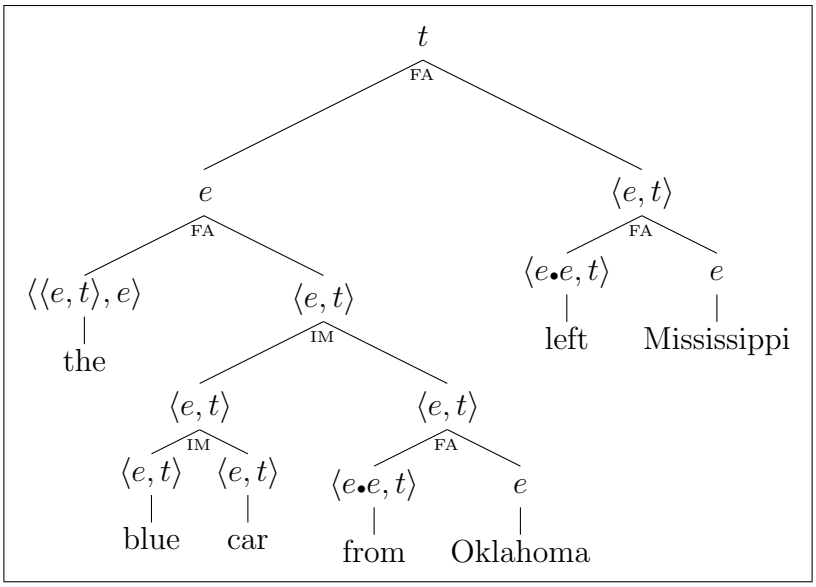


Figure 2: **Intersective modification of nominals**. *In nominals, standard intersective modifiers (here 'blue' and 'from Oklahoma') are predicates of type* $\langle e, t\rangle$ *that target the* e *argument of the noun.*

classes. Some of these aspects can be observed by looking at modification constructions with different categories. In this section we consider nominal modification and its differences from modification with verbs, adjectives and prepositions, and show how these differences are reflected in the formal semantic analysis.

Modification of nouns by adjectives often has a conjunctive meaning, for example:

(2) x is a *blue car* = x is a car and x is blue

In this paraphrase, both the noun and the adjective act as predicates that apply directly to the entity x, and the two propositions that this gives rise to are conjoined. We refer to this analysis of modification as *intersective* (IM).[7] It is accounted for by introducing another way of combining types on top of function application.[8] Specifically, intersective modification with $\langle e, t\rangle$ predicates is described using the following rule:

$$\langle e, t\rangle + \langle e, t\rangle \xrightarrow{\textbf{IM}} \langle e, t\rangle$$

This rule applies in many other cases of nominal modification besides adjectives, which is illustrated in Figure 3.

Our analysis of intersective modification with nominals is inadequate when it comes to

[7]This analysis is not applicable to adjectives like *skillful*, whose predicative meaning may shift depending on the nominal they modify. For instance, *a skillful driver* is skillful at driving, and it would be underinformative to describe her as being 'skillful'. Other adjectives (e.g. *main*) do not even appear in predicative positions. See (Siegel, 1976; Partee, 2010) for a non-intersective analysis of such adjectives, and (Baker, 2003, p.205-211) for relevant discussion.

[8]Another way to achieve intersective modification is to assign a function of type $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$ to the modifier. Such meanings allow us to do the intersection as part of the modifier's semantics using only function application.

modelling modification with other categories. Consider for instance the following sentences:

(3) a. Karl *sang quietly*.
b. Eileen is *extremely quick*.
c. Jonathan flew *10 meters above La Pedrera*.

When analyzing the modified phrases in these examples, we should pay attention to the following semantic differences:

x *sang quietly*	$\neq$	x sang and x is quiet
x is *extremely quick*	$\neq$	x is quick and x is extreme
x is *10 meters above La Pedrera*	$\neq$	x is above La Pedrera and x is 10 meters (high?)

In contrast with nominal modification, we see that modifiers of verbs, degree adjectives and locative prepositions are not readily analyzed as intersective. Someone who sang quietly is not necessarily a quiet person; an extremely quick person is not necessarily extreme; being 10 meters above La Pedrera does not mean "being 10 meters".

To analyze these constructions we retain the intersective analysis of modifiers, but introduce a distinction between nouns and other categories. Equivalences as in (2) illustrate that as far as nouns are concerned, the entity that is targeted by the modifier ('x is blue') is the same entity that appears as an argument of the noun ('x is a car'). Accordingly, we assume that nouns only have one kind of entity argument(s), which can both be targeted by modifiers and predicated extrinsically. The non-identities in (3a-c) show that this is not the case for verbs, adjectives and prepositions: the modifiers in these examples target different entities. But which entities can these be? To answer this question, we observe the following intuitive paraphrases of sentences (3a-c):

x *sang quietly*	$=$	x sang in some **event** y, and y is quiet
x is *extremely quiet*	$=$	x is quiet to some **degree** y, and y is extreme
x is *10m above L.P.*	$=$	x is at the end of some **region** y pointing upwards from La Pedrera, and y is 10 meters long

This kind of analysis was pioneered in (Davidson, 1967) for adverbial modification, and was extended for degree adjectives in (Cresswell, 1976) and locative prepositions in (Bierwisch, 1988; Wunderlich, 1991).[9] These analyses crucially employ the semantic notions *event*, *degree* and *region*. These 'intrinsic' elements of meaning are distinguished from the 'extrinsic' e-type arguments that are operational with nominal modification.[10] Verbs, adjectives and prepositions, in contrast to nouns, are assumed to have two different kinds of arguments. The entity argument(s) that is described by the extrinsic type of Vs, As and Ps is the entity that they apply to as predicates. For instance, the e in the $\langle e, t\rangle$ type of the intransitive verb *run* refers to the entity that acts as a subject argument in the sentence *Ben runs*. By

[9] Davidson's proposal was revised in (Parsons, 1990) and (Kratzer, 1996); for a review see (Maienborn, 2011). On degree modification see the book-length overview (Morzycki, 2016). On vectors in spatial semantics see (Zwarts, 1997, 2020).

[10] The terms "intrinsic" and "extrinsic" are semantic, and should be distinguished from the syntactic terms *internal/external argument*.

contrast, modification with Vs, As and Ps targets a different entity in their meaning: event (E) with Vs, degree (d) with As, and region (r) with Ps, as illustrated in the analyses above. We refer to these specialized entity arguments as *intrinsic*.

Modification of manner adverbs (ADV) is analyzed similarly to degree adjectives. Many adverbs are derived from degree adjectives, and we assume that they inherit their intrinsic degree argument. This is in view of examples like the following:

Sue ran *extremely fast* = Sue ran in some event z, and z was fast to some **degree** y, and y was extreme

With some notable exceptions (see below), intrinsic arguments are not accessible to extrinsic operation of function application. Thus, events, degrees and regions do not as a rule appear as subjects or objects predicated in the sentence. Conversely, the extrinsic arguments of Vs, As, Ps and ADVs are not a natural target for modification. This is one way in which the category N is distinguished from other categories: it is the only lexical category that systematically supports intersective modification of its extrinsic argument. This leads us to a general principle about categories in formal semantics:

Principle 1 – intersective modification:
Intersective modification targets the extrinsic argument of Ns, but the intrinsic argument of Vs, As and Ps.

One exception to this principle is *noun incorporation*. Mithun (1984, p.863) defines this phenomenon as an "N stem [that] is incorporated to narrow the scope of the V", where "the compound stem can be accompanied by a more specific external NP which identifies the argument". For instance, consider the following Chamorro example from (Chung and Ladusaw, 2003, p.109):

(4) si Carmen *gäi-ga'* i ga'lagu (CHAMORRO)
UNM[11] Carmen AGR.*have-pet* the dog
"Carmen has the dog as pet"

Chung and Ladusaw analyze the incorporated noun *ga'* ('pet') as a modifier that targets the object argument of the verb *gäi* ('have'). The modified verb applies to the extrinsic argument *i ga'lagu* ('the dog'). This analysis is informally stated below:

x *gäi-ga'* y = x has-pet y = x has y and y is a pet

The noun 'pet' in this analysis modifies an extrinsic argument (y) of the verb, in contrast to Principle 1. Cross-linguistically, however, such cases of N incorporation involve special morphological processes, and do not have the default status of common adverbials that target the intrinsic event argument.[12]

Another exceptional semantic process concerns sentences like *Laura laughed a loud laugh* (Mittwoch, 1998). In such cases, the 'cognate' indefinite syntactically acts like a complement of the verb. Semantically, however, it modifies the event argument, and similarly to adjuncts it licenses further adverbial modification. Thus, it does not 'saturate' or 'reduce' an argument

[11] UNM = unmarked morphological case

[12] For more on noun incorporation in Catalan, Spanish and other languages, see (Espinal and McNally, 2011) and references therein.

of the verb like ordinary, 'extrinsic', objects do. This modificational behavior is illustrated in the following Hebrew example:

(5) ha-matos naxat nexitat xerum be-sade natuS (Hebrew)
the-aircraft landed landing emergency in-field deserted
"the aircraft made an emergency landing in a deserted field"
= "there is an event x with the aircraft as agent, where x is an emergency landing and x occurred in a deserted field"

This behavior is perfectly in line with Principle 1, but it highlights the semantic nature of this principle: the intrinsic event argument in (5) is semantically modified (rather than saturated), although its modifier is syntactically realized without a preposition as if it were an object 'argument' of the intransitive verb.[13]

Summing up, Figure 3 showcases the formal analysis of the English categories we have discussed so far. In this analysis, function application (FA) only targets extrinsic arguments, whereas intersective modification (IM) targets intrinsic or extrinsic arguments according to Principle 1. Thus, with the noun *bird* in Figure 3, IM targets the extrinsic entity (e) argument, while with other categories IM targets the intrinsic argument: event (E) with Vs, degree (d) with As and ADVs, and region (r) with Ps. For example, the $\langle E, t\rangle$ meaning of *extremely quickly* modifies the intrinsic event argument of the verb *flew* without affecting the verb's extrinsic argument (e). The analysis is similar with the degree modifier *extremely* within the adverbial phrase, and the region modifier *ten meters* in the prepositional phrase. At the phrase level, the intrinsic $E/d/r$ argument is "erased" using an Existential Closure (EC) operator ("there is an event/degree/region such that..."). Thus, while the verb *flew* has the meaning of a relation between entities and events (type $\langle e, t\rangle^E$), the verb phrase headed by *flew* ends up having the standard meaning of one-place predicate over entities (type $\langle e, t\rangle$).

3 Nouns as restrictors of quantificational domains

Principle 1 above is a formal semantic criterion that distinguishes nouns from other lexical categories in terms of their combination with intersective modifiers. Typological studies also distinguish nouns from other categories in terms of their intuitive semantic function for identifying individuals (Croft 1991, p.63, Hengeveld 1992, ch.4). As we will see in section 4, such intuitive criteria are not easy to state in the precise terms of formal semantic theories. Before entering this controversial territory, however, we examine a related but more consensual formal semantic characteristic of nouns: their ability to act as restrictors of quantificational domains. Let us consider the following sentences:

(6) a. Every cat ate.
b. Some cat ate.
c. Most cats ate.

[13] Hebrew does not mark bare nouns for case, but Mittwoch remarks that in Ancient Greek, Standard Arabic and other languages, cognate objects are usually marked with the accusative. Russian and Hebrew also allow cognate objects with instrumental case/preposition.

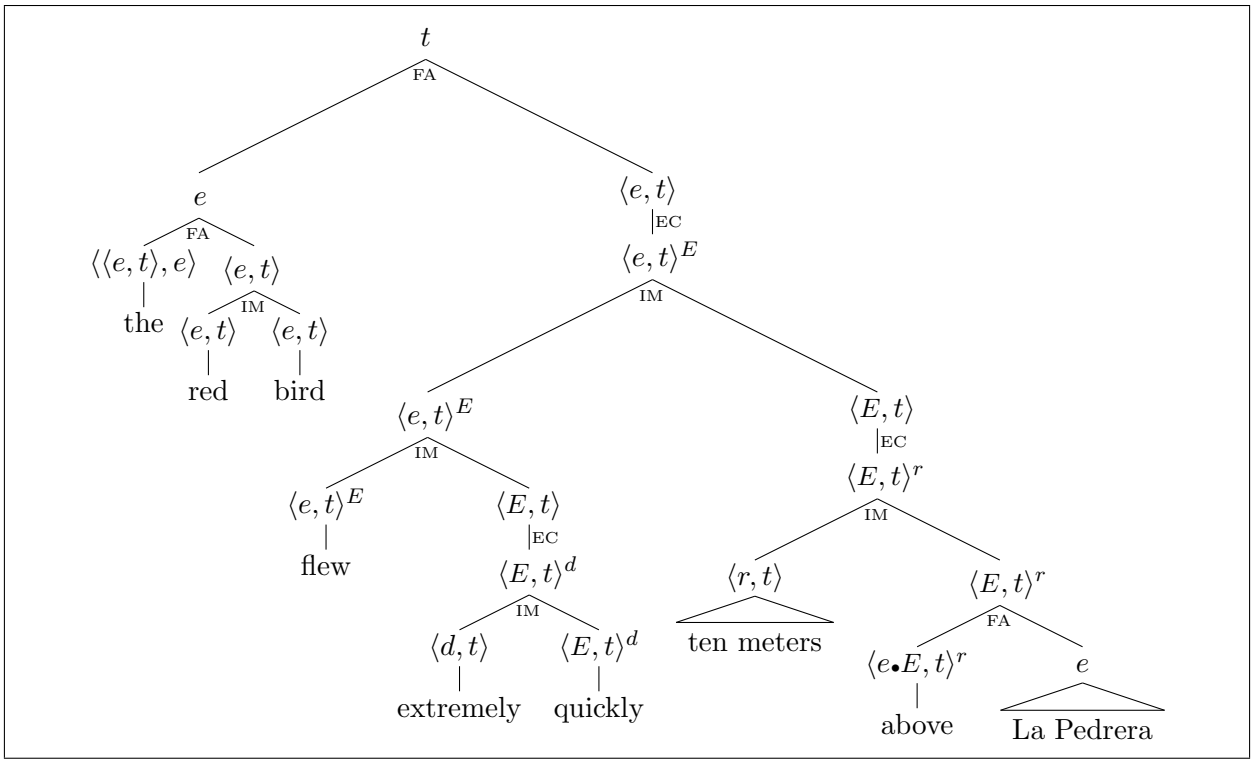
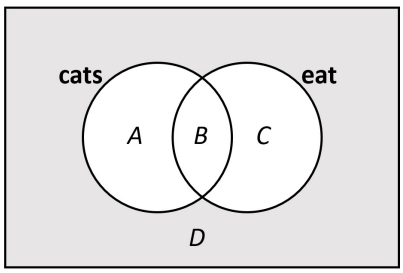


Figure 3: Intersective modification and extrinsic/intrinsic arguments

To determine whether simple sentences like (6a-c) are true or false in a given situation we need to consider the set of cats and the set of entities that ate, as well as the relation between them. That relation is expressed by the determiners *every, some* and *most*. In (6a) the required relation between the two sets is *inclusion*: for every cat to be eating we need to have the set of cats included in the set of eaters. In (6b) the required relation is *having a non-empty intersection*: for some cat to be eating there must be some element(s) in the intersection of the cats and the eaters. In (6c) the relation is that *the intersection set of the cats and the eaters has a majority of cats*.

We see that the truth-conditions of sentences as in (6a-c) are determined by different relations involving the N-set (e.g. the cats) and the V-set (the eaters). However, there are important limitations on these relations. As it turns out, in (6a-c) we do not need to consider entities that are neither cats nor eaters. Furthermore, we also do not need to consider all the eaters: only *cats* that ate are relevant for determining whether these sentences are true or false. In Figure 4, this is observed by considering that only the sets A (the cats that didn't eat) and B (the cats that ate) are relevant for determining the truth or falsity of (6a-c). The sets C (the eaters that are not cats) and D (the non-eaters that are not cats) can be safely ignored.

This observation shows an important asymmetry between Ns and Vs. It is the N-set that "sets the stage" for the quantificational process by determining which elements within the V-set are relevant for the sentence's truth or falsity. We say that the noun *restricts the domain of quantification*, or, in more technical terms, that quantification in (6a-c) is



Sentence:	***True* if and only if**:
every cat ate	A is empty
some cat ate	B is not empty
most cats ate	B includes more elements than A

Figure 4: **N-conservativity**. *In the sentences on the right (=6a-c), it is only elements of the N-set (i.e. members of A and B) that determine whether the sentence is true or false. Elements of the V-set that are outside the N-set (i.e. members of C), and entities that are outside both the N-set and the V-set (i.e. members of D) are semantically irrelevant.*

N-conservative. This property is quite general, and holds for a variety of quantificational expressions, including the following English expressions (Keenan, 1996):

(7) *every, each, some, no, several, neither, both, most, ten, a dozen, a few, many, few, between five and ten, exactly/approximately/more than/fewer than/at most ten, too many, a few too many, (not) enough*

The prevalence of N-conservativity among determiners has led formal semanticists to propose the following hypothesis (Barwise and Cooper, 1981; Glanzberg, 2006):

Principle 2 – N-conservativity:
Across languages, in all quantificational constructions that involve nouns and verbs, it is the noun that restricts the quantificational domain, rather than the verb.

Principle 2 is a robust semantic generalization about quantification in natural language.[14] Together with Principle 1, it provides us with a semantic method to distinguish nouns from verbs in situations where morphology and syntax do not give us a direct criterion for categorization. Although this point is implicit in many semantic discussions, it has not been emphasized enough in the semantic literature. The analysis below of genericity in Modern Hebrew, which appears to be new, demonstrates the implications of this point.

Example: semantic disambiguation of noun-verb flexibility in Hebrew

The fact that Principles 1 and 2 hold for nouns but not for other categories gives a semantic twist to the search for definitional criteria of lexical categories. As semantic criteria, these principles are applicable to words that are morpho-syntactically underspecified between N and V (Rijkhoff and van Lier, 2013). According to Principles 1 and 2, a language may still give us a semantic indication of categorical differences with such words by: (i) allowing modification of entity arguments with noun-like elements, as opposed to other word classes;

[14] A potential counterexample is the word *only*. In *only cats ate*, the sentence's truth or falsity depends on whether *non-cats* ate. Thus, *only* may be viewed as giving rise to quantification that is not N-conservative. However, the consensus has been that *only* should be treated as a special case of focus-sensitive adverbials, which are exempt from Principle 2 (Glanzberg 2006 and references therein).

(ii) restricting quantificational processes on nominal-like items, but not on verb-like elements. We illustrate these general points using profession nouns/verbs in Modern Hebrew.

Hebrew has a large class of participle forms, which function both as the present tense of verbs and as nominal modifiers (Doron, 2013). Additionally, many Hebrew participles are also nouns, as illustrated by the following profession terms in three morphological templates:

(8) V/N participles in Hebrew (singular masculine forms):

(i) *oved* 'work/worker', *yo'ec* 'advise/adviser', *xoker* 'research/researcher'

(ii) *metaxnet* 'program/programmer', *me'amen* 'coach', *mefaked* 'command/commander'

(iii) *mamci* 'invent/inventor', *malxin* 'compose/composer', *mafik* 'produce/producer'

Unlike the other verbal tenses in Hebrew, participles are not inflected for person. The result is that inflections of present tense verbs are the same as nominal inflections. Consequently, the profession terms in (8) can form sentences without any formal difference between N and V. For instance, in the bare singular sentence *metaxnet metaxnet* ('a programmer programs') the subject and the predicate are phonologically identical. Any assignment of categories to such occurrences of N/V words must rely on indirect considerations like the semantic principles 1 and 2 above.

Let us first illustrate it using Principle 1, in relation to the participle *oved* ('work/worker') and the adjective/adverb *naki* ('clean/ly'). When the verb 'work' appears in the past tense it is inflected for person and has no nominal reading. Accordingly, *naki* is disambiguated as an adverb ('cleanly'):

(9) tal avad naki (Hebrew)
Tal worked-3.masc.sg cleanly
Unambiguous: "Tal worked cleanly"

Sentence (9) refers to Tal's manner of work, and does not imply anything about his being a clean person. To put sentence (9) in the present tense we have to use the verb in its participle form, which leads to the following ambiguity:[15]

(10) tal oved naki
Tal works/worker clean/ly
Ambiguous: "Tal worked cleanly" or "Tal is a worker and is clean"

Sentence (10) is ambiguous between a present tense version of (9), and another reading that refers to Tal's clean habits. Principle 1 directly expects this variation under the assumption that *oved* is ambiguous between N and V. In sentence (9), with a non-ambiguous verb in the past tense, Principle 1 expects event-oriented modification referring to Tal's manner of work. With the V-analysis of the participle in (10), the adverbial modification works the same. By contrast, under the N-analysis of the participle in (10), Principle 1 expects reference to Tal as being a 'clean entity'. This is in agreement with the sentence's other meaning where *oved* is interpreted as 'worker'.[16]

[15] A related kind of ambiguity appears in English, with some adjectives and *-er* nouns that are fully specified categorically, as in *Olga is a beautiful dancer*. For discussion and analysis of such cases, see (Larson, 1998; Winter and Zwarts, 2012; Alexeyenko, 2015; Maienborn, 2021).

[16] The predicative N-reading of *oved* ('worker') in (10) appears without a copula, which is not obligatory with predicative nominals in Hebrew (Doron, 1983).

Principle 2 about N-conservativity also has implications for categorical identification, specifically in quantificational sentences with bare nominal arguments. Hebrew has bare nominals both in the singular and in the plural. The quantificational processes with Hebrew bare nominals are morphologically silent, and similarly to English bare plurals (Krifka et al., 1995), they support generic readings as well as existential readings. For instance, in the following examples the bare singular *kelev* ('dog') leads to two different interpretations:

(11) a. kelev nove'ax kshe-margizim oto (Hebrew)
dog barks when-annoy-PL it
"a dog barks when annoyed" (generic)

b. kelev navax kshe-nixnasnu
dog barked when-entered-1PL
"a dog barked when we entered" (existential)

An independent fact about Hebrew is that subjects may often appear in post-verbal positions. This is illustrated by the following examples with the verb *nigmar* 'ended':[17]

(12) ha-mamtakim nigmeru li / nigmeru li ha-mamtakim
the-sweets ended to-me / ended to-me the-sweets
"I ran out of all sweets"

Taken together, these facts give us an opportunity to look at the effects of N-conservativity on categorial identification. Let us consider the following sentence:

(13) eclenu ba-xevra oved metaxnet
at-us in-the-company work/er program/er
(i) "in our company, a worker programs"
≈ "most workers program" (generic)
(ii) "in our company, some programmer is employed"
≈ "some programmer works" (existential)

As the gloss indicates, sentence (13) is ambiguous. Without analyzing this ambiguity there is no way to disambiguate the category of the words *oved* ('work/er') and *metaxnet* ('program/er') in (13). This is so because in syntactic contexts like (13), occurrences of these words might give rise to either an SV order or a VS order. This is seen in similar sentences with an adjacent unambiguous word:

(14) a. eclenu ba-xevra oved fisikai
at-us in-the-company work physicist(N) – *oved* is V-like
"in our company, some physicist is employed"

b. eclenu ba-xevra oved mita'mec
at-us in-the-company worker labor(V) – *oved* is N-like
"in our company, a worker labors"

[17] Although the discussion below does not hinge on this fact, it should be noted that this verb is unaccusative. Non-unaccusatives do not so easily support post-verbal subjects (Costa and Friedmann 2012; Kastner 2020).

c. eclenu ba-xevra mistovev metaxnet
at-us in-the-company hang(V) programmer – *metaxnet* is N-like
"in our company, some programmer hangs around"

d. eclenu ba-xevra fisikai metaxnet
at-us in-the-company physicist(N) program – *metaxnet* is V-like
"in our company, a physicist programs"

We conclude that from a morpho-syntactic point of view, the string *oved metaxnet* in sentence (13) can be analyzed either as an N-V sequence or as a V-N sequence. However, the sentence's interpretation reveals a curious asymmetry: the only generic reading of (13) is 'most workers program' and there is no reading like 'most programmers work'. This asymmetry follows from Principle 2 if N-V is the only category assignment that supports the generic reading. An N-V order can be responsible for the attested reading 'most workers program' since such a generic reading is N-conservative when *oved* is assumed to be a noun ('worker'). By contrast, a reading like 'most programmers work' (or similarly, 'most people who program are workers') is ruled out for the N-V category assignment. According to Principle 2, assigning the category sequence N-V to *oved metaxnet* ('worker program') means that we are not allowed to consider entities outside of the N-set for *oved* ('worker') when assessing the sentence's truth-value. For the hypothetical reading 'most people who program are workers' to be true, the set of workers who program should constitute a majority among the people who program. Such a procedure would require us to consider programmers who are not workers. Since these entities are outside the N-set of *oved* ('worker'), the process would not be N-conservative, thus violating Principle 2.

We have seen that Principle 2 predicts a possible categorical origin for the asymmetric availability of generic readings for (13). There is independent evidence for this account, which is well-known across languages. In situations where V/N categories are lexically or morphologically specified, Hebrew – similarly to other languages – has severe restrictions on generic readings of post-verbal indefinites. This is illustrated by the following sentences (cf. (12)):

(15) a. mamtakim te'imim nigmarim li maher (Hebrew)
sweet-PL tasty-PL end-PL to-me quickly
"I run out of tasty sweets quickly" – generic

b. **?**nigmarim li maher mamtakim te'imim
end-PL to-me quickly sweet-PL tasty-PL

In (15), the words *mamtakim* ('sweets') and *nigmarim* ('end') are categorically specified: as a noun and a verb, respectively. The generic sentence (15a) has the noun preceding the verb, and it is perfectly acceptable. By contrast, inverting the verb and the subject as in (15b) leads to an unacceptable sentence.[18] Similar semantic effects are well-known in other languages, under the heading of the *Mapping Hypothesis* (Diesing, 1992). For example, let us consider the following examples from German (Diesing) and Italian (Longobardi, 2000):

[18]Sentence (15b) is marked as questionable and not as downright unacceptable, since with a very specific intonation (heavy stress on *maher* and a clear break afterward) it might become acceptable. This is similar to the effect that Longobardi (2000) describes for the Italian example in (17) below, though in the Hebrew example (15) the effect is somewhat clearer due to the lack of an existential reading.

(16) a. ...weil Kinder ja doch auf der Straße spielen (German)
...since children indeed in the street play
"...since (typically) children play in the street" – generic

b. ...weil ja doch Kinder auf der Straße spielen
...since indeed children in the street play
"...since there are children playing in the street" – existential

(17) vengono chiamati spesso medici del reparto di pronto intervento (Italian)
are called up often doctors of department of early intervention

(i) with an intonational break between V *chiamati* and N *medici*:
'typically, doctors of the first aid department are called up often' – generic

(ii) without an intonational break between V *chiamati* and N *medici*:
'some doctors of the first aid department are often called up' – existential

To summarize, we have seen that Hebrew profession terms give rise to sentences like (13), which morpho-syntactically, are underspecified in terms of their N/V categorization. However, the semantic Principle 2 on N-conservativity leads us to deduce that the only available generic reading, 'most workers program', must be derived from a specified N-V structure. This prediction is supported by the fact that with morpho-syntactically specified nouns and verbs, Hebrew does not allow generic readings for post-verbal indefinites, similarly to German and Italian.

4 Nouns as individuators

As mentioned above, some typological works distinguish nouns from other categories in terms of their intuitive referential properties (Croft, 1991; Hengeveld, 1992). In a bold attempt to transcend informal classifications, Baker (2003) sets up to provide a cross-linguistic semantic criterion that explicitly *defines* what characterizes noun meanings. Baker builds on the semantic intuitions of Geach (1962, p.39,54) and Gupta (1980), who address specialized aspects of noun meanings using the philosophical notion of *identity criteria*. Informally, such criteria are taken to be "a component of meaning that makes it legitimate to ask whether some X is the same (whatever) as Y" (Baker, 2003, p.96). This property of nouns is assumed to be responsible for the fact that we can refer to *the same giant* but not to **the same huge*, or to *the same bride* but not to the **the same marry*. According to Baker, such contrasts are syntactic effects that point to a "deeper truth": noun meanings involve identity criteria whereas meanings of other categories do not. Baker proposes that identity criteria is what allows nouns to support referential expressions, which according to the conventions of Government and Binding theory, he annotates using referential indices.

There is no reason to deny the intuitive appeal of identity criteria as a basis for the semantics of nouns, or to contend their usefulness for descriptive studies (see e.g. Abner et al. 2019). However, incorporating identity criteria into the exact theoretical machinery of formal semantics is a harder enterprise than what Baker assumes. Indeed, most current works in formal semantics adopt the simple extrinsic typing reviewed in section 1, which does not distinguish nouns from other predicative categories. As we saw, intransitive nouns, verbs and adjectives are all treated using the extrinsic type $\langle e, t\rangle$. Adapting Geach's approach to conform with the massive literature that emerged from this type system is a major task,

and there is little agreement on the motivation for such an enterprize. Two major stumbling blocks are discussed below.

4.1 The elusiveness of sameness 1: co-predication

One and the same noun may intuitively refer to very different kinds of objects. For example, a *newspaper* may be a physical object, an informational object, or an institution:

(18) a. My cat sat on the newspaper.
b. The newspaper contains a lot of fake news.
c. The newspaper fired the editor.

Similar multi-functionality is observed with *book, lunch, sonata* and many other nouns (Pustejovsky, 1995). This on its own is not necessarily problematic for Geach's approach: we might adopt the inelegant assumption that such nouns are ambiguous between different readings. Each of those readings might involve different identity criteria and surface with predicates of different selectional restrictions. Thus, while in (18a) the "physical reading" is manifest, the informational and institutional readings are absent: it is hard to "sit on" an institution or an abstract piece of information. However, the problem has other aspects that cannot be simply analyzed by the ambiguity approach. To see that, let us consider the following scenario (Chomsky, 2000, p.16):

(19) In the municipal library there are two copies of *The Man Without Qualities*: one copy with a red cover and another with a blue cover. Samantha borrowed the red copy and Annabel borrowed the blue copy.

Now let us consider the following sentences:

(20) Samantha and Annabel borrowed the same book.

(21) a. Samantha borrowed a well-written book with a red cover.
b. The book that Annabel borrowed is well-written and has a blue cover.

Sentence (20) is judged as true when we consider *book* as referring to an informational unit, but false if *book* refers to physical copies. This may again be attributed to a putative ambiguity of *book*, and to two different sets of identity criteria. However, these criteria cannot work separately from one another, as the sentences in (21) show. In these sentences, the same occurrence of the noun *book* is used with an "informational" predicate and a "physical" predicate simultaneously. This so-called *co-predication* requires a much more complex semantic analysis than ambiguity of nouns. In one way or another, we need to allow nouns to refer to abstract objects with both "physical" and "informational" aspects. In some cases these aspects are invoked separately from one another, as witnessed by the ambiguity of (20); in other cases they are invoked simultaneously (21). A general analysis of such contrasts is required before the "deeper truth" about the semantics of nouns can be fathomed. For some proposals see (Gotham, 2017) and the references therein.

4.2 The elusiveness of sameness 2: stage-referring nouns

Gupta (1980, p.23) pointed out the following example:

(22) National Airlines served at least two million passengers in 1975.

Sentence (22) can be true although the number of different *people* taking National Airlines flights was less than two million. In semantic jargon, we say that in (22), different *stages* of the same individual may be counted separately (Carlson, 1977). Gupta proposes to account for this fact by assuming different identity criteria for the nouns *passenger* and *person*.

This proposal is problematic for at least two reasons. First, as Krifka (1990) points out, the kind of reading that Gupta illustrates using the "stage noun" *passenger* also appears with nouns that typically refer to individuals. Krifka's example is:

(23) Four thousand ships passed through the lock last year.

Sentence (23) may describe a situation with less than four thousand individual ships. Its most prominent reading counts stages of ships: snapshots of ships as they were passing through the lock. Barker (2010) illustrates the same point for the noun *people*:

(24) Newton has a new, state-of-the-art, award-winning library which served 602,951 people in 1993.

As Barker points out, the prominent reading of (24) counts stages of book borrowers rather than individual people. The accepted conclusion is that stage readings may appear with any noun, including nouns like *ship* and *people* that intuitively refer to "temporally rigid" entities. Conversely, Barker discusses examples like the following (see also Gotham 2021):

(25) How many of National Airlines's passengers live in your house?

Barker considers a situation where your household only has three people, each of them flew National Airlines twice. He points out that in such a situation it would be odd to give the answer "six" to the question in (25). Thus, in (25), the noun *passenger*, which intuitively refers to stages of people, may be used for counting individuals. Thus, we cannot lexically encode the intuitive 'individual' reading of *person* and 'stage' reading of *passenger* in their identity criteria. The same point applies to many other nouns. This is an obstacle for using Geach's idea as a semantic criterion that distinguishes nouns from other predicates, as suggested by Gupta, Baker, and more recent work (see Chatzikyriakidis and Luo 2020 and references therein). Against proposals along these lines, we find alternative semantic proposals, as described by Barker:

> *...criteria of identity are not exclusively part of lexical meaning, but depend also on compositional or pragmatic variability. [...] variability in tolerance for degrees of similarity, is a pervasive, systematic feature of language use, and should not be encoded in information associated with specific lexical items. Rather, this variability is a matter of semantic interpretation (e.g., Nunberg 1984) or pragmatics (e.g., Lasersohn 2000).*

Given this on-going controversy, at this point it is too early to judge if Geach's approach to nouns can be adapted to conform with the bulk of work in formal semantics. Without denying its intuitive appeal and potential usefulness, at this point the semantic properties of "sameness" that Baker relies on are not understood well enough to serve as a definition of the category "noun" in a cross-linguistic formal semantics.

5 Mass meanings cross-linguistically

So far we have discussed standard syntactic categories, with little attention to more fine-grained semantic distinctions within each such word class. Distinctions within traditional word classes are critical for natural language semantics: think of telic vs. atelic verbs, gradable vs. non-gradable adjectives, spatial vs. temporal prepositions, or definite vs. indefinite determiners. In relation to nouns, one of the central semantic distinctions is between mass nouns and count nouns. This section reviews two important contributions to the cross-linguistic semantics of mass terms and its connection to the distinction between the nominal and adjectival categories. Chierchia (1998) proposes a cross-linguistic generalization which aims to describe major classes of languages in terms of their treatment of bare nouns and the count/mass distinction. Francez and Koontz-Garboden (2017) introduce a related cross-linguistic generalization about the N/A distinction and the common use of mass nouns across languages ('Dan has wisdom') for conveying "adjectival" meanings ('Dan is wise').

5.1 Chierchia (1998): bare nouns and the mass/count distinction

Many languages allow nouns to appear without articles or determiners in argument positions. The conditions under which such *bare nouns* are licensed vary dramatically between languages: from languages like French with strong prohibitions against bare nouns (26), to languages like Mandarin Chinese where bare nouns are widespread (27):

(26) J'ai acheté (un/le/*ϕ) livre / (des/les/*ϕ) livres / (du/le/*ϕ) lait (French)
I-have bought (a/the/*ϕ) book / (INDEF.PL/the/*ϕ) books / (INDEF.MASS/the/*ϕ) milk
"I have bought a book/the book/books/the books/milk/the milk"
(Le Bruyn et al., 2017)

(27) zuotian wo mai le *shu* (Mandarin Chinese)
yesterday I buy ASP *book*
"Yesterday, I bought one or more books"

gou jintian tebie tinghua
dog today very obedient
"The dog/s was/were very obedient today"
(Rullmann and You, 2006)

In between these two extremes there lie many other options. English shows a rather liberal use of bare plural and mass nouns, but with a general prohibition against bare singular count nouns. Italian uses bare nouns more restrictively than English, but not as restrictively as French (Longobardi, 1994).

Chierchia's proposal makes a cross-linguistic connection between the licensing of bare nouns and the count/mass distinction. In many languages, numeric expressions can only combine with nouns by adding a classifier expression, without an obvious mass/count distinction. For instance, in the examples below from Mandarin Chinese, both nouns *niu* ('cow') and *tang* ('soup') require a classifier for counting (Cheng and Sybesma 1999):

Parameter	N-type	bare nouns?	classifiers?	plural marking?	example
A	e (mass)	+	general	−	Chinese
P	$\langle e,t\rangle$ (mass/count)	− (w. empty D)	only mass	+	Romance
A/P	e or $\langle e,t\rangle$	+ (restricted)	only mass	+	Germanic

Table 2: Chierchia's cross-linguistic classification of noun meanings

(28) ba tou/*ϕ niu san wan/*ϕ tang (Mandarin Chinese)
eight CL-head/*ϕ cow three CL-bowl/*ϕ soup
"eight cows" "three bowls of soup"

According to Chierchia, the apparent similarity between count nouns and mass nouns in Chinese is related to the licensing of bare nouns. Languages like Chinese, which generally allow bare nouns, are assumed not to have $\langle e,t\rangle$ nouns to begin with. Chierchia proposes that in Chinese and other languages without a clear mass/count distinction, nouns are lexically of type e, and refer to *kinds* of entities (Carlson, 1977). According to Chierchia, Chinese nouns like *niu* ('cow') and *tang* ('soup') refer to 'kind entities' that describe general semantic properties of the noun: being a domestic animal for *cow*, being liquid for *soup*, etc. By contrast, the $\langle e,t\rangle$ meanings of *cow* and *soup* in English describe individual cows or quantities of soup, not the general kind.

On top of this cross-linguistic distinction between the types and the meanings of nouns, Chierchia adopts some fairly standard formal semantic assumptions on mass terms and plurality. From these assumptions, two prototypical types of languages are deduced:

Languages with argumental (A) nouns: Languages like Chinese, where the e type of nouns allows them to appear as bare arguments. Chierchia's semantics deals with all e-type nouns as kinds of mass entities, hence such nouns are expected not to have plural marking, and to require classifiers for counting.

Languages with predicative (P) nouns: Languages like French, where the $\langle e,t\rangle$ type of nouns disallows them to appear as bare arguments. Nouns of type $\langle e,t\rangle$ may have countable or non-countable meanings. Countable meanings support plural marking and counting without classifiers, whereas non-countable meanings support a mass term behavior.

These deductive considerations about two extreme 'prototypical' kinds of languages leave room for some variation. English and other Germanic languages are classified as A/P-languages. These are languages where nouns may be of either type e or type $\langle e,t\rangle$, hence they are (correctly) expected to show a mixed behavior: a count/mass distinction together with licensing of bare nouns.[19] Italian, as well as other Romance languages, is classified as a P-language, but with a complex set of additional syntactic assumptions regulating a postulated empty determiner position (Longobardi 1994, Chierchia 1998, p.383-394). This theoretical picture is summarized in Table 2.

Chierchia's assumptions about the possible types of noun meanings across languages have

[19]Germanic languages do not have bare singulars, which Chierchia tries to account for on general considerations, but see (Doron, 2003; Dayal, 2004, 2021) for problems and further considerations.

Hausa	*àkawai s da kyâu!* exists 3pl with beauty	lit. 'there is them with beauty' = 'they're really beautiful!'
Huitoto	*rozill̵ naɨmé-re-de* pineapple sweet-have-3sg	lit. 'the pineapple has sweetness' = 'the pineapple is sweet'
Bisa	*a gwilli ta-w* 3sg weight exists-in	lit. 'there is its weight' = 'it is heavy'
Ulwa	*yâka û-ka yâka yûh-ka* that house-3sg.poss that long-3sg.poss	lit. 'that house has length' = 'that house is long'

Table 3: Languages with a productive possessive strategy (FKG 2017,p.25-32)

been hotly debated in recent work. It is widely agreed that only a small part of the massive cross-linguistic data on bare nouns, classifiers, plural marking and the mass/count distinction is formally derived as resulting from the cross-linguistic parameter that Chierchia postulated. Notwithstanding, Chierchia's approach marked an important step in formal semantics by showing how the type system reviewed in section 1 can be used for addressing major cross-linguistic puzzles about the meaning and distribution of nouns. Accordingly, elements of Chierchia's proposal are adopted in many recent works on cross-linguistic semantics. For some of these developments, see (Doron, 2003; Dayal, 2004; Rothstein, 2017; Dayal and Sağ, 2020; Dayal, 2021), and the references therein.

5.2 Francez and Koontz-Garboden (2017): mass terms and predicates, nouns and adjectives

Francez and Koontz-Garboden (FKG) address a major cross-linguistic variation in the way an entity's properties are expressed. In English, as in many other languages, the most natural way of saying that an entity has a certain property is to use predication as in 'he is hungry'. Other languages prefer possessive constructions like 'he has hunger', which are only occasionally used in European languages (cf. French *il a faim*). Some of FKG's examples for languages that extensively use the possessive construction are reproduced in Table 3.

FKG's semantic study aims to account for the cross-linguistic aspects that regulate the relations between predication/possession constructions and the use of an adjectival/nominal category. FKG analyze meanings of nouns like *wisdom* and *beauty* on a par with 'concrete' mass terms like *milk* and *sugar* (cf. Moltmann 2009). They point out the linguistic similarity between such mass terms in terms of disjointness (milk is disjoint from sugar, wisdom is disjoint from beauty, etc.) and *ordering*: two people can be compared in terms of their wisdom or beauty, whereas two cakes can be compared in terms of the milk or sugar that they contain. Meanings of 'abstract' mass terms like *wisdom* and *beauty* are referred to as *qualities*, and FKG propose the following generalization:

(29) *A/N property meanings*: Cross-linguistically, *adjectives* can only refer to properties of entities by denoting predicates, but they never denote qualities. By contrast, *nouns* can refer to properties using either predicates or qualities.

Generalization (29) is proposed as a language universal on the matching between property meanings and categories. It describes both European languages, where the adjectival-predicative strategy is widespread, and languages like Hausa, which prefer using qualities in the nominal-possessive strategy (Table 3). Importantly, (29) also describes the uncommon strategy where nouns express properties not using qualities, but using predicative meanings, similarly to adjectives. FKG rely on an early version of work by Jenks et al. (2018), who study 'adjectival nouns' in Basaá. These are Basaá items that generally behave like other nominals, but appear in predicative constructions like adjectives (Hyman et al., 2013). Jenks et al. observe that adjectival nouns are licensed in predicative constructions like (30a) below, which are also characteristic of adjectives and locatives in Basaá. This is contrasted with other predicate nominals that describe properties, which ascribe these properties to entities in possessive constructions as in (30b):

(30) a. hí-nuní híí hí yé li-múgɛ̂ (Basaá)
19-bird 19.that 19.SUB be 5-quiet
'that bird is quiet'

b. a gweé ma-sɔ́dá
1.AGR have 6-luck
lit. 'he/she has luck' = 'he/she is lucky'

FKG account for such differences between nouns by letting the noun in (30a) denote a property of entities (similarly to the English adjective 'quiet'), while the noun in (30b) denotes a quality (similarly to the English noun 'luck'). Further, FKG point out that adjectival nominals behave like count nouns. Thus, the noun in (30a) describes 'quiet entities'. By contrast, quality nominals as in (30b) behave like uncountable mass terms that describe quantities (of 'luck'). This distinction corresponds to Chierchia's distinction between predicative count nouns of type $\langle e, t\rangle$ and kind-denoting mass terms of type e. In this way, FKG's principle (29) describes the cross-linguistically flexible kind/predicate meaning of nouns, as opposed to a rigid predicative analysis of adjectives.

6 Conclusions

This paper has reviewed basic principles and recent proposals in formal semantics that bear on the relationships between word classes and meaning. The core assumption is that expressions have *extrinsic types*, which describe the function-argument relations that words give rise to. Intersective meaning composition regulates the semantics of *modification* across categories, with a major distinction between nouns and other word classes. While nominal modifiers predominantly target the extrinsic entity argument of the noun, modification with other categories involves intrinsic aspects of the category's meaning. One of the main contributions of nouns to sentential meaning is their support of *conservative quantification*, which restricts the way quantificational determiners interact with the rest of the sentence. Other important aspects of nominal meaning concern their ability to individuate entities, their specification of mass and count properties, and the division of labor between nominal meanings and adjectival meanings in different languages. On-going research in formal semantics aims to give precise shape to our understanding of the connections between categorical

identity of words and their contribution to sentential meaning. At the same time, these developments are reshaping formal semantics itself, including its relationships with research in language typology, historical linguistics, philosophy of language and psycholinguistics.

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