1 Introduction

> 'You've hit the nail on the head my boy,' the devil replied. 'The thing that makes numbers so devilish is precisely that they *are* simple.'
>
> Hans Magnus Enzenberger, *The Number Devil*

1.1 INTRODUCTION

This book is about the semantic interpretation of numerical expressions, and in particular of cardinal numericals. Cardinal numericals are used in different ways. They denote numbers in counting sequences such as *one, two, three . . . ninety-nine*. They are used alone in answer to questions such as *How many N are there?*, they are used to make statements such as *Two and two are four* and they are used in complex linguistic expressions, such as *two cats, two kilos of flour, two glasses of wine* and so on. So it is not enough to talk about the meaning of cardinal numericals out of context – we need to examine the different ways in which these meanings are incorporated into language. This book investigates this topic. It focuses on two basic operations which make use of cardinal numbers, counting and measuring, and investigates how these operations are expressed grammatically.

Numbers are abstract objects used in counting and in mathematical operations. *Numerals* or *numericals* are the expressions denoting these objects. The word *two* and the symbol *2* both denote the same abstract object, as do the complex expressions 2^1, *1+1*, *4–2* and so on. I will use the term *numeral* or *numeral expression* to refer to any of the sample expressions in the previous sentence, and use *numerical* for numeral expressions phrased in words. So *two* and *2* are both numeral expressions, but only *two* is a numerical expression. *Two* is a cardinal numerical, but when the context does not require further elaboration, I will call it, and expressions like it, simply 'numericals'.

In addition to cardinal numericals, there are other semantically more complex numerical expressions which incorporate cardinal

numbers into their interpretation. These include the ordinals, such as *first, second, third*; expressions which are apparently equivalent to cardinals such as *dozen* and *score*; approximatives such as *hundreds, thousands, dozens* and *scores*; numerical adverbials such as *twice*, which means 'two times'; complex expressions such as *two-square* (2^2) or *two plus two*; fractions such as *one-half* and *one-third* (½ and ⅓); as well as decimal expressions such as *twenty-two point two* (22.2), and percentages, such as *twenty per cent* (20%). There are also 'quasi-numerical' expressions such as *double* and *triple* which mean 'multiply by 2'/'multiply by 3', *pair* and so on. Each of these different kinds of numerical expressions has its own syntactic and semantic properties. For the most part, I shall focus in this book on cardinal numericals, not because the others are unimportant or uninteresting, but because the whole topic of numericals is far too big a subject to be treated in one book. (Chapter 2 will, however, explore some complex numerical expressions – in particular, ordinals and approximatives.)

As already noted, numericals appear in different linguistic contexts. These contexts can be classified in terms of the kind of quantity operation they involve. So, in addition to counting sequences such as *one, two, three*, they can be used to express the result of counting, as in *I have two cats*, and in statements which express the result of measuring, such as *This bag of flour weighs two kilos*. They are used in mathematical statements where properties are ascribed to numbers, as in *Two plus two is four* or *Two is the only even prime number*. They are also used as labels, as in telephone numbers, numbers for bus lines and metro lines, identity numbers and so on, as in *Bus 4 will take you to the train station*. This last use, among others, is discussed at length in Wiese (2003). I shall be concerned in this book with the first three uses – counting and measuring and mathematical statements, and I shall argue that a grammar of numericals must distinguish between all three uses. For example, in (1), *two* is an argument and seems to be naming an abstract object. The sentence itself predicates a particular property of that object, that of being the smallest prime number.

(1) Two is the smallest prime number.

In (2), in contrast, *two* gives a property of certain pluralities of cats, namely those which are made up out of two individual cats, or consist of two atomic cats.

(2) I have two cats.

(3) illustrates numericals used with classifiers in measuring contexts. Intuitively, (3) contrasts with (2) because there are no two

individuable litres of orange juice which can be identified as the atomic parts out of which the whole is constructed.

(3) There are two litres of orange juice in this punch.

A central thesis of this book is that counting and measuring are two very different semantic operations, despite the fact that they both use numerical expressions. Counting is putting individual entities in one-to-one correspondence with the natural numbers and this involves individuating the entities which are to be counted, while measuring involves assigning to a body (plurality or substance) an overall value on a dimensional scale which is calibrated in certain units. *I have two cats* requires locating individual cats and assigning each one a number in order, while *There are two litres of orange juice in this punch* assigns a value *two litres* as the overall quantity of orange juice in the punch on the volume dimension, without identifying individual litre-units. A single measuring operation can easily give a number of different values, depending on the unit of measurement: *two litres of juice* or *two thousand millilitres of juice* or *sixty-seven-point-six US fluid ounces of juice* are all results of the same measure operation and they use the same dimensional scale, though in each case the unit of calibration is different. Distinguishing between counting and measuring is complicated by the existence of expressions which are ambiguous. While *two cats* clearly is a counting expression and *two litres of orange juice* involves measuring, *two glasses of juice* can denote a plurality of two glasses filled with juice or juice which is equal to that contained in two glasses. In the first case, illustrated in (4a), *two* is used in a counting operation which involves individuating glasses full of juice and counting them, while (4b) illustrates a measuring use, in which *glasses* is used as a unit term analogous to *litre*, and no individuation of parts of the juice is required.[1]

(4) a The waiter brought us two glasses of juice.
b The cook added two glasses of juice to the punch.

A lot of this book will be devoted to exploring the linguistic differences between counting and measuring. While they have always been distinguished, most linguists have tended to try and reduce one to the other. Commonly, it has been assumed that measuring can be reduced to counting, since measuring can be analysed as imposing a unit structure on some stuff and then counting the number of units involved. Thus Gil (2013) in the *World Atlas of Language Structures*

[1] In fact there are more than these two uses, as we will discuss in Chapter 8.

Online (ch. 55) says explicitly that expressions like ***glass*** *of N* and ***pound*** *of N* are often called 'mensural numeral classifiers', and that they 'provide nouns of low countability with a unit of measure by means of which they may then be counted', while Lyons (1977) suggests that 'a mensural classifier is one which individuates in terms of quantity' (p. 463). Less common has been the attempt to analyse counting as a form of measuring. In this approach, the natural units of individuation replace the explicit units mentioned in measure expressions. The most explicit account of this is Krifka (1989, 1995), who analyses *four cows* as denoting a sum of cows whose value is four on a scale calibrated in terms of natural units.

The position I shall argue for in this book is that in a significant number of languages, from different typological families, counting cannot be reduced to measuring, nor can measuring be reduced to counting. Counting and measuring are two different operations, expressed, usually, through different syntactic structures, and numericals are interpreted differently in each case. The examples in (4) play a crucial role in constructing this argument, since we will see that in a number of languages, the two different interpretations of these classifier constructions are associated with two different syntactic structures. In the counting examples like (4a), the numerical is adjectival, giving a property of the plurality in the denotation of the plural N; while in measuring contexts like (4b), the numerical combines with the measure unit to form a complex predicate. I shall suggest that the measure/counting contrast is fundamental in language, and that we can use it to throw new light on the contrast between mass nouns and count nouns. Specifically, I shall argue that, independent of any particular theory of mass and count nouns, the following generalization holds: mass nouns denote entities which can be measured, while count nouns denote sums of individuals which can be counted. In fact, I shall suggest, this may well be at the root of the mass/count distinction. This generalization will allow us to solve a number of puzzles about the mass/count contrast, and, in particular, the question of what makes nouns like *furniture, literature* and *rice* mass when they so obviously denote stuff which comes in individuable units. It will also give insight into the parallels and contrasts between so-called 'mass/count languages' like English and 'classifier languages' like Mandarin Chinese.

This book has a number of goals. It aims to review some of the major more recent linguistic results in the semantics of numericals, in counting and measuring and in theories of the mass/count distinction. But I also want to report on some of my own work on the topic, and on

the research of some of the people I have collaborated with. I will not try to hide my own views on, for example, the semantic properties of numericals, or on the basis of the mass/count contrast. I have used my own theory of the mass/count distinction to work out semantic interpretations (since they must be worked out in some particular theory). However, I have tried to keep a lot of the discussion in theory-neutral terms, and many of the results about numericals, counting and measuring are independent of my theory of mass/count. The main goal of the book is to draw attention to the contrast between counting and measuring, and to argue that it needs to be central to any attempt to understand the use of numerical expressions, classifiers and count nouns in different languages.

The book draws heavily on crosslinguistic research, but I do not pretend to give a crosslinguistic survey of numerical phenomena or of counting and measuring expressions crosslinguistically. Instead, I present, in depth, studies of counting and measuring in a number of typologically unrelated languages. Much (though not all) of the crosslinguistic data come from research that I have been directly or indirectly involved in, and focuses on Arabic, Brazilian Portuguese, Dutch, English, French, Hungarian, Mandarin Chinese, Modern Hebrew, Russian and Yudja. This choice of languages is serendipitous: I discuss these particular languages because I had (in most cases) collaborators and students who were willing to work with me on these languages, and I had in all cases direct or indirect access to native informants. I thus had access to data which allowed a quite detailed exploration of counting and measuring crosslinguistically. I have been encouraged by the degree to which this research has yielded interesting results. In fact, one of the goals of the book is to show just how fruitful parallel crosslinguistic research into a single topic can be. What should come out clearly from this book is that the count-measure contrast is expressed in languages from different language families in different ways, depending on the morphosyntactic properties of the particular language, but that, beyond the differences, there are some fundamental structural commonalities at both syntactic and semantic levels. My hope is that this book will encourage the in-depth study of these phenomena in more and more languages, and that our general understanding of the semantics of numericals, counting and measuring will increase and be enriched. This hope is reflected in the suggestions for further research at the end of each chapter, which frequently encourage readers to explore the syntax and semantics of specific constructions in any language that they have access to.

I want to stress that the morphosyntactic devices described in this book that are used to mark contrasts between counting and measuring, mass and count nouns, individuated and non-individuated sets in the languages under discussion are in no way presumed to be exhaustive, and I have specifically tried to make generalizations in terms of patterns and not parameterization. I make no claims about universals, and my aim is to describe both the commonalities and the variation in an (I hope) balanced way.

The book is intended for a wide readership and not only for people with a strong background in formal semantics. This reflects my belief that understanding how numbers are used semantically is an essential part of understanding language and languages, and my conviction that these issues should be understood by as wide a range of linguists as possible. I have tried to keep semantic formulae to a minimum, and I have kept my model extensional, so that the formulae will be as straightforward and readable as possible. I have explained the meaning of the formulae used in English, so that the arguments will be accessible to people with no training in formal semantics at all. These readers are invited to skip the derivations if they look too scary. However, for those who do want to understand how the compositional interpretation takes place, and to see how parallel compositional processes occur crosslinguistically on the basis of different syntactic structures, the derivations should not be skipped. The kind of introduction found in any introductory semantics textbook is necessary to follow the derivations, but should also be sufficient. Those with a stronger background in formal semantics who want to add intensionality (where relevant) are invited to do so.

There are many topics which this book does not discuss. Central among them is the syntax and semantics of comparatives in the adjectival domain, as in *Jan is taller/older/cleverer than Kim*. Comparatives like these obviously involve comparison of measurements and as such are directly related to the topic of the book. However, adjectival comparatives constitute a huge topic and there was no way I could discuss them; so I have restricted myself strictly to measurement in the nominal domain. Other topics that I say little or nothing about include the derivational morphology of number systems, number as a morphological feature, the semantics of plurality, and crosslinguistic variation in the way in which singularity vs non-singularity is expressed. In contrast to adjectival comparative constructions, these issues do all interact directly with numerical expressions in the nominal domain, and at various points I do make reference to these issues, and direct the reader to selected relevant

literature. I also (with regret) do not discuss the fascinating topic of number systems and of the various ways that different languages and cultures construct number systems.

1.2 OVERVIEW OF THE BOOK

The book is divided conceptually into three parts. Chapters 2 and 3 look at the semantics of numericals, and numericals in counting and measuring contexts. Chapters 4 to 7 focus on the mass/count distinction and its connection to counting and measuring. Chapters 8, 9 and 10 discuss classifiers and measure heads in counting and measuring contexts. Chapter 11 offers a brief conclusion. Chapter by chapter, we proceed as follows. Chapter 2 presents a semantic theory of cardinals, and thus provides a framework for the rest of the book. I adopt the traditional view that simple numericals are ambiguous between names of abstract entities (as in *Two is a prime number*) and predicates of pluralities (as in *two cats*). I work this out in a theory of predication based on Chierchia (1984) and Chierchia & Turner (1988). Chapter 3 presents evidence that counting and measuring are two different operations, drawing on data from a number of languages including English, Modern Hebrew, Hungarian and Mandarin Chinese. We show that, in these languages, in counting expressions such as *three cats* and *three glasses of water* (on its counting reading), numericals are interpreted as nominal modifiers, while in *three kilos of flour* and *three glasses of water* (on its measure reading), numericals denote abstract entities and are of the same type as numericals used in arithmetical expressions. Chapters 4 and 5 are devoted to a discussion of numericals and the mass/count distinction. Chapter 4 reviews semantic accounts of the mass/count distinction, including Link (1983), Gillon (1992), Chierchia (1998a), Chierchia (2010), Krifka (1989, 1995), Rothstein (2010) and Landman (2011a, 2016). We see that the contrast between mass and count nouns cannot be reduced to an ontological distinction between 'stuff' and 'individuals', nor can it be reduced to vagueness, or a distinction between expressions denoting sets of stable atoms and those denoting sets of non-stable atoms. We propose instead that countability is a grammatical property, and that the mass/count distinction reflects the distinction between nouns which lexically encode countability and those which don't. Chapter 5 discusses in depth the problem posed by *furniture* nouns which are crucial in any analysis of the mass/count contrast. These so-called 'object mass nouns' have the syntax of mass nouns, but denote sets of individuable

atomic entities, as was shown experimentally in Barner & Snedeker (2005). We show, using crosslinguistic data, that object mass nouns support the hypothesis that mass morphosyntax is associated with measuring, while count morphosyntax is associated with counting. Chapter 6 is the heart of the crosslinguistic discussion, and explores how the mass/count and the measuring/counting contrast are related to each other crosslinguistically, especially in classifier languages. Chapter 7 is really a very long footnote on the much-vexed question of the Universal Grinder, and is included for completeness. Chapter 8 looks at classifiers, in languages like English, and at the contrast between English noun classifiers and Mandarin functional heads. Chapter 9 discusses measures. Chapter 10 examines the contrast between measure predicates in pseudopartitives, such as *two inches of wire*, and measure expressions as attributive modifiers, such as *two-inch wire*. In Chapter 11, I allow myself to muse briefly on what I think the extended study may have shown and to draw the reader's attention to what I take to be the next big questions. Each chapter (except for this one) ends with some questions and suggestions for further research. These are intended for the most part either to encourage crosslinguistic comparisons or to draw the reader's attention to interesting questions and issues which I have not had time to discuss in this book. Most of the questions will probably take a Ph.D. thesis to explore properly.