# Take 'five'

## The meaning and use of a number word

Bart Geurts

University of Nijmegen

*Chocolate is its own reward.*
Jeffrey Steingarten

### Abstract

It is somewhat of an embarrassment to semantics and pragmatics alike that there is no consensus on the meaning of number words like *five*. According to the orthodox neo-Gricean view, *five* in fact means 'five or more'. According to the naïve view, which in recent years has begun to regain ground, *five* simply means 'five'. All things considered, the naïve view seems to be the most promising, but still the orthodox neo-Gricean position has its merits as well.

Like so many discussions about issues involving conversational implicature, the debate about number words suffers from a methodological problem. It is that observations about the interpretation of sentences are used for pinpointing lexical meanings without an explicit framework for dealing with the combinatorics of meaning. It will be evident, however, that a great deal is going to depend on this. To illustrate this point, I adopt a type-shifting framework within which theories of number terms can be compared. Against this background, I argue for a version of the naïve view according to which the primary meaning of five is that of an 'exact' quantifier, from which an 'exact' predicate meaning and an 'at least' quantifier meaning are derivable by standard type-shifting rules.

## 1 Introduction

This paper is concerned with the meaning and use of the word 'five'. I trust that most of my observations, claims, and mistakes pertaining to this word will extend to the other numerals.

In the last few decades, considerable quantities of ink have been spilt on the semantics and pragmatics of number words. To explain what is at issue, consider the following examples:

(1) a. You must take five cards.
    b. You may take five cards.

In: Svetlana Vogeleer and Liliane Tasmowski (eds.), *Non-definiteness and plurality.* Benjamins, Amsterdam/Philadelphia. Pp. 311-329.

On the face of it, (1a) would appear to be ambiguous between an exact reading ('you must take five cards, and no more') and an 'at least' reading ('you must take at least five cards'), and similarly, (1b) seems to allow for an exact as well as an 'at most' construal ('you may take five cards, but neither more nor less' vs. 'you may take at most five cards'). The problem is how all these various readings are to be accounted for, and in particular, how the lexical meaning of 'five' contributes to the interpretation of sentences in which it occurs.

On the orthodox neo-Gricean view, the lexical meaning of 'five' is 'at least five', which, depending on the context, may be strengthened by way of a scalar implicature (Horn 1972, 1989, Levinson 2000, and many others). There are serious problems with this theory, which led even its inventor to abandon it after 20 years (Horn 1992), but it is still endorsed by Levinson (2000) and Winter (2001), among others. Other researchers have been more impressed with the evidence against the neo-Gricean account, and have generally adopted the common-sense view that 'five' means 'exactly five' (e.g. Horn 1992, Geurts 1998b, Breheny 2005). A somewhat special position is taken by Carston (1998), who maintains that the lexical meaning of number words is strictly neutral between the various construals distinguished above.

I believe that the debate about the meaning and use of numerals has been marred by two rather fundamental problems. First, arguments for or against this or that analysis of number words have usually been deployed in the absence of an explicit framework of compositional semantics. It is evident, however, that a great deal will hinge on this. To illustrate the extent of the problem, it is a well-worn observation in semantics (though not in pragmatics) that postulating an exact lexical meaning for 'five' does not necessarily imply that a sentence in which the numeral occurs will have an 'exactly five' interpretation (see Section 3 for further discussion of this point). Consequently, the observation that, for example, the *sentence* in (1a) is, in some cases at least, paraphraseable with 'at least five' does not entail that, on such occasions, the *word* 'five' has an 'at least' meaning. This conclusion may (or may not) be valid once it has been made explicit how the meaning of 'five' combines with that of 'cards', and so on; but without a theory of meaning composition it is just a leap of faith.

The second problem is one of presupposition failure. Most of the extant studies on numerals purport to inquire into *the* meaning of 'five' and its kin (Bultinck 2002 is an honourable exception). But surely it is a mistake to ask for the unique meaning of 'five', considering that this word is used in very different ways:

| | | |
|---|---|---|
| (2) | arithmetical : | Five is the fourth Fibonacci number. |
| | quantifying : | Five ducks entered the lobby. |
| | predicative : | These are five buckets. |
| | adjectival : | the five girls |
| | measure : | five pounds of buckwheat |
| | label : | Chanel number five |

Although it may be that the same lexical meaning of 'five' is involved in its predicative and adjectival uses, for example, it is most unlikely that a single lexical meaning can account for all the uses illustrated here. On the other hand, it is equally unlikely that the various uses of 'five' are entirely unrelated. In short, it would seem that, like the vast majority of lexical items, 'five' is polysemous, i.e. it has several related senses.

I don't claim that the observations in (2)*prove* 'five' to be polysemous. I wouldn't know how to prove so strong a proposition—be it for 'five' or for any other word. My claim is just that, if it is accepted that polysemy is prevalent, there is no reason why we should expect number words to be exceptional, and the data in (2) suggest that, indeed, they are not.

If 'five' has several senses, it may be that some of them are exact, while others are not. I will argue that this is not just a logical possibility, and that indeed 'five' has an exact meaning in some of its uses, whilst on other occasions it has an 'at least' meaning. In a way, this is to say that mine is a halfway house between the scalar and non-scalar accounts of number terms. However, my position is actually closer to the non-Gricean view, because, on the one hand, I will argue that the primary sense of 'five' is exact, while the 'at least' sense is merely derived, and on the other hand, pragmatic inferences will not play a central part in my story.

## 2 Type shifting and polysemy

The upshot of the foregoing observations is that, if we want to make an informed choice between alternative theories of 'five', we need a general framework of compositional semantics that allows us to formulate such theories without being biased towards one or the other. Furthermore, we need the conceptual wherewithal for accommodating polysemy: it must be possible to assign 'five' several senses and make explicit the semantic relations that hold them together. Such a framework is available and has been widely used in the past decades (the key reference is Partee 1986). In this section I will outline the main ideas.

Let us start by comparing the occurrences of the noun 'visitors' in the following sentences:

(3) a. Visitors complained about the poor service.
    b. They are visitors.

In (3a), the bare plural 'visitors' occurs in argument position, and therefore has existential force. The resulting reading may be represented as follows:

(4) $\exists x[\text{visitor}(x) \wedge \text{complain}(x)]$

This is to be read as stating that there is a group of complaining visitors. That is to say, the first-order variables in our semantic representations range over groups of individuals; individuals will be treated as singleton groups. Whereas in (3a) the bare plural acts as an existential quantifier, in (3b) it serves the function of a predicate, and the latter sentence is analysed simply as:

(5) visitor(they)

Hence, depending on the grammatical environment in which it occurs, the noun 'visitors' may be construed either as a predicate or a quantifier, but we wouldn't want to conclude from this that the noun is homonymous, for intuitively its two senses are related. This intuition can be given its due by adopting meaning transformations, or type-shifting rules, as they are usually called. To explain how such rules work, suppose that the primary sense of 'visitor' is predicative; more precisely, let it be the property of being a group of visitors, i.e. $\lambda x[\text{visitor}(x)]$. There is a type-shifting rule, which I will call 'Existential Closure', that maps this into a quantifier meaning, as follows:

*Existential Closure*
$\lambda x[\text{visitor}(x)] \rightsquigarrow \lambda P \exists x[\text{visitor}(x) \wedge P(x)]$

The quantifier $\lambda P \exists x[\text{visitor}(x) \wedge P(x)]$ combines with a predicate to form a proposition. For example, if it is combined with the predicate $\lambda x[\text{complain}(x)]$, the result is (4).

Adopting Existential Closure, we can say that 'visitors' is polysemous between a predicative and a quantifier sense, and that the latter is derived from the former. However, from a logical point of view, we may just as well start with the quantifier sense, and adopt a type-shifting rule that transforms quantifiers into predicates, as follows:

*Quantifier Lowering*
$\lambda P \exists x[\text{visitor}(x) \wedge P(x)] \rightsquigarrow \lambda x[\text{visitor}(x)]$

Assuming Quantifier Lowering, one could claim that the quantifier sense of 'visitors' is primary, while the predicate sense is derived.

Note that in this example, applying Quantifier Lowering and Existential Closure consecutively, in either order, yields an output that is identical to the initial input. However, while Quantifier Lowering always 'undoes' the effect of Existential Closure, the converse is not generally true: if we apply Quantifier Lowering to a quantifier Q so as to obtain a predicate P, and then apply Existential Closure to P, the result may but need not be Q.

Existential Closure and Quantifier Lowering were among the type-shifting rules studied by Partee (1986), and I will follow her in assuming that both rules are available in natural language. That is to say, I will suppose without argument that Existential Closure and Quantifier Lowering are equally well motivated on independent grounds, and that it speaks neither for nor against a theory of number words (say) if it employs one rather than the other, or both.

There are various views on the status of type-shifting rules, which may but need not exclude each other. They may be seen as operators associated with (possibly covert) lexical elements, as generative rules to be applied freely at any point in the semantic derivation, or only if a type mismatch occurs. Another view, hinted at already, is that type-shifting rules underwrite certain kinds of polysemy. By definition, an expression is polysemous if it has several related senses, where the relation in question may be represented by means of some function or other. One familiar example is that many nouns have count as well mass senses; cases in point are 'chicken', 'beer', 'apple', and so on. Usually, one sense is primary while the other is derived. In the case of 'apple', it is presumably the count sense that is primary, while the mass sense is derived, and the connection between the two is some sort of deindividuating function: apple (mass sense) is obtained, for instance, by mashing one or more apples (count sense). With 'beer', the mass sense is primary, and a count sense (as in 'two beers') is derivable by means of a portioning function.

Viewing type-shifting rules as being on a par with the mashing and portioning functions that underwrite the mass/count polysemy, one can say that the distinction between the predicative and quantifier senses of 'visitors' parallels that between the count and mass senses of 'apple'. It is just that in the former case the relation between the two senses is more abstract than in the latter; but since the meanings involved are more abstract, too, one could hardly expect otherwise.

One last remark before we start doing business. I assume as a matter of course that polysemy is not confined to lexical items; phrases can be, and usually are, polysemous, too. The reason why I note this is that in the following discussion I will be going back and forth between number words, like ‘five’, and number phrases, like ‘five cows’. I hope this will not be objectionable, and that it will help to make the discussion easier to follow.

## 3 Theories in four flavours

With these preliminaries out of the way, let us proceed to formulate some theories of ‘five’, confining our attention to what are arguably the main senses of the word, and beginning with a theory that is perhaps the closest to the orthodox neo-Gricean view, the staunchest defender of which is Levinson (2000); I will call it the ‘Vanilla Theory’. On this account, ‘five’ has a single predicative sense and a single quantifier sense, both of which are ‘at least’ meanings. That is to say, the predicative sense of ‘five cows’ is $\lambda x[\#x \geq 5 \wedge cow(x)]$ and the quantifier sense is $\lambda P\exists x[\#x \geq 5 \wedge cow(x) \wedge P(x)]$. ‘#’ counts the indivuals in a group, so $\lambda x[\#x \geq 5 \wedge cow(x)]$ is a predicate that holds of a group iff it consists of five or more cows. $\lambda P\exists x[\#x \geq 5 \wedge cow(x) \wedge P(x)]$ is a predicate of predicates: (6b) is analysed as stating that the quantifier denoted by ‘five cows’ holds of the predicate ‘mooed’, which is the case iff five or more cows mooed. Hence the sentence meanings of (6a) and (6b) come out as follows:

(6) a. These are five cows.
$\#these \geq 5 \wedge cow(these)$
b. Five cows mooed.
$\exists x[\#x \geq 5 \wedge cow(x) \wedge moo(x)]$

According to the Vanilla Theory, (6a) means that the gathering pointed at consists of cows and contains five or more individuals, and (6b) is construed as saying that there was a group of five or more mooing cows. These meanings will usually be complemented by (scalar) conversational implicatures. For (6a) the implicature will be that the group in question doesn’t contain more than five cows, and (6b) will generally implicate that the number of mooing cows didn’t exceed five. Thus, by default ‘at least’ meanings are pragmatically strengthened so as to yield ‘exact’ interpretations.

Assuming that ‘five cows’ is polysemous between $\lambda P\exists x[\#x \geq 5 \wedge cow(x) \wedge P(x)]$ and $\lambda x[\#x \geq 5 \wedge cow(x)]$, which of these senses comes first and which is derived? It doesn’t matter: we can start with the predicative sense and derive the quantifier sense by way of Existential Closure, or we can start with the quantifier sense and derive the predicative sense with Quantifier Lowering. The resulting pair of senses will be the same in either case.

So much for the Vanilla Theory. Things become more interesting with the Strawberry Theory, which has it that the primary sense of ‘five cows’ is an exact predicative meaning: $\lambda x[\#x = 5 \wedge cow(x)]$. The quantifier sense is then derived by means of Existential Closure, which, somewhat surprisingly perhaps, yields an ‘at least’ meaning, namely $\lambda P\exists x[\#x = 5 \wedge cow(x) \wedge P(x)]$. (This may look like an exact meaning, but it isn’t, as we will presently see.)

(7) a. These are five cows.
$\#these = 5 \wedge cow(these)$

b. Five cows mooed.
$\exists x[\#x = 5 \wedge cow(x) \wedge moo(x)]$

According to the Strawberry Theory, (7a) states that the number of indicated cows equals five, while (7b) merely says that the number of mooing cows was five or more; for the fact that there was a group of five mooing cows does not rule out the possibility that there was a larger group of mooing cows, so on the reading assigned to it by the Strawberry Theory, (7b) is true iff five or more cows mooed. Like the Vanilla Theory, the Strawberry account theory appeals to scalar implicature for deriving the exact construal of (7b), but the meaning of (7a) is exact from the start. The Strawberry Theory was first adumbrated, I believe, by Partee (1986).

The third candidate to be considered is the Chocolate Theory, which will be our favourite. It starts with an exact quantifier sense, assigning 'five cows' the quantifier $\lambda P \exists! x[\#x = 5 \wedge cow(x) \wedge P(x)]$, which holds of a predicate iff the predicate holds of one and only one group of five cows. From this, Quantifier Lowering derives an exact predicate sense, which in its turn gives rise to an 'at least' quantifier sense, courtesy of Existential Closure. So the senses associated with 'five' are the same as in the Strawberry Theory plus an exact quantifier sense, which produces the following reading for (8):

(8) Five cows mooed.
$\exists! x[\#x = 5 \wedge cow(x) \wedge moo(x)]$

('$\exists! x$' means that there is just a single x such that . . . ) Had there been more than five mooing cows, there would have been more than one group of five mooing cows, so if there is just a single group of mooing cows, as this interpretation has it, the number of mooing cows must have been five, no more and no less.

The Caramel Theory, which is the last on my list, is a reduced version of the Chocolate Theory—reduced in the sense that we now suppose that, for some reason or other, the Existential Closure rule is not available. So we start with the same exact quantifier meaning as in the Chocolate Theory, derive an exact predicate meaning, and in default of Existential Closure that is the end of the story. Of all the theories under consideration here, the Caramel Theory is the one that is closest to the New Orthodox View on number terms.

The following table sums up the main features of our four theories. Exact meanings are represented by the identity sign, 'at least' meanings by '≥'. Primary senses are encircled (recall that for the Vanilla Theory it doesn't matter which sense is primary).

| | *predicate sense* | *quantifier sense(s)* |
|---|---|---|
| *Vanilla* | ≥ | ≥ |
| *Strawberry* | (=) | ≥ |
| *Caramel* | = | (=) |
| *Chocolate* | = | (=), ≥ |

Other theories are possible, of course. In particular, one might wish to try flavours that take 'at most' senses as primary. It turns out, however, that none of the more obvious ways of implementing this possibility are particularly promising: if we start with an 'at most' quantifier sense, the predicate sense derived by Quantifier Lowering is clearly wrong, and beginning with an 'at most' predicate sense will result in a quantifier meaning that is semantically empty.

It would seem, therefore, that the type-shifting framework we have adopted is biased against 'at most' meanings. However, I am not worried by this, because, as I will argue in §4.5, 'at most' construals are always pragmatically derived, anyway; there are no lexical 'at most' meanings for number words.

Given that predicate meanings and quantifier meanings are very different entities, it isn't entirely obvious that labels like 'exact sense' and 'at least sense' have a constant meaning in all cases. I will not attempt here to give precise definitions of these labels, but there is one critical property that separates them from each other. It is that 'at least' meanings form sets that are ordered by entailment, while exact meanings don't. A predicate sense is a property of groups, and if it is an 'at least' sense, any group falling under 'five' will fall under 'four', 'three', ..., as well: a group of at least five cows perforce is a group of at least four, three, ... cows. With quantifier senses it is the same. When used as an 'at least' quantifier, 'five cows' is a predicate that applies to a property iff there is a group of at least five cows that have the property. If mooing is such a property, then obviously the quantifiers denoted by 'four cows', 'three cows', ... apply to it, as well. So, the 'at least' quantifier senses of the numerals line up in an entailment scale just as their 'at least' predicate senses do.

Exact senses are different. If 'five' has an exact predicate meaning, i.e. $\lambda x[\#x = 5]$, then no group to which this predicate applies will fall under any other number predicate. Still, the exact sense of 'five' is implicative in another way: if a group has the property $\lambda x[\#x = 5]$, then it will have sub-groups of which the properties $\lambda x[\#x = 4]$, $\lambda x[\#x = 3]$, ... hold. This yields a rank ordering of sorts, but it is not an entailment ordering. The same holds, mutatis mutandis, for exact quantifier meanings.

Before we go on to compare the theories we have defined, it bears emphasising that, at least as far as I can see, there are no methodological grounds for preferring either one of them to any of the others. Each of our theories stipulates just a single lexical meaning for 'five'; any further senses are always derived by rules that are motivated on independent grounds. So the fact that the Chocolate Theory produces three senses, while the others have only two, may not be held against it. Whatever one might think of Grice's (1989) maxim that senses are not to be multiplied beyond necessity (and I am admittedly sceptical; see Geurts 1998b), it simply doesn't apply here.

One last caveat: my use of the labels 'exact' and 'at least' for the purpose of characterising meanings of number words is intended to be non-committal with respect to the semantics of the *words* 'exact' and 'at least'. If a theory assigns 'five' an exact quantifier meaning, it is not committed to the view that 'five' is synonymous with 'exactly five', in any of its senses; and the same for 'at least' meanings. In this section we have defined to some degree of precision what 'five' means in a range of theories; nothing has been said about the meanings of expressions like 'exactly five' or 'at least five', and as we will see below (§4.2), the semantics of such expressions is not cut and dried by any means.

## 4 Not just a matter of taste

In the remainder of this paper, we will compare our four theories on a number of counts. As I have intimated already, the Chocolate Theory is our destined winner; runners-up will be the Caramel and Strawberry Theories; the Vanilla

Theory is to be withdrawn from the contest at the beginning of the third round. So the final score will be as follows:

1. Chocolate
2. Caramel, Strawberry
3. Vanilla

Readers who already at this point are satisfied with this outcome may wish to skip to the references section.

### 4.1 Entailment patterns

Consider the following arguments:

(9) a. Barney wrote five papers.
These are the papers he wrote.
———
So: These are five papers.

b. These are five papers.
They are the papers Barney wrote.
———
So: Barney wrote five papers.

Intuitively speaking, both arguments are valid, and it would seem that both involve essentially the same kind of reasoning. However, according to the Strawberry Theory, only (9b) is correct by virtue of its logical form; (9a) only goes through on the assumption that the first conjunct of the premiss is construed as implicating that Barney didn't write more than five papers. Put otherwise, the Strawberry Theory predicts that, whereas (9b) is (logically) valid, it depends on the context whether (9a) is correct or not. I take it that this discrepancy is counterintuitive.

On the remaining accounts, both arguments are valid, but the theories secure their validity in different ways. For the Caramel and Chocolate Theories, the arguments are valid because all occurrences of 'five' in (9) demand or at least prefer exact readings. For the Vanilla Theory, the arguments are valid because all occurrences of 'five' in (9) have 'at least' readings—which is intuively wrong, and as we will see in a moment this intuition is supported by good arguments. First brownie points for the Caramel and Chocolate Theories.

The Vanilla Theory is the only one to support the validity of (10), which doesn't argue in its favour:

(10) These are five cows.
———
So: These are four cows.

On the other hand, the Caramel Theory is the only one *not* to support the validity of (11), which prima facie speaks for it and against its competitors:

(11) Five cows mooed.
———
So: Four cows mooed.

However, on reflection it is less than certain that (11) is not valid, come what may. If there were five mooing cows, one might argue, then it must also be true that there were four mooing cows. While there is no way of construing the number words so as to make (10) come out valid, it is at least arguable that (11) is valid in some sense. Be this as it may, it should be noted that only the

Vanilla and Strawberry theories are committed to the view that (11) is valid *tout court*. For the Chocolate Theory, the number words can be interpreted in such a way that the argument comes out valid, but it is not the preferred way, for the principal senses of 'five' and 'four' are exact. It seems to me that this view is reasonable enough.

## 4.2 Redundancy arguments

Several authors have argued that semantical considerations regarding modifiers such as 'at least', 'at most', and 'exactly' may be used to arbitrate between competing analyses of number words (e.g. Koenig 1991, Carston 1998, Geurts 1998b). The argument goes as follows. Consider how complex expressions like 'at least five', 'at most five', and 'exactly five' are interpreted. If 'five' has an exact meaning, then the modifier in 'exactly five' is semantically empty, for then 'five' is synonymous with 'exactly five'. Furthermore, if 'five' is exact, the modifier in 'at least five' selects (speaking loosely) the interval starting with 5 and going upwards, while 'at most' selects the interval starting with 5 and going downwards. So, on the assumption that 'five' has an exact meaning, the semantic contributions of 'at least' and 'at most' are mirror images, as one should expect. By contrast, if 'five' has an 'at least' meaning, 'exactly five' is not redundant, but 'at least five' is, the modifier being semantically empty, and therefore very different from what would seem to be its dual, i.e. 'at most'. In brief, we will have to choose between claiming either that 'at least' and 'at most' mirror each other and 'exactly' is semantically empty, or that 'at least' is semantically empty while 'at most' and 'exactly' resemble each other more than either of them resembles 'at least'. Since the first horn of the dilemma is clearly the more attractive one, we are entitled to conclude that 'five' has an exact meaning.

This argument is flawed. To begin with, as a matter of empirical fact, 'at least' and its kin take as arguments expressions with 'at least' meanings, as witness, 'at least warm', 'more than happy', and so on. Secondly, theories developed by Krifka (1999) and Geurts and Nouwen (2005) prove that it is possible to analyse 'at least' and 'at most' in such a way that they are mirror images and apply to scalar and non-scalar arguments alike. Thirdly, on the account I proposed with Rick Nouwen, 'at least five' and 'five' are not synonyms, even if 'five' has an 'at least' meaning. We argue that superlative modifiers like 'at least' and 'at most' have modal meanings, and that a sentence like (12) conveys two things: that the speaker is *certain* that five cows mooed, and that he considers it *possible* that more than five cows mooed.

(12) At least five cows mooed.

(Note, incidentally, that if the modal analysis of 'at least' and 'at most' is on the right track, it is a mistake to assume, as it is standardly done, that these modifiers are the linguistic counterparts to '$\geq$' and '$\leq$', respectively, and that it is misleading to speak of 'at least' and 'at most' senses of number words. Cf. also Bultinck 2002: 229-231). It is not the purpose of this paper to defend the modal analysis of 'at least' and 'at most'. The relevant point for now is just that theories such as Krifka's and Geurts and Nouwen's appear to be feasible, which is enough to discredit the redundancy argument.

But even if the argument is flawed, part of it can be saved, as follows. If 'exactly' accepted arguments with 'at least' meanings, expressions like 'exactly warm' and 'exactly happy' should be possible—which they are not. As it turns out, 'exactly' doesn't *make* its argument exact; the argument has to have an exact construal, to begin with: compare 'exactly five cows' or 'exactly half of the dough' with '*exactly warm', '*exactly some cows', etc. These observations argue against the Vanilla Theory and in favour of the Caramel and Chocolate Theories. It depends whether they confirm or disconfirm the Strawberry Theory. If the argument of 'exactly' is always predicative, they confirm the theory; if it may be a quantifier, they disconfirm it. Since, prima facie at least, the *-ness of expressions like 'exactly every cow' suggests that 'exactly' does not combine with quantifiers, we will be generous and award the Strawberry Theory a point, too.

If 'exactly' is semantically empty, as I maintain, then its purpose must be to reduce pragmatic slack, in much the same way as adjectives like 'real' and 'genuine' do (Geurts 1998b, Lasersohn 1999). A 'real flower' is just a flower and a 'real elephant' is just an elephant; the adjective doesn't add anything to the semantic content of the noun—which is not to say that it is redundant, for it blocks the kind of pragmatic modulation we observe in 'plastic flower' or 'marble elephant':

(13) a. ?These are real flowers and they are plastic.
b. ?The terrace was surrounded by real elephants, made of pink marble.

'Exactly' works the same way, more or less.

### 4.3 Predicates vs. quantifiers

As observed by Partee (1986), whereas number terms allow for 'at least' interpretations when used as quantifiers, in their predicative uses they are always exact. The following examples illustrate the contrast:

(14) a. Fred took five pills—in fact, he took six.
b. ?These are five pills—in fact, there are six of them.

While the Strawberry and Chocolate Theories account for this contrast, the Vanilla Theory does not (the Caramel Theory will be taken up two paragraphs down). I consider this to be strong evidence against the latter, and it is reinforced by the observation that the 'at least' use of number terms is exceptional in two ways. First, it seems clear that cases like (14a) are quite rare. Secondly, if we consider again the variety of possible uses of number terms illustrated in (2), it would seem that, among these, only the quantifier and measure uses give rise to 'at least' interpretations (for pertinent observations, see Sadock 1984, Horn 1992, Bultinck 2002). The main tenet of Vanilla Theory is that 'at least' interpretations are basic, which apparently is not the case. It will be evident by now that this theory is not viable, and I will consider it no further.

An anonymous reviewer suggests that there may be contexts in which one could truly and felicitously state (15), even while referring to a collection of more than five cows:

(15) These are five cows.

Suppose that our interlocutors need five cows for some rural purpose or other. After some searching, they come across an entire herd of cows. Pointing at the herd, might one of the rustics use (15) to make a true and felicitous statement?

I very much doubt it. Or try the following. Point at Da Vinci's *Last Supper*, and say: 'These are five apostles.' Doesn't work, does it?

The Strawberry and Chocolate Theories explain the contrast between (15a) and (15b) by providing an exact predicate sense and an 'at least' quantifier sense. It may be argued that the Chocolate Theory has an edge over the Strawberry Theory, because it captures the observation we just made that cases like (15a) are somewhat unusual: if the dominant quantifier sense of 'five' is exact and its 'at least' sense is recessive, as the Chocolate Theory has it, this is as expected.

At first sight, it would appear that the Caramel Theory fails to explain these data, too, but we shouldn't dismiss it too soon. The 'in fact' construction is standardly used for establishing if a given expression admits of a scalar interpretation, but other constructions have been used for the same purpose (Horn 1989, Matsumoto 1997):

(16) a. The weather is warm, if not hot.
  b. Fred took five pills, if not six.
  c. These are five pills, if not six.

The 'if not' test only partly confirms our initial results. It corroborates that, when used as a quantifier, 'five' has a scalar meaning, but it also suggests that the same holds for the predicative use of 'five': (16c) would be felicitous in a context in which the speaker is making a bet about the content of a closed box, for example. So what, if anything, do these tests prove?

As shown in some detail by Matsumoto (1997), the various tests for diagnosing scalarity are not equipollent; they test for different things. To illustrate, rank-order terms like 'major' and 'lieutenant colonel' test positive on one diagnostic and negative on the other:

(17) a. She is a major, if not a lieutenant colonel.
  b. ?She is a major—in fact, she is a lieutenant colonel.

Being a lieutenant colonel does not entail being a major; on the contrary: having either rank entails not having the other. Nevertheless, 'lieutenant colonel' and 'major' co-inhabit a scale of sorts: the former is higher than the latter; and this is good enough, apparently, for passing the 'if not' test.

That the 'in fact' diagnostic tests for entailment, and not just for any kind of precedence ordering, is corroborated by Matsumoto's observation that examples like the following are fine:

(18) We bought a dog—in fact, a German shepherd.

If it isn't a priori obvious that being hot entails being warm, there can be no doubt that being a German shepherd entails being a dog; the 'in fact' test confirms this.

The upshot of the foregoing argument is that the contrast exhibited in (14) is the crucial datum. To explain this contrast, we need a theory that predicts that numerals line up in entailment scales when used as quantifiers but not when used predicatively. The Strawberry and Chocolate Theories meet this requirement; the Vanilla and Caramel Theories don't.

## 4.4 Experimental evidence

In recent years, experimental studies have yielded a wealth of data on how scalar expressions are processed and acquired, and some of these results, especially the ones reported by Papafragou and Musolino (2003) and Musolino (2004), are germane to the issues under discussion here.

In an experiment conducted by Papafragou and Musolino (2003), Greek-speaking 5-year olds and adults were invited to evaluate sentences like the following in situations that rendered them under-informative (the scenarios are indicated here in square brackets). More accurately, each of the sentences might be construed, in principle, as being true in the relevant scenario.

(19) a. Some of the horses jumped over the fence. [All of them did.]
b. The girl started making the puzzle. [She finished it, too.]
c. Two of the horses jumped over the fence. [Three of them did.]

Adult speakers, Papafragou and Musolino found, almost always reject all of these sentences, the average rate of acceptance being 5%. Children, by contrast, accepted statements like (19a) and (19b) in the majority of cases (mean acceptance rates were 87.5% and 90%, respectively), while accepting statements like (19c) only 35% of the time. Other experiments by Papafragou and Musolino (2003) and Musolino (2004) confirm these results. (Is it defensible to assume, as Papafragou and Musolino do, that 'start' and 'finish' are scalar expressions? Frankly, I have no strong feelings one way or the other, but for our purposes it doesn't matter, anyway.)

Note that in the materials used in this experiment, numerals are construed as quantifiers, and the same holds for the other experiments reported by Papafragou and Musolino. What these data show, then, is that young children clearly differentiate between scalar expressions and quantifying number words, and most importantly that for children numerals and scalar quantifiers like 'some' are not at all alike. This is bad news for the Strawberry Theory, which maintains that, when used as quantifiers, numerals are scalar expressions. It is good news for the Caramel Theory, which holds that numerals can never be construed as scalars, as well as for the Chocolate Theory, which grants numerals a scalar interpretation, but also claims that their preferred interpretation is exact.

At this juncture, advocates of the Strawberry Theory are bound to object that the acquisition data merely confirm what should have been clear from the beginning, namely that in the math-literate cultures in which Papafragou and Musolino conducted their experiments, number words are used very differently from (other) scalar terms. It is more than likely, for example, that the great majority of children that participated in these experiments knew how to count. Levinson discusses this point at some length, and ends up suggesting that '... all implicatures are potentially subject to a process of conventionalization and the number words may be under pressure to lexicalize the 'exactly' reading ...' (Levinson 2000: 89-90) If I understand Levinson correctly, this is not to say that number words have exact lexical meanings, but rather that they have 'at least' meanings which are complemented by 'generalised conversational implicatures'. However, as I have argued elsewhere (Geurts 1998b, cf. also Carston 2004), despite Levinson's hefty contribution on the subject, it is not at all clear what generalised conversational implicatures *are*, and most to the point, it isn't clear how they are to be distinguished from good old-fashioned meanings. Pending further clarification of the concept of generalised conversational implicature, it very much looks as if the Strawberry Theory can only be saved by introducing exact meanings under a different name.

There is another way for the Strawberry Theorist to respond to Papafragou and Musolino's experimental results, namely by pointing out that, even if their results show that, for whatever reason, children differentiate between scalar expressions and number words, adult participants do not. According to Papafragou and Musolino's data, grown-ups equally often accept statements with 'some' and corresponding statements with numerals, in situations in which they are pragmatically infelicitous—that is to say, both types of sentence are almost always rejected. However, it should be noted that the patterns of adult responses in Papafragou and Musolino's experiments were exceptionally dichotomous in comparision to similar experiments reported elsewhere. For example, one of Noveck's (2001) findings was that adults accept statements like (20) in only 41% of the cases, and other studies have yielded similar results.

(20) Some giraffes have long necks.

Unfortunately, as far as I know, there have been no experimental studies aimed expressly at comparing how adults deal with number words vs. scalar quantifiers like 'some', though preliminary results obtained by Pouscoulous (forthcoming) suggest rather strongly that Papafragou and Musolino's acquisition data are mirrored in adult behaviour.

## 4.5 'At least' vs. 'at most' readings

It has been claimed by Carston (1998), among others, that in addition to an exact and an 'at least' interpretation, number words also have an 'at most' interpretation, which is on a par with the others. Some of Carston's examples are:

(21) a. She can have 2000 calories without putting on weight.
  b. The council houses are big enough for families with three kids.
  c. You may attend six courses.

The most plausible interpretation of (21a) is that the person in question can have *at most* 2000 calories without putting on weight, and the other sentences, too, are paraphreasable with 'at most'. Carston takes this to imply that number words may give rise to 'at most' interpretations, which have the same status as exact and 'at least' interpretations, and she proposes to derive all of these construals from a single lexical meaning which 'is neutral among the three interpretations' (Carston 1998: 208). Carston likens the meaning of 'five' to the semantics of genitive endings. Just as 'Fred's cow' may refer to any cow that stands in a contextually salient relation to Fred (it may be a cow that Fred owns or one he saw, embraced, etc.), 'five' may be used to express various numerical concepts somehow related to the number five.

One problem with Carston's suggestion is that the range of possible construals that 'five' admits of is quite narrow in comparison to that of the genitive. Whilst the latter is indefinitely large, the possible construals of 'five' are not even a handful: 'exactly five', 'at least five', 'at most five', and perhaps 'approximately five'. It is fairly evident that 'five' cannot be used to express notions like 'three times five', 'any number but five', or 'ten' (which, after all, is definable as the smallest number divisible by, but not equal to, five). Hence, the interpretation of 'five' is much more constrained by its meaning than Carston allows for, and it would seem that building in suitable constraints into its lexical entry would come down to stipulating multiple senses; the proposed analysis would collapse into an ambiguist account.

As far as I can see, the only way of capturing Carston's assumption that the various construals of 'five' have the same status is by hardwiring all of them into the lexicon—which is not what Carston wants, nor anybody else, for that matter. However, it is instructive to consider a weaker version of Carston's homogeneity claim, namely the idea that the 'at least' and 'at most' construals of 'five' are on a par in that they both arise as pragmatic embroidery on an exact semantics. This is the position advocates of the Caramel Theory are committed to, and prima facie it looks promising enough. Consider Carston's example (21c), for instance. If the Caramel Theory is right, this can only be construed as giving the addressee permission to attend exactly six courses. But as the permission to attend *fewer* than six courses is less of concession, it is natural (though not mandatory) to infer that this is permitted, too; while on the other hand, since the permission to attend *more* than six courses is more of concession, it is natural (though not mandatory) to infer that this is not permitted. Hence, the 'at most' understanding of (21c) is readily explained as resulting from pragmatic inference. (21a) and (21b) can be accounted for along the same lines, and to the best of my knowledge, the same goes for 'at most' construals across the board.

'At least' construals of sentences like the following are equally amenable to a pragmatic analysis:

(22) a. Wilbur doesn't have five cows: he has two.
b. Wilbur doesn't have five cows: he has eight.

(23) If Wilbur has five cows, he must be a happy farmer.

If 'five' only has an exact quantifier meaning, one would expect that not having five cows is consistent with having more or fewer than five, and as shown by (22a,b), this turns out to be so. Moreover, neither sentence seems more marked than the other, so there is no reason to suppose that one is 'metalinguistic' while the other is not (Horn 1989, Geurts 1998a).

(23) admits of at least two readings. It may be construed as implying that, if the number of Wilbur's cows does not equal five (that is, if he owns more or fewer than five cows), there is no saying if he will be a happy farmer. Alternatively, and more plausibly, the sentence may be construed as saying that, if Wilbur owns five or more cows, he must be a happy farmer. Thus understood, the sentence yields an 'at least' interpretation, but this is not to say that on this construal the word 'five' has an 'at least' meaning. For suppose that it has an exact meaning. Then the literal meaning of (23) is that, if Wilbur has neither more nor fewer than five cows, he is a happy farmer. This doesn't exclude the possibility that owning more than five cows will make him happy, but since having more than five cows is likely to be considered preferable to owning a mere five, it may be inferred that, if Wilbur has more than five cows, he will be happy, too, and possibly even happier. Note, incidentally, that an 'at most' interpretation would be derivable in the same way, provided the sentence was uttered in a context in which having fewer than five cows was considered preferable to having five.

The foregoing observations might be taken to suggest that 'at least' construals of sentences containing 'five' are always pragmatically derivable, and therefore on a par with 'at most' construals. However, this is not the case, as witness the minimal pair in (24):

(24) a. You may take five cards.
b. You must take five cards.

Sentence (24a) admits of an 'at most' construal, and in our discussion of (21c) we have already seen how this may be derived on the basis of an exact interpretation of the number word. Sentence (24b) admits of an 'at least' construal, and this is *not* derivable along the same lines. For suppose that 'five' has an exact reading. Then (24b) states that the addressee must take neither more nor fewer than five cards, which entails that he or she may not take more than five cards; so an 'at least' interpretation of the sentence is ruled out by its semantic content. Put otherwise, if we want to account for the fact that (24b) may be understood as allowing the addressee to take more than five cards, 'five' will have to have an 'at least' meaning.

The Caramel Theory entails that the only way of obtaining an 'at least' or 'at most' construal for a sentence containing 'five' is by means of pragmatic inference. By contrast, the Chocolate Theory entails an asymmetry: whereas an 'at most' interpretation can only be pragmatic, an 'at least' reading may be a semantic matter. The upshot of the foregoing discussion is that, in this respect at least, Chocolate beats Caramel.

# 5 Chocolate wins

And with a margin, too. The Chocolate Theory is the only one not to have encountered any difficulties in the foregoing pages. The Caramel Theory fails to account for the differences between predicate and quantifier senses and the asymmetry between 'at least' and 'at most' readings. The same asymmetry is a stumbling block for the Strawberry Theory, which in addition is hindered by experimental evidence and some of the entailment patterns licensed by 'five'. As for the Vanilla Theory, it was an act of mercy to take it out of the race at an early stage, for it would only have gone on making a fool of itself.

To conclude, it should be noted that, though the author loves Chocolate, championing any particular theory of number words was not the main objective of this paper. Rather, it was to illustrate a general approach to the semantics of number words, which is based on the assumption that such words are polysemous, and that their polysemy can be captured by means of type-shifting rules. And besides, the case for the Chocolate Theory is still incomplete, since we have confined our attention to two of the senses of 'five' and its congeners, and there may well be more.

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