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## Plurals

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## Plurals

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### 1 Introduction

This article considers some of the logical and linguistic issues surrounding plural reference and plural interpretation. The central questions, in our view, are three in number:

- (i) What do plurals refer to?
- (ii) How does their reference figure in the meanings of the sentences in which they occur?
- (iii) What conceptual resources does a speaker need to know the answers to (i) and (ii)?

Our tentative answers to these questions are at variance with recent literature including Higginbotham (1980), Scha (1981), Gillon (1983), Link (1983) and (1987), and Lonning (1987), but may be regarded as a partial development of an alternative view prefigured in M. Bennett (1972) and in Boolos (1984).

Briefly put, much of the literature on plurals conceives of them as referring to *objects* (including in particular sets, which are objects), or, in a higher-order setting, to the *individuals* therein. Extra-logical axioms relate plural objects to the ordinary, non-plural objects that belong to or are parts of them. Hence, a speaker who is to know about plurals must have mastered a

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certain metaphysical theory, including the extra-logical axioms. It is in this way that the literature putting forth what we call below the *objectual* view of plurals answers the questions (i)-(iii) above.

The view that we will argue for here, in part following Bennett and Boolos, conceives of plurals as referring to the things to which predicative expressions refer; hence, not to objects, but to predicates, or to *concepts* in the sense of Frege.<sup>1</sup> Extra-logical axioms for plurals then become unnecessary. The only notions that a speaker must master to know about plurals are quantification and predication; and these notions are minimally required to speak a language at all.

The view that we advocate is intimately connected with the thesis that the predicates of natural languages are first of all classifiers of *events*, in the sense of Davidson (1966), and as subsequently developed by many authors. The concepts to which plurals refer put conditions on the nature of the participants in events. Thus a sentence like *John and Mary lifted the piano (together)* does not report the exploits of a "plural object," but an event that had more than one agent. The systematic use of this idea, elaborated more fully in Schein (1986), leads to a number of definite predictions about ambiguity in plural sentences.

The organization of this note is as follows. In section 2 we motivate our view of the reference of plurals, and in section 3 explain some of the applications it admits when combined with the Davidsonian account of events. Some other applications and comparisons with the published literature are given in section 4.

## 2 Plural Reference

The problem of plural reference is the problem of extending our familiar notion of reference to plural terms, and correlatively of extending our conceptions of satisfaction and truth to sentences containing such terms. The problem is already apparent in the simplest plural sentences, for example in (1) as contrasted with (2):

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1. In this exposition, we will use the Fregean *concept* for the reference of grammatical predicates, reserving the word *predicate* for linguistic expressions.

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(1) They left

(2) He left

For an utterance of (2) to be true is for the object which constitutes the reference of *he* in that utterance, the object *a* say, to satisfy the predicate *left*, as employed in that utterance. The condition of satisfaction of the predicate, known to speakers of English, may be taken as (3):

(3)  $x$  satisfies *left*  $\leftrightarrow$   $x$  left

In (3) the variable ' $x$ ' ranges over objects. The object *a* then satisfies *left* just in case *a* left. The native speaker, in knowing these facts, knows what it is for an utterance of (2) to be true or false.

How is the above characterization of (2) to be extended to (1)? The plural seems to refer, as one might say, not to *one* object, but to several objects *a*, *b*, *c*, ..., all at once. If that is so, when is the predicate *left* satisfied by those objects?

Plurals can be understood *distributively* and *non-distributively*. A distributive interpretation of (4), for example, is one that permits the paraphrase (5):

(4) John and Mary left

(5) John left and Mary left

Our standard interpretive scheme is adequate to (5), hence adequate to (4), distributively taken. Many plural sentences can thus be reduced to sentences without plurals. But the reduction of plural to singular predication fails as a general strategy, because plurals are not always distributed. The example (6), taken from Boolos (1984) shows "essentially plural" predication:

(6) The rocks rained down

Even in the presence of distributivity, the central problem of plurals resurfaces for sentences with plural terms that apply to several objects without enumerating them. Consider again (1), taken distributively. So taken, it would have the paraphrase (7):

(7) Each of them left

But the quantification in (7) is restricted by a relational clause:

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For each  $x$  *among* them

We understand the quantification only if we understand the relational predicate *among*, for instance as it occurs in

$x$  is (one) among them

But the plural *them* is then undistributed. More generally, all plural pronouns whose interpretation is not given by a conjunction of singulars are necessarily undistributed, even in their distributed interpretations.

An idea that has been attractive to many, and goes back at least to Russell (1903), is that plural reference is singular reference in light disguise. According to this conception, plurals refer after all to objects of some sort, call them *pluralities*. The simple principles of predication, for instance as in (3), are then adequate for both singulars and plurals, and no extension of the notions of reference and satisfaction is required. Let us call any view that endorses this conception an *objectual* view of plurals and plural predication. We have both logical and linguistic reasons for rejecting the objectual view in any of its formulations known to us.

The objectual view needs to explain, in a metalanguage that does not contain plural terms, what plural terms like *the rocks*, *John and Mary*, and *they* refer to, and it needs to explain some relation corresponding to *among* in order to characterize distributivity. Hence on the objectual view there will be an operator taking predicates into singular terms, whose reference is that of the plural term corresponding to the predicate. This reference will be composed in some way of the objects falling under the predicate. We denote the plural-forming operator by ' $\{x:\dots x\dots\}$ ', where ' $\dots x\dots$ ' is the predicate. Boolos's example (6) will then be construed as in (8):

(8)  $\{x: \text{rock}(x)\}$  rained down

For (4) we will have (9):

(9)  $\{x: x \text{ is John or } x \text{ is Mary}\}$  left

(1) will remain unchanged, since the plural pronoun refers to a plural object. For the distributive understanding of (1), or for (7), we will have (10):

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(10) [Each  $x$ :  $x$  is (one) among them]  $x$  left

The predicate that we have written *among* occurs also in the distributive interpretation of (9), or the distributive interpretation of *The rocks are (each) heavy*. It will have to be understood so as to make (9) logically equivalent to (5), and to make *The rocks are heavy* analytically equivalent to (11):

(11) [ $\forall x$ : rock( $x$ )] heavy( $x$ )

Also, it is an implication even of the essentially plural (8) that there are such things as individual rocks. For both of these reasons, axioms are required to mediate between plural terms and the objects falling under their predicates. In the case of a distributive predication of *the rocks*, the axiom is (12):

(12)  $y$  is among  $\{x$ : rock( $x$ ) $\}$   $\leftrightarrow$  rock( $y$ )

The objectual view now threatens to crash headlong into Russell's paradox. For (12) above is just an instance of the *comprehension scheme* (13):

(13)  $y$  is among  $\{x$ : ...  $x$  ... $\}$   $\leftrightarrow$  ...  $y$  ...

from which Russell's paradox follows.<sup>2</sup>

Paradox is avoided if plural terms *the Fs* may fail of reference, and the scheme (13) is modified to (14):

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2. Link (1987) forms terms like *the rocks* in two stages. The noun *rocks* denotes all of the possible "i-sums" of rocks, and then the article *the* picks out the supremum among these denotations. Corresponding to *of* or *among* is a special predicate constant  $*\pi$  read "is an atomic i-part of" and satisfying the comprehension principle as given below. We thus have in general

$x * \pi$  the  $F$ s  $\leftrightarrow$   $F(x)$

Russell's paradox then follows if

things that do not bear  $*\pi$  to themselves

is a noun of the language.

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- (14)  $y$  is among  $\{x: \dots x \dots\}$   $\leftrightarrow$   $[Ez]$   
 $(z = \{x: \dots x \dots\} \ \& \ \dots y \dots)$

Besides conflicting with ordinary understanding, referential failure raises a subtle, related difficulty for the objectual view following discussion in Boolos (1984). Suppose for concreteness that plural terms refer to sets. Consider the example (15) (modeled after examples in Boolos):

- (15) Given any ordinals, one of them is the least of them

The quantification here is over things that are the reference of plural NPs, such as *the ordinals between 10 and 20*, *the ordinals larger than  $\omega+5$* , etc. Thus, the instances of (15) are statements like

One of the ordinals between 10 and 20 is the least of the ordinals between 10 and 20

One of the ordinals larger than  $\omega+5$  is the least of the ordinals larger than  $\omega+5$

and so forth. (15) asserts the truth of *one of  $O$  is the least of  $O$* , as  $O$  ranges over these things, one of which would seem to be the reference of the phrase *the ordinals* itself. But if that is so, then the reference of such phrases, and hence the range of the quantifier, cannot be restricted to sets, because there is no set of all ordinals. Boolos's problem will recur whenever there are predicates  $F$  such that *the  $F$ s* does not refer to a plural object.

In view of the above issues for the objectual view, we turn to a different suggestion, close to M. Bennett (1972), and to Boolos.<sup>3</sup> Instead of regarding plural terms as arising from a term-forming operator on predicates, we may think of them as themselves predicative in nature. The term *the rocks* will refer to a concept satisfied by rocks and by nothing else; the term *John and Mary* will be satisfied by John and by Mary and by nothing else; and the term *they* will be satisfied by just the objects to which it was applied. The plural term *the rocks*, then, refers to the concept that is the reference of the predicate

$(\exists x) (\forall y) (x(y) \leftrightarrow \text{rock}(y))$

If plurals are predicative, then there is no need for a special relation between the reference of plural terms and the objects making up such reference, and therefore no threat of paradox.

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3. For Bennett, see (1972), note 11.

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Likewise, quantification over *all* things satisfying a plural will not be thwarted by the fact that some plural predicates do not have extensions. Finally, because comprehension principles are otiose, we will be able to characterize certain implications without recourse to extra-logical premisses.

However, if plural terms answer to concepts rather than to objects, how is objectual reference ultimately secured? Following Schein (1986), we will suggest that plurals serve to give certain relations between objects and events. We explain this proposal in the next section.

### 3 Events, Objects, And Concepts

We assume here a picture of the argument structure of words and phrases belonging to the major (predicative) categories according to which they function as classifiers of events and situations, as originally suggested in Davidson (1966) and pursued, with some extensions and modifications, in Higginbotham (1985) and (1986, forthcoming) and in Schein (1986). According to this picture, all ordinary V have, besides the argument positions that are realized in the sentences in which they occur, also a position for events, or *E-position* as we shall call it. The projections of V also have E-positions, and thus serve first of all to classify events. Thematic relations, expressing notions such as *actor*, *patient*, and *instrument* are conjoined to the basic interpretation of V to provide an interpretation of V together with its arguments. We may consider the intransitive verb *leave*, for example, as carrying some thematic information  $\Theta$ , and as semantically interpreted by the statement (16):

(16)  $\langle x, e \rangle$  satisfies *leave*  $\leftrightarrow$   $\text{leave}(e) \ \& \ \Theta(x, e)$

Hence, an utterance of *he left* (example (2) above), where the reference of *he* as there uttered is *a*, is satisfied by those events *e* such that  $\text{leave}(e)$  and  $\Theta(a, e)$ .<sup>4</sup>

The apparatus just sketched is put to work in the present connection as follows. Where an argument position is occupied by a plural term, we may understand it as expressing multiplicity over the thematic relation  $\Theta$  pertinent to that position. Just as an event is classified by *he left* if it was a leaving whose actor was *a*, so it may be classified by *they left* just in case it was a leaving whose actors (plural) were *a, b, c, ...*. Assume that *they*

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 4. Here and elsewhere we will ignore tense. We regard tenses as indexicals, fixing the time or times of the events over which the variable *e* is to range.



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refers to a concept satisfied by a, b, and c, and by nothing else, and assume that in the sentence *they left* (example (1) above) it taken as describing the things in the domain of the relation  $\Theta$ . Then we may take (1) as shown in (17):

(17)  $[\mathbf{E}e: \text{leave}(e)] (\mathbf{A}x) (\Theta(x,e) \leftrightarrow \text{they}(x))$

The distributed interpretation of (1) is as in (18):

(18)  $[\mathbf{A}x: \text{they}(x)] [\mathbf{E}e: \text{left}(e)] (\mathbf{A}y) (\Theta(y,e) \leftrightarrow y=x)$

On the view advanced here, then, plurals in simple sentences are always in a sense distributed; that is, the plural terms ultimately occupy predicate positions, not argument positions. The "collective" readings represent distribution interior to the clause.

The ambiguity between distributed and undistributed interpretations of plurals now becomes a matter of scope. In an example such as (19):

(19) John and Mary lifted the piano

(meaning one after another, or once or more together), we may give the plural scope only over the thematic relation of the subject to the lifting (here, agency), or over the whole sentence. In the first case we have (20) and in the second (21):

(20)  $[\mathbf{E}e: \text{lift the piano}(e)] (\mathbf{A}x)(\text{John and Mary}(x) \leftrightarrow \Theta(x,e))$

(21)  $[\mathbf{A}x: \text{John and Mary}(x)] [\mathbf{E}e: \text{lift the piano}(e)]$   
 $(\mathbf{A}y)(\Theta(y,e) \leftrightarrow y=x)$

where the compound predicate *John and Mary* is true of John, Mary, and nothing else (see section 4 below for some elaboration). Essentially plural predications like (6) come out as in (22):

(22)  $[\mathbf{E}e: \text{rain down}(e)] (\mathbf{A}x) [\Theta(x,e) \leftrightarrow (\exists X)[(\mathbf{A}y)(Xy \leftrightarrow \text{rock}(y))]] (x)$

The matrix of (22) simplifies by ordinary second-order logic, giving (23):

(23)  $[\mathbf{E}e: \text{rain down}(e)] (\mathbf{A}x) (\Theta(x,e) \leftrightarrow \text{rock}(x))$

From this point of view, a truly collective reading of a plural terms would be one in which there is higher-order predication. Certain predicates of number, measure and constitution provide such examples. In fact, in the old chestnut (24) we see a collective reading, in our sense:

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(24) The apostles are twelve<sup>5</sup>

On our view, we should take (24) as in (25):

(25)  $\text{twelve}(e, (\exists X)[(Ax)(Xx \leftrightarrow \text{apostle}(x))])$

with *the apostles* referring to a concept, and occupying an argument position in the higher-order predicate. Thus, the true collective in (25) and the undistributed interpretation of (26) are found to have different logical forms. The undistributed interpretation, which might be read in (27) as "e is a piano-lifting whose agents were the Apostles," employs only first-order predication:

(26) The apostles lifted the piano

(27)  $[\exists e: \text{lift the piano}(e)] (Ax)$   
 $(\Theta(x,e) \leftrightarrow (\exists X)[(Ay)(Xy \leftrightarrow \text{apostle}(y))])(x)$

We suggest that this difference in predication underlies the contrast observed in (28) and (29):

(28) Some Apostles lifted the piano

(29) \* Some Apostles are ten

Were undistributed interpretations to involve higher-order predication, the contrast would be unexpected:

(30)  $[\exists X: \text{apostles}(X)] \text{lift the piano}(e,X)$

(31)  $[\exists X: \text{apostles}(X)] \text{ten}(e,X)$

We suppose that *some* is not an operator that forms terms, and so *some apostles* has no representation at LF where it remains *in situ*. QR must apply. It is further assumed that QR leaves only objectual variables:

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5. There are any number of similar examples:

Those guys constitute the Boston Celtics  
 The French number several millions  
 Four hamburgers is/are more things than three boys  
 John and Mary and John and Susan are two groups of two each

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(32) [Some apostles] [ $\Theta(t,e)$  lifted the piano(e)]

Subsequent interpretation derives the undistributed reading in (33):

(33) [EX:some(X) & (Ay)(Xy  $\rightarrow$  apostle(y))][Ee:lift the piano(e)]  
(Ax) (Xx  $\leftarrow$   $\Theta(x,e)$ )

In the case of a true collective predicate, the objectual variable left by QR results in an incoherent interpretation, whether *some apostles* is taken as an objectual or as a second-order quantifier:

(34) [Some apostles] [ten(t,e)]

(35) [Some x:apostle(x)] ten(x,e)

(36) [EX: some(X) & (Ay)(Xy  $\rightarrow$  apostle(y))]  
(Ee) (Ax) (Xx  $\leftarrow$  ten(x,e))

Recall that the definite article is here assumed to be a term-forming operator, or at least to have that as one of its functions. It thus remains *in situ* at LF, where it can properly serve as the argument to a higher-order predicate:

(37) The Apostles are ten

(38) ten(e, ( $\uparrow$  X)[(Ax)(Xx $\rightarrow$ apostle(x))])

### 3.1 The syntax of second-order quantification

On the objectual view of plurals, the variables of objectual quantification range over both singular and plural objects. On our view, as in Bennett (1972) and Boolos (1984), plurals introduce second-order quantification. Hence, there are two types of variables, the objectual variables and the concept variables. The difference between first- and second-order quantification is, we suggest, reflected in the facts of weak crossover and in the behavior of pronouns as bound variables reported in Montalbetti (1984). Weak crossover appears to be a condition on objectual variables but not on concept variables. Thus, in the configuration of a weak crossover violation, as in (40), the pronoun *their* cannot be understood as an objectual variable bound by *some students*:

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(39) *Some students* helped *their* friends solve the problems

(40) *Their* friends helped *some students* solve the problems

The sentence does not have the interpretation that each of some students is such that his friend(s) helped him solve the problem(s). There is however no violation of weak crossover in (40) when the pronoun *their* is anaphoric to the concept variable introduced by *some students*. The interpretation is that the friends were the friends of some students and they helped them.

We expect to obtain two interpretations of the anaphoric relation in (41):

(41) *Many students* think [*they* are intelligent]

One of these is ordinary binding to an objectual variable. The other would make *they* anaphoric to the concept-variable, giving the interpretation that there is an X that is many and applies only to students, where each x such that X(x) thinks that the X are intelligent. Montalbetti (1984) reports that in the Spanish sentence corresponding to (41) the two interpretations are distinguished overtly. The overt pronoun is anaphoric only to the concept variable, and empty pro is bound only to an objectual variable.

### 4 Some Further Applications

We have thus far considered three kinds of plural terms, namely the plural pronouns and demonstratives, the conjoined singulars, and the plural definite descriptions, and also the distinctively plural interpretation of general plural NPs *Q Fs*, *F* a simple or complex N. In closing, we shall consider some further types, and some implications and extensions of the view developed thus far.

Heim, Lasnik and May(1988) and Lonning (1987) give reasons for supporting the view that some distributive interpretations arise from silent operators with a distributive meaning. We support this view, but wish to call attention to a certain complication in the semantics. Consider an explicitly distributed plural, as in (42):

(42) Each of 3 children watched the movie

This quantification might be understood as in (43):

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- (43) [EX: 3(X) & (Ax)(Xx --> child(x))] [Each x: Xx]  
 [Ee: watch the movie(e)] (Ay) ( $\Theta(y,e) \leftrightarrow y=x$ )

that is, "There are some three children, each of whom watched the movie." Clearly, this is equivalent to (44):

- (44) [3x: child(x)][Ee: watch the movie(e)] (Ay) ( $\Theta(y,e) \leftrightarrow y=x$ )

Such an equivalence obtains whenever a quantifier is adjectival (applying to a pair of predicates if and only if it applies to their common part) and monotone increasing. The equivalence fails for non-monotone quantifiers, such as *at most 3*:

- (45) Each of at most 3 children watched the movie

This sentence is equivalent to, "At most 3 children watched the movie," but the application of the method employed in (43) would give the wrong results. What we want, rather, is something that might be paraphrased as

At most 3 children are such that each of them is such  
 that he/she watched the movie

Formally, the interpretation may be represented as in (46):

- (46) [At most 3 z: child(z)] [EX: Xz] [Ax: Xx]  
 [Ee: watch the movie(e)] (Ay) ( $\Theta(y,e) \leftrightarrow y=x$ )

In our conception, then, the distributor *each* distributes, not over the predicate answering to the quantificational NP *at most 3 children*, but rather over the residual predicate variable that may be associated with the thematic position quantified over. A similar treatment is called for in reciprocal constructions, assuming that these represent the association of *each* with the antecedent of the anaphor, as in (47):

- (47) At most 3 people here hate each other

This sentence is not verified by the fact that there are no four-person groups of mutual haters among the people here; for if there are two such three-person groups it is intuitively false. The reader may verify that taking up (47) as (48):

- (48) Each of at most 3 people here hates the others

and then proceeding as in (46) gives a better result.

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The properties of plurals may be used to probe the ways in which relativity of predicates to situations influences the truth conditions of utterances. Consider the following minimal pair:

(49) Some odd number of men are here

(50) An odd number of men are here

Suppose that in fact there are exactly 30 men here. Then, in our judgment, (49) may be defended as true: for if 30 men are here, then 29 are here, and 29 is an odd number. But (50) is unequivocally false. Allowing the plurals to distribute over just the thematic relation obtains the interpretations shown in (51):

(51)  $here(e) \ \& \ [EX: \text{Some/An}(X) \ \& \ odd(X) \ \& \ (Ax)(Xx \ \rightarrow \ man(x))]$   
 $(Ax)(\Theta(x,e) \ \leftarrow \ Xx)$

The sentences (49)–(50), however, cannot be regarded as made true by the existence of *some* event satisfying the predicate; for if there are 30 men here, then there are many events of there being 29 men here. We are led to conclude that the sentence is to be regarded as making a report about an event, where the speaker is deemed to be attempting to give maximal information, the indefinite article implying uniqueness, and the predicate *some* of concepts not. Here the relativity of truth value to situations is particularly apparent.

In our discussion above, it was assumed that the conjoined NP *John and Mary* was understood as a complex predicate, true of John, Mary, and nothing else. We briefly consider the nature of such compounding in general. One puzzle that an account of plurals must solve is the status of sentences like (52):

(52) They are cups and saucers

The compound (conjoined) predicates *A and B* are systematically ambiguous. On the one hand they can be understood as applying to each thing to which both applies, and on the other as applying to things to which either applies. The first interpretation of such compounds results by simply taking the conjunction of the predicates making up the compound. The second interpretation, like the interpretation of a conjunctive plural term, represents a distribution of the component predicates over the notion of satisfaction, or application. Denoting the second form of compounding by  $\&\&$ , the semantics may be written as

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A && B applies to x  $\leftrightarrow$  A applies to x or B applies to x<sup>6</sup>

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6. There is a counterpart of predicate compounding on the side of mass terms, as in *That is whisky and water*, an example we owe to unpublished work by the late Richard Sharvey.

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