Cardinal Numerals and other Numerical Expressions
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Draft version, all comments welcome!

1 Introduction

In this paper address the issue of the categorial status of cardinals is addressed. Focusing on (Greek) complex (i.e. two-word) cardinals, we try to pin down the categorial status of cardinals and propose syntactic analyses which reflect their distribution and, in particular, their morphological and syntactic similarity with adjectives on the one hand and their interpretive similarity with weak/existential quantifiers (Milsark 1977) on the other.

We argue, in particular, that cardinals in Greek are morphologically and syntactically adjectives, hence they assume a modificatory function. In this they pattern just like weak quantifiers, which also display the morphology of adjectives with which they further share their prenominal positioning. Syntactically, we take cardinals, like weak Qs, to be connected with NumP (cf. Corver ans Zwarts 2006—C&Z henceforth).

We also draw a distinction between one-word multiplicative cardinals, called simplex, and two- (or more-) word multiplicative cardinals, called complex, essentially clarifying notions employed by I&M (2006) and Zweig (2005).

The paper is organised as follows:

2 The facts

Greek has several types of numerical expressions, the most relevant ones for our current purposes being absolute numerals (cardinals), (1), and numerical nouns, (2).

(1) ena vivlio ‘one book’, eksi vivlia ‘six books’, ekato vivlia ‘a hundred books’, xilja vivlia ‘a thousand books’ (and see (4) below).

(2) mia eksada vivlia ‘(a set of) six books’, tesseris decades molivia ‘three (sets of) ten pencils’, tris xiljades vivlia ‘three thousand books’, etc.

In S&T we focused on the syntactic properties of numerical nouns and drew a distinction between those which, together with preceding cardinal, have a cardinal interpretation (example (5)) and those that are morphologically identical to them, but semantically different, in that they refer to sets of elements (rather than to individual items), examples (2) and (6) below. In what follows we offer a detailed description of the empirical domain on which that work was based, expanded by the addition of the facts that constitute our current domain of investigation.

2.1 Simplex cardinals

A large number of Greek cardinals are one-word items, known as simplex cardinals (see Ionin and Matushansky 2006—I&M henceforth). These are either morphologically underived, as in (1), or derived, as in (3):

(3) a. Agorasa tetrakosjes efimerides.
bought-1s four-hundred newspapers  
‘I bought four hundred newspapers.’
b. Plirosa eksakosia evro gi afito to palto.  
paid-1s six-hundred euros for this the coat  
‘I paid six hundred euros for this coat.’

(3) shows that multiplicatives of 100 in particular (not only those of course, but our illustrative examples are based only to multiplicatives of 100 for easiness of exposition, see note 1) are one-word items. They are morphologically derived from a base denoting the multiplier (2, 3, etc.) followed by a suffix which is a reduced stem of the multiplicand, namely, ekato, ‘hundred’. For instance, eksakosia (600) consists of eksi, ‘six’ and ekato, ‘hundred’. Cardinals formed in this way are thus different from their English counterparts: as the glosses in (3) demonstrate the latter are complex, in that they are not one-word items. In the light of these remarks, it emerges that Greek has fewer complex cardinals than English.²

2.2 Complex cardinals

By the term complex cardinals we refer to cardinal numbers that consist of two words (or more). They are of interest to the linguist as the raise the question of what the internal structure of the complex numeral is. They are of two types: additives as in (4), and multiplicatives, as in (5). In this paper we confine ourselves to multiplicative cardinals.

(4) a. ikosipende vivlia  
twenty five books
b. ekaton triandaokto molivia  
hundred thirty eight pencils

(5) a. dio xiljadès vivlia  
two thousand books
b. tria ekatomiria anthropi  
three million people

(5) illustrates that, by contrast to the multiplicatives of 100 discussed in the previous section, (3), cardinals which are multiplicatives of 1000 or 1000000 are two- 

word lexical items, just like their English counterparts. They consist of a simplex cardinal which is followed by what is called numerical noun. Closer inspection reveals that the similarity between the cardinals in (5) and their English counterparts is apparent,

¹ The same holds for multiplicatives of 10 from thirty to hundred, i.e., trianda ‘thirty’, peninda ‘fifty’, etc. These cardinals are also morphologically derived, as they contain the bound morpheme which historically contains the root for ‘ten’ (deka).

² It is worthwhile pointing out, especially in view of what will be an important aspect of our analysis (cf. section 5) that there is no syntactic recursion with one-word cardinals of the above type, but they may be used to form additives (see section 2.2) via compounding: eksakosia ena ‘600 + 1 = six hundred one’, xilja tetrakosja ‘1000 + 400 = a thousand four hundred. They may be one-word compounds of the dvadva (co-ordinated) type (for cardinals up to 20), e.g. dekatria for deka ‘ten’ + tria ‘three’, or two-word (syntactic) compounds (for cardinals from 20 onwards), e.g. ikosi pente for ikosi ‘twenty’ + pente ‘five’, tetrakosja dio for tetrakosja ‘four hundred’ + dio ‘two’, etc. This convention is probably contingent upon the number of syllables of the first word of the compound. We will not pursue the issue further here.
as *xiljades* and *ekatomiria* are morphologically nouns. Thus, *xiljades* in (5a) and *ekatomiria* in (5b) are marked for plural (contrast with English: *two thousands books* and *three millions people*.)

To summarize so far, we have drawn a linguistically relevant distinction between one word and two-word cardinals in Greek: (i) one-word cardinals correspond to the *simplex* cardinals of I&M and are either morphologically underived (*dio* ‘two’, *oko* ‘eight’) or derived (*diakosia* ‘200’). (ii) two- (or more-) word cardinals correspond to I&M’s *complex* cardinals. (iii) two-word multiplicative cardinals in particular contain a noun as their second element, (5). In what follows we offer a syntactic analysis that accounts for the differences between complex cardinals and seemingly identical numerical expressions, which we have shown in Stavrou & Terzi (2008) not to have a cardinal interpretation. In the context of this investigation we also address the more general issue of the categorial nature of cardinals and their position within the nominal projection (see also C&Z 2006, and I&M for similar issues).

2.3 **Nominal numerical expressions**

We pointed that cardinal numerals which are multiplicatives of *xilja* ‘a thousand’ (and of *ekatomirio* ‘a million’) are complex and that their second part is a noun. Notice that the numerical expressions in (6) are also syntactically complex expressions, consisting of a (simplex) cardinal followed by the same type of numerical noun. The numerical noun in (6) is formed via suffixation of the nominal suffix, -*ada* (plural: -*ades*), to a cardinal smaller than *xilja* ‘a thousand’ (in particular to 2, 3, 4, 5, 6, 8, 10, 11, 12, 20, (possibly also 50 and 60), 100 (S&T).

\[
\begin{align*}
\text{(6)} & \quad \text{a.} & \quad \text{Agorase tesseris ekatondades vivlia.} \\
& & \quad \text{bought-3s four hundred-ades books} \\
& & \quad \text{‘She bought four sets/boxes/etc. of a hundred books.’} \\
& \quad \text{b.} & \quad \text{Efere tris eksades bires.} \\
& & \quad \text{bought-3s three six-ades beers} \\
& & \quad \text{‘She brought three (packs of) six beers.’}
\end{align*}
\]

As indicated by the glosses, the above numerical expressions are not cardinals. They are nouns that refer to sets of entities and in S&T we called them numerical nouns with a *SET interpretation*.

In contrast to (6), the example in (7) shows that numeral expression containing the noun *xiljades*, which is of the same morphological type as *ekatondades*, is a cardinal, i.e., it does not refer to sets, but it counts items (see also (5a)).

\[
\begin{align*}
\text{(7)} & \quad \text{Katanalosan tris xiljades (3.000) bires sto gamilio parti.} \\
& & \quad \text{consumed-3p three thousand-ades beers at the wedding party} \\
& & \quad \text{‘They consumed three thousand beers at the wedding party.’}
\end{align*}
\]

Comparing (6) with (7)=(5), both involving a numerical noun, we see that the complex numerical expression has a different function in each case; in (6) it is employed to denote sets, while in (7) and (5) it is a cardinal numeral. Given this difference in interpretation, the question that arises is whether the numerical expressions in (7) and (5) on the one hand and that in (6) on the other are subject to the same syntactic analysis. This is one of our main questions, and we take it up in
section 3. Before doing so, however, a brief description of the morphology of the numerals is in order, as one of our claims is that morphologically cardinals (and quantifiers for that matter) are adjectives.

3 Morphology and distribution of Greek numerals

3.1 Morphology

Greek cardinals display agreement in phi-features with the noun and all the modifiers that may appear in the extended nominal projection, including determiners. In particular, the cardinal enas ‘one’, tris ‘three’ and tesseris ‘four’ display overt morphological agreement, namely, they have different forms for masculine, feminine, and neuter. In (8) below we give a DP containing the definite article and the morphologically underived numeral tesseris/a ‘four’, and (9) is an example of a DP containing the morphologically derived numeral tetrakosji/es/a ‘four hundred’.³

(8) a. tus tesseris andres
the. pl.acc.masc. four men.pl.acc.masc ‘the four men’
b. tis tesseris jinekes
the.pl.acc.fem four women.pl.acc.fem ‘the four women’
c. ta tesser pedja
the.pl.acc/nom.neu four kids.pl.acc/nom.neut ‘the four kids’⁴

(9) a. i tetrakosji andres
the.pl.masc.nom four-hundred.pl.masc.nom man.pl.masc.nom
‘the four hunded man’
b. i tetrakosjes ginekes
the.pl.fem.nom four-hundred.pl.fem.nom woman.pl.fem.nom
‘the four hundred women’
c. ta tetrakosja pedja.
the.pl.neu.nom four-hundred.pl.neu.nom child.pl.neu.nom
‘the four hundred children’

In (8) and (9) we see that the noun, the article and the numeral overtly agree in phi-features (see also footnote 4). (8) and (9) show that cardinals are morphologically adjectives. Adjectives also agree in phi-features with the noun and the determiner, (10).

³ Similar considerations hold for complex (i.e., two-word) cardinals, by virtue of the fact that they consist of a simplex cardinal and a numerical noun. See however section 5.5 for gender agreement in particular.
⁴ All other simplex cardinals up to dodeka ‘twelve’ are morphologically invariable, with (plural) number, gender and case marking appearing only on the determiner and the noun (as well as on any other modifier that may occur in the DP).

(1) a. ta pende pedja
the.pl.acc/nom.neu five kids.pl.acc/nom.neu ‘the five kids’
b. ton pende pedjon
the.pl.gen.masc/fem/neu five kids.pl.gen.neu ‘of the five kids’
Thus, it is clear that Greek numerals are quite unlike their Russian counterparts, in that they are never case assigners (cf. I&M). Therefore, a strong argument of I&M concerning the nominal status of cardinals, is weakened in the case of Greek.

3.2 Distribution of cardinals

In this subsection we will give a sketch of the distribution of cardinals, first within the nominal projection and then in the clause.

3.2.1 Inside the DP
Cardinals, like all adjectives in Greek, are uniquely prenominal (Alexiadou et al. 2007). Furthermore, they appear high in the nominal structure, preceding all other adjectives, (11a)-(11b). When the definite article is present, the cardinal also comes immediately after the article, (11c):

(11) a. tris nees orees evropaikes tenies
    three new good european films
b. *nees tris orees evropaikes tenies
    new three good european films
c. i tris nees orees evropaikes tenies
    the three new good european films

3.2.2 In the clause
In this subsection we illustrate certain striking similarities between cardinals and non-intensional predicative adjectives (12)-(15). The existence of these similarities provide us with an argument in favour of considering cardinals as adjectives, in at least the relevant respects.

    Just like (non-intensional) adjectives, cardinals can license nominal ellipsis, (12), can be substantivized in the presence of the definite article, (13), be used predicatively, (14), and follow pronominal determiners in appositive-like constructions, (15):

(12) Ι Μαρια αγορασε μονο τρια/ενδιαφεροντα οιωλια, ενο τι Ελενι πεντε/ασχετα
    the M. bought only three /interesting books while the Eleni five/θνιντερστινγ
    books
    ‘Mary bought just three interesting books while Eleni five.’

(13) I pende/diakosji/psili prokalesan episodia.
    the five/two-hundred/tall caused impression
    ‘The five/two hundred/tall made an impression.’

(14) Ta potiria sto dulapi ine eksi/eksakosja/orea/ksystalina.
    the glasses in-the cupboard are six/six-hundred/beautiful/crystal
‘The glasses in the cupboard are six/six hundred/beautiful/crystal.’

But cardinals also differ from adjectives in certain other respects. In (16)-(19) we illustrate certain important differences between cardinals and non-intensional predicative adjectives. Unlike these adjectives, cardinals can license a ‘bare’ DP subject, (16), may function themselves as arguments (in subject or object position) without a following noun, (17), may head the partitive construction, (18), and allow for split topicalization, (19):

| (16) | a. Tris/*eksipni fitites parusiasan to arthro.   
|      | three/*clever students presented the article  
|      | b. Irthan tris/?eksipni fitites. 
|      | came three/?clever students  

| (17) | Sinandisa tris/diakosjus/*omorfus. 
|      | met-1s three/two-hundred/handsome  
|      | ‘I met three/two hundred/*handsome.’  

| (18) | Eksi/pendakosji/*psili apo t̥us diadilotes prokalesan episodia  
|      | six/five-hundred/tall of the demonstrators caused trouble  
|      | ‘Six/five hundred/*tall of the demonstrators caused trouble.’  

| (19) | Vivlia agorasa epta/eptakosja/*endiaferonda.  
|      | books bought-1s seven/seven-hundred/interesting  
|      | ‘Books I bought seven/seven hundred/*interesting.’  

3.3 *Distribution of cardinals and weak quantifiers*

Cardinals and weak quantifiers share a basic semantics, namely existential force, whereby they can appear in existential *there*-sentences (see Landman 2003 and I&M 2006, p. 6-7 and references therein), cf. (20). In section 5 it will be argued that both cardinals and Qs lose their existential force when they appear in a definite noun phrase, (21):

| (20) | Exi pola/tria/vivlia pano sto trapezi.  
|      | has many/three books on the table  
|      | ‘There are many/three books on the table.’  

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Notice that C&Z use similar facts (along with additional evidence) to support their claim that cardinals are nouns in Dutch. Unlike in Greek, Dutch cannot form appositives as in (15) with adjectives, but only with nouns (N. Corver, p.c.). In Greek, on the other hand, both adjectives and nouns can be employed in this context. Nevertheless, it should be pointed out already here (see section 5.3 for discussion) that the numeral that follows the definite article in (15) is not a real numeral but a quantity denoting adjective (see also C&G for this view). Example (15) thus provides more support for the existence of QA as distinct from cardinals and weak Qs, which cannot follow a personal pronoun in Greek:

(i) *emis tris* (we three) Appositional structures like the one in (15) consist of two definite DPs in juxtaposition.
(21) Ida t
us ligus/pende andres pu …
saw-1s the few/pende men that …
‘I saw the few/five men that …’

In (21) the underlined words are quantity adjectives (in terms of Giusti 1991; Cardinaletti & Giusti 2005), rather than Qs or cardinals (see section 5.3 for discussion).

In (22) we see that both cardinals and Qs may have scope ambiguities:

(22) Den ida poles/tris ginekes.
    neg saw-1s many/three women
    ‘I didn’t see many/three women.’

(22) means either that there are many or three women that I didn’t see, or that I didn’t see many or three women but few or 4, or 6, or (so called metalinguistic negation).

The data in (23)-(26) illustrate further that the properties in which cardinals differ from non-intensional predicative adjectives are exactly those properties in which they pattern with weak (or existential) quantifiers. Cardinals and weak quantifiers are both able to license a ‘bare’ subject, (23), they can appear in argument position without a following noun, (24), they can head the partitive construction, (25), they allow for split topicalization, (26).

(23) a. Tris/ligi fitites parusiasan to arthro.
    three/few students presented the article
b. Irthan tris/ligi fitites.
    came three/few students

(24) Sinandisa merikus/ligus/tris.
    met-1s several/few/three
    ‘I met several/few/three.’

(25) Meriki/ligi/tris apo tus diadilotes prokalesan episodia.
    several/few/three of the demonstrators caused trouble
    ‘Several/few/three of the demonstrators caused trouble.’

(26) Vivlia agora
    sa merika/liga/deka.
    books bought-1s several/few/ten
    ‘Books I bought several/few/ten.’

The facts so far have demonstrated that cardinals display common morphological properties with non-intensional adjectives in Greek. At the same time, they display a cluster of properties that, while they differentiate them from adjectives, place them together with (weak) quantifiers.

The facts in (16)-(17) and (23)-(26) suggest that cardinals function as determiners, in that they can turn the noun phrase that contains them into an argument, unlike descriptive adjectives.6 The facts in (8)-(9) and (14), on the other hand, suggest that cardinals and weak quantifiers are semantically modifiers, i.e., of

6 In fact, in the semantics literature on cardinals one of the approaches is exactly the one that treats them as determiners, i.e. as type <<d,t>, t>. See section 4.1 immediately below.
the type \(<<e,t>, <e,t>>\). Cardinals have been treated in the literature as either determiners or as modifiers (see I&M 2006 for discussion and references). The syntactic structure we will offer for cardinals in the following section aims at capturing both their modificatory role with regard to the lexical noun and their ability of functioning as arguments (or licensing a nominal argument), as well as their agreement properties. Moreover, while we pointed out their semantic similarities with weak quantifiers, our analysis sets apart cardinals from quantifiers by assigning to them the feature [card] (see section 5).

4 Towards an account of the syntax of cardinals

4.1 Recent proposals on the status of cardinals

Until recently, numerals primarily attracted the attention of semanticists. As pointed out in C&Z and I&M, who also provide a wealth of references), there have been three major approaches to cardinals from a semantic point of view; they have been considered as a) determiners, b) predicate modifiers (adjectives) and c) individual constants (C&Z). As an effect of the recent extensive research on the nominal structure and the refinement of the categories which constitute its architecture, there has been an increased interest in the syntax of cardinals as well. A particular issue that is being addressed in this respect is the categorial status of numerals. Thus, both C&Z and I&M, based on different evidence, take cardinals to be nouns.

Considering the recursion manifested by complex cardinals, (27), I&M propose that cardinals (both, simplex and complex) are semantically modifiers, i.e., of the type \(<<e,t>, <e,t>>\), which take an NP argument.\(^7\)

(27) a. four books b. four hundred books

On the other hand, C&Z, on the basis of prepositional numerals such as (28) from Dutch, but also of the distributional similarities between cardinals and nouns, (29), propose the structure in (30).

(28) *Rond de twintig gasten kwamen er op het feest.*
round the twenty guests came there at the party
‘Around twenty guests came to the party.’

(29) a. can be complements of Ps
b. combine with quantificational determiners
c. have nominal distribution in idiomatic expressions.
d. complement pronominal determiners

(30) a. \([\text{NumP}\ [\text{NP} 20]\ [\text{Num}\ NUM\ [\text{NP kinderen}]])\]
b. \([\text{NumP}\ [\text{PP rond de 20}]\ [\text{Num}\ NUM\ [\text{NP kinderen}]])\]
‘(around) 20 children’
C&Z: (51).

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\(^7\) Note that I&M also note that their claims do not have to be adopted for languages that have no complex cardinals.
C&Z on the basis of examples like (30) take cardinals to be nouns, since Ps only take nouns as arguments. Since the defining property of cardinals is that they are predicates over the cardinality of the associated noun, they are situated in SpecNumP, because C&Z take NumP to be associated with cardinality. Our analysis below shares with that of C&Z the importance of cardinality in positioning the cardinal. On the other hand, as already shown in section 3, cardinals in Greek do not pattern with nouns but with adjectives and (weak) Qs.

Finally, Zweig (2005) holds that some numerals are nouns, while others are adjectives. The status of numerals may thus vary across languages, nevertheless, numeral phrases are universally NPs (by virtue of the fact that they modify a silent noun NUMBER).

4.2 Our proposal: an outline

In the previous sections we presented evidence showing that simplex cardinals are morphosyntactically adjectival and at the same time they share semantic and syntactic properties with weak quantifiers. It must be further emphasized that weak Qs are also adjectival, in that they agree in phi-features with the noun (and the determiner), exactly like adjectives, and that they too occupy a prenominal position.

The central question then we address in this section is where cardinals are located in the nominal projection. Some answers are already found in the literature: Jackendoff (1977) and Selkirk (1977) take numerals to be essentially quantifiers, hence, be located in the same structural position as the latter, namely, in N’’ (under their ‘three-level hypothesis’). Loebel (1993) takes (weak) Qs and cardinals to be situated at the specifier position of the category QP which comes between D and NP in the extended nominal projection. Giusti (1991, 1997) and C&G (1992, 2005)8 lump together all Qs and cardinals and advance a syntactic theory of quantificational noun phrases consisting of two parts.

(i) The QP hypothesis
All Qs, and cardinals, head QP, which is merged outside and above the DP and select the category that follows them (NP, PP, DP), see also Cornilescu (1993) and Giusti (1991, 1997):

(31) a. [[QP many/three [NP years]]]  
    b. [[QP many/three [PP of the years (to come)]]]  
    c. [[QP many/three [DP a year]]] (dialectal/marginal)  
    d. [[QP all [DP the years]]]

(ii) The AP hypothesis
C&G (op.cit.) argue that when many, three, etc., are preceded by the definite determiner, (32), they are not Qs or cardinals but quantity denoting adjectives (QA). They occupy an adjectival position inside the DP which is high enough, since quantity adjectives precede all other adjectives

(32) a. the many/three boys  
    b. the many/three clever young boys

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8 For extensive discussion and survey of the literature see C&G (2005).
Being adjectives, such Qs and cardinals are situated in the specifier position of a functional category, just like other adjectives:

\[(33) \quad [\text{DP the [QAP[many/three] [NP boys]]}]\]

With regard to their AP-Hypothesis, C&G (2005:21) write: “The idiosyncrasy in the possibility for a lexical item expressing quantity to be either a quantifier, or a quantity adjective, or both, is expected under the hypothesis that these elements can have different categorial status, independent of the meaning of a given element. In each language a given element is assigned either status, or both. What is striking is that the syntactic behaviour directly depends on the categorical status of the element, not its semantic value.”

In the following section, we will see that the QA in Greek do have different interpretation than cardinals/weak Qs. Using Cardinaletti and Giusti’s diagnostics for QA we will further see that in Greek QA are indeed different lexical items (cf. example 21 above) than cardinals and for that reason they are assigned a different syntactic analysis.

5. A syntactic analysis of Greek numerals

5.1 Simplex Cardinals

In section 3.3, we illustrated a number of semantic similarities between cardinals and weak quantifiers. In is worth noting that, to the best of our knowledge, in the syntactic literature on the status of quantifiers, no distinction is drawn between quantifiers and cardinals. Rather, it is implied that cardinals and quantifiers fall under the same syntactic category. In this study, we capitalize on what we believe is an important difference between the two: while cardinals are by nature recursive elements, quantifiers are not, (34).

\[(34) \quad \text{a. } *\text{Pola arketa, *merika liga, *arketa kambosa, etc.} \\
\text{many some/some few/some a few} \\
\text{β. } \chi\lambda\xi\alpha, \delta\iota \chi\lambda\xi\alpha\delta\varepsilon, \tau\rho\iota\alpha \varepsilon\kappa\alpha\omicron\omicron\mu\iota\alpha \gamma\kappa\alpha\omicron\sigma\xi\varepsilon\varepsilon \chi\lambda\xi\alpha\delta\varepsilon \\
(\text{a) thousand/two thousand/three million five hundred thousand, etc.})\]

Recursion with numerals is of course an inherent property of numbers. Here we leave aside the arithmetic aspect of it and focus on its linguistic expression. As the gloss in (34b) indicates, the linguistic expression of a numeral is expandable, hence exhibits recursivity. We assume that this important property of recursivity can be encoded in a feature \[\text{[card]}\], which all cardinal numerals bear. Cardinality in the syntactic structure is associated with Number Phrase, and only items with this feature can appear in it (reference - Bouchard). We therefore assume that cardinals are hosted in Number Phrase and, in particular, in its Specifier position, (35).\[\text{[card]}\]

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9. See I&M, who offer a semantic account of the recursive property of numerals.

10. It could alternatively be assumed that they lexicalize the head Num. We leave this issue open for the moment, as it also bears on one’s view of the position of approximative/degree expressions such as \peri\nu ‘approximately’, \svedon ‘almost’, etc. If these approximative expressions occupy spec, Num, then cardinals must be in the head position. However, adopting the common view that degree adverbials head a projection above AP, we assume that approximative adverbials, like degree
The head Num in (35) selects the category that follows it, which can be an NP, as in (35), or a (partitive) PP, as in (25) earlier (but not a DP). In essence, it is the numeral in the Specifier of NumP that selects this category by virtue of it agreeing with the head Num. Recall from section 3 that cardinals and Qs alike license bare nominal arguments. There are two alternatives at this point. It can be assumed that the cardinal in (35) raises from Spec, NumP to Spec, DP so that the nominal projection acquires argumental status. Or, it may be assumed that the cardinal stays in NumP and that argumental status is granted by the empty D. As I&M point out (op. cit.: 6-7) any theory of indefinites or empty D’s can account for cardinals as well (for instance Longobardi (1994), Chierchia 1998, Landman 2003, a.o.). We opt for the latter alternative, as the more economical and general one. So our analysis, on these grounds, can capture the facts presented in (16)-(17).

By proposing the structure in (35) we further capture the fact that cardinals agree with the noun and all other modifiers in the nominal projection, because they are specifiers of a functional projection. Furthermore, (35) accounts for the high position of cardinals, given that NumP is situated high in the DP. Finally, our analysis is in the spirit of I&M (2006), who take cardinals to be semantically modifiers, since, by virtue of being in Spec, NumP, cardinals are considered to be syntactic modifiers of the noun, just like other adjectives that are situated in the specifier position of functional/agreement categories.

Notice incidentally that our proposal in (35) reflects the assumption that the indefinite article is merged in a position lower than the definite article itself. As indicated in (35), the Greek indefinite article is homophonous to the cardinal ‘one’ (ена-s).

In the light of (35) and what was said in the beginning of this section, we conclude that cardinals are a special class of quantifiers, the members of which bear the feature [card]. (Weak) quantifiers are therefore taken to project a category QP, as is standardly assumed for these items (e.g. Abney 1987 and subsequent literature in the GB/Minimalist paradigm).

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11 In view of the ungrammaticality of *tris i mathites ‘three the students’.
12 According to C&G (op.cit.) this holds for all quantifiers, but here we deal only with weak Qs.
5.2 Complex Numerals

5.2.1 Numerical Nouns with SET interpretation
Recall from section 2.3 that:
(i) two-word cardinals higher than 1000 consist of a simplex cardinal followed by a numerical noun in –ada.
(ii) two-word numerals smaller than 1000, comprising numerical nouns in –ada, do not have a cardinal interpretation. Rather, they denote sets of elements, in particular, they have a SET interpretation (S&T), consider again (6) repeated below for convenience.

(6) a. Agorase tesseris ekatondades vivlia.
   bought-3s four hundred-ades books
   ‘She bought four sets/boxes/etc. of a hundred books.’

b. Efere tris eksades bires.
   brought-3s three six-ades beers
   ‘She brought three (packs of) six beers.’

Stavrou & Terzi (2008) consider such numerical nouns in –ada as semi-lexical (van Riemsdijk 1998), comparable to the classifier phrases in Chinese (Chierchia 1998; Cheng & Sybesma 1999; Loebel 1999; Stavrou 2003). We further assigned to them the structure in (36), proposed by Stavrou 2003 for the Greek pseudopartitive construction.

(36)

\[
\begin{array}{c}
\text{DP} \\
\text{3} \\
\text{D'} \\
\text{3} \\
\text{D} \\
\text{g} \\
\text{3} \\
\text{NUMP} \\
\text{[-def]} \\
\text{g} \\
\text{NUM'} \\
\text{3} \\
\text{tris} \\
\text{three} \\
\text{NUM} \\
\text{[±PL]} \\
\text{3} \\
\text{NUMCLP} \\
\text{NUMCL'} \\
\text{3} \\
\text{NUMCL} \\
\text{NP} \\
\text{g} \\
\text{4} \\
\text{eksades} \\
\text{six-ades} \\
\text{bires} \\
\text{beers} \\
\text{ekatondades} \\
\text{vivlia} \\
\text{hundred-ades} \\
\text{books} \\
\end{array}
\]

In (36) the Numerical Phrase headed by the numerical noun introduces a Pseudopartitive (PsP) construction. The numerical noun in –ada patterns with the nouns which regularly participate in the PsP construction, namely, measure nouns

13 It must be said that whether a numerical noun with the suffix-ada has a noun or cardinal interpretation is not a random fact. It correlates with whether or not there is a simplex cardinal available with a proper cardinal interpretation. Thus for multiplicatives lower than 1000, there is a simplex cardinal formed the way illustrated in 2.1. But for numbers from 1000 onwards there is no a simplex cardinal. Consequently, the complex cardinal has uniquely a cardinal and not a set (viz. nominal) denotation. The relevance of this important fact will become clear in section 5.3.
(kilo), classifier-like nouns (bunch), group nouns (herd, flock), numerical nouns (dozen), etc. We follow the view that PsP is a unitary nominal phrase with a single referent, despite the inclusion of (apparently) two nouns in it (Riemsdijk 1998; Stavrou 2003).

Like all other semi-lexical nouns, eksades ‘sets of six’ or ekatondades ‘sets of a hundred’, in (6), select as their complement the lexical N, bires ‘beers’ and vivlia ‘books’ respectively, in (36).

5.2.2 Numerical Nouns with Cardinal interpretation
Greek (multiplicative) of xilja ‘a thousand’ and of ekatomirio ‘a million’ consist of two words and are cardinal numbers (cf. 7):

(37) a. Katanalosan tris xiljades bires sto gamilio parti.
    consumed-3p three thousand-ades beers at the wedding party
    ‘They consumed three thousand beers at the wedding party.’

b. I vivliothiki tu tmimatos exi tessera ekatomiria vivlia.
    the library the department has four million books
    ‘The departmental library has four thousand books.’

The structure we propose for these complex cardinals appears in (38). (38) is essentially a combination of (35) and (36). The entire numerical expression (i.e. tris xiljades ‘3,000’) occupies Spec, Num, the position where we assume cardinals regularly occupy. In other words, in (38) theSpecifier of NumP hosts the PsP construction.\footnote{It is interesting that I&M, their example (22b), reach a very similar conclusion.}

(38)

\[
\begin{array}{c}
\text{DP} \\
\text{3} \\
\text{D'} \\
\text{3} \\
\text{D} \\
\text{g} \\
\text{[-def]} \\
\text{3} \\
\text{DP} \\
\text{3} \\
\text{NUMP} \\
\text{3} \\
\text{g} \\
\text{NUM'} \\
\text{3} \\
\text{D'} \\
\text{3} \\
\text{NUM} \\
\text{3} \\
\text{FP} \\
\text{3} \\
\text{g} \\
\text{NUM'} \\
\text{3} \\
\text{F'} \\
\text{3} \\
\text{g} \\
\text{NUM'} \\
\text{3} \\
\text{NP} \\
\text{Q [card]} \\
\text{tris} \\
\text{3} \\
\text{NUM} \\
\text{3} \\
\text{NUMCLP} \\
\text{vivlia} \\
\text{3} \\
\text{NUMCL} \\
\text{3} \\
\text{g} \\
\text{NUMCL} \\
\text{3} \\
\text{books} \\
\text{3} \\
\text{xiljades} \\
\text{three} \\
\text{NUM} \\
\text{3} \\
\text{NUMCLP} \\
\text{vivlia} \\
\text{3} \\
\text{NUMCL} \\
\text{3} \\
\text{g} \\
\text{NUMCL} \\
\text{3} \\
\text{books} \\
\text{3} \\
\text{xiljades} \\
\text{three} \\
\text{NUM} \\
\text{3} \\
\text{NUMCLP} \\
\text{vivlia} \\
\text{3} \\
\text{NUMCL} \\
\text{3} \\
\text{g} \\
\text{NUMCL} \\
\text{3} \\
\text{books} \\
\text{3} \\
\text{xiljades}
\end{array}
\]

[\text{num: locus/source of recursion}]

Just as in (36), D is empty here too--being [-def]. As we did for (35), we assume here too that the indefinite interpretation is related to the empty D (Longobardi 1994) and
that what we said about the argument status of simplex cardinals in (35) hold for complex cardinals in (38) as well.

An important fact which will be highly relevant to what follows is that in all previous structures, i.e., (35), (36) and (38), the noun phrase gets a weak/existential interpretation (Milsark 1977) (cf. examples (20)-(22)).

Having underlined the similarities between the PsP structure in (36) and in the complex cardinal structure in (38), we now must point out the differences between them. While in (36), the (numerical) semi-lexical noun selects the lexical NP, in (38) there is no such selection relation between the semi-lexical noun and the NP. This is because the semi-lexical noun in (38) is embedded in the DP which is in Spec, NumP and from that position it cannot select the noun in the ‘main’ DP. Rather the entire DP in spec, Num modifies the lexical noun, as in (35). In (38), just as in (35), it is Num that takes the (main) NP as its complement. WE NEED TO THINK ABOUT THE SELECTION ISSUE.

We assume that the numerical noun that participates in the PsP construction in (36) does not carry the feature [card]. The implication of this assumption is that even in the cardinal interpretation ((38)) numerical nouns do not carry the feature [card]. Instead, it is by virtue of the numerals that precede them that the whole complex cardinal in (38) is located in the Spec, NumP position. A complication at this point—hopefully not a serious one—is that there is nothing in principle to prevent numerical nouns like eksada (a six), or ekatondada (a hundred) from being merged in structure (38). But we have assumed that (38) represents a structure where cardinals, in their ‘true’ cardinal function are merged in specNum. Rather it is structure (36) that is ‘reserved’ for numerical nouns without a cardinal interpretation. We assume that a factor which is responsible for the non-occurrence of ekatondada in (38) is the fact that there is a simplex cardinal—djakosia (two hundred)—which exists and is merged in (38). The existence thus of a simplex cardinal has a blocking effect (Embick 2003) for the appearance of the numerical noun in the same position. This assumption still leaves us with the question why can a numerical noun with a SET interpretation, and for which there is no corresponding simplex cardinal—not appear in (38). The null hypothesis would be that it can but if it does, the derivation will crash as it will not receive any interpretation.

In conclusion, one-word and two-word cardinals are treated alike syntactically; despite their different internal make-up, they are both placed in Spec, NumP.

5.3 ‘Cardinals’ and definite DPs

In this subsection we will tackle the issue of definiteness of the DP in which a cardinal or weak Q appears. So far, we have been tacitly assuming that the DP in which cardinals (simplex and complex alike) figure are inherently indefinite. Let us draw attention to the fact that the main D in (35), (36) and (38) bears the feature [-def], and as a sequence the resulting DP gets an indefinite (weak/existential) interpretation. The question is can the DP-with-cardinal not be definite? Apparently it can.

In particular, in section 3.3 we said that cardinals and weak quantifiers share the property of being preceded by the definite article, (11c) and (26) are relevant examples. Importantly, however, we assume, with C&G (1992, 2005), that when the numeral (or the weak quantifier) follows the definite article, as in ta tria pedia ‘the three children’ and ta pola pedia ‘the many children’, they are not the same,
semantically and syntactically, as in an indefinite DP. In the former case they are taken to constitute a particular subclass of adjectives; namely, the subclass of quantity denoting adjectives. We adopt the term QA from C&G for these ‘cardinal’ adjectives. QA, being adjectives, must thus be considered as specifiers of an agreement-type projection (designated as F1P) in (41 below). This projection must be quite high, as quantity adjectives precede all other adjectives:

(39) ta tria orea sigxrona kalokerina sinema
    the three nice modern summer cinemas

In the remaining of this subsection we will provide some empirical evidence for the claim that QA are indeed different from cardinals and weak Qs (as they feature in indefinite DPs).

In Stavrou 2003 it was suggested that the pseudopartitive construction is an inherently indefinite DP (2003: 344-345). This is shown in the first place in examples like (Stavrou’s example (24a-b)):

(40) a. Dose mu ena potiri krasi.
    give-IMP me a glass wine
b. *Dose mu to potiri krasi apo ki pano.
    give-IMP me the glass wine from there above

In an indefinite DP the measure/classifier phrase is used to count or measure what the lexical NP denotes. Stavrou (op.cit.: 340) writes that “ena potiri (a glass, S&T) (…) behaves like a true quantifier and gets a weak, cardinal reading.” In contrast, when preceded by the definite article the same measure nominal expression acquires the function of an attributive adjective/modifier, which is used to identify the referent of the containing DP (ibid). Extending those observations to the data examined here and to our proposed structures, the same claim can be made for the PsP structure in (36). Following further the line of reasoning of Stavrou (2003), and based on similar data, we claim here that when D is realized by the definite article in (35) and (38), the numerical expression does not count/measure any longer but refers back to an already counted/measured entity. The definite counterpart of (35) is given in (41):

(41)

\[
\begin{array}{c}
\text{DP} \\
3 \\
D \quad \text{F1P} \\
g \quad \text{F1} \\
i \quad \text{QAP} \\
\text{the} \quad \text{F1’} \\
\text{diakosii} \quad \text{F2P} \\
two \text{hundred} \quad \text{F2} \\
\text{epithetiki} \quad \text{NP} \\
\text{aggressive} \quad 4
\end{array}
\]

\[\textsuperscript{15}\]To be more precise here, what we claim about cardinals in definite DPs applies also for weak Qs. However, for simplicity reasons, and since Qs are not our immediate concern here, we focus only on cardinals and their ‘definite’ counterpart, viz. quantity adjectives.
The main point here is that *diakosii in (41) is not a cardinal but a quantity denoting adjective (QA). It occupies the specifier position of F1P.16

However, a question arises at this point, namely, whether a cardinal or Q can also be present when QAP is present in the structure. The ungrammaticality of the sentences below shows that it cannot:

(42) *i djakosii poli diadilotes
    the two hundred many demonstrators

The reason however must be a purely semantic one, namely that not more than one quantificational expression may be present in any single DP. Such a constraint must be assumed independently; it was, e.g., proposed by Jackendoff (1977:104, his ‘Specifier Constraint’) to exclude the co-occurrence of the two quantifiers which were otherwise assumed to come out form the two higher levels of the noun phrase (N’’’ and N’’). A similar restriction is assumed to hold by Zamparelli 1995, who also proposes two positions for quantifiers in the noun phrase (see also C & G for discussion of Zamparelli’s constraint).

Mention of the constraints on the co-occurrence of more than one cardinal /Q gives us an excellent opportunity to refer to the empirical evidence that supports the non-cardinal status of QA in (xxa). As C&G point out, while a cardinal or a Q inside a partitive construction (‘Ymany of the Xmany..’) gives rise to ungrammaticality (a):

(43) a. *many of two hundred and forty tests to mark… (C&G:22, their ex (74)-(75))
when there is a QA in the partitive complement, no ungrammaticality arises:

   b. many of the two hundred and forty tests to mark… (C&G:op.cit)

The above example can be reproduced in Greek with the same result. But we want to take C & G’s argument one step farther and say that it is exactly because it is a QA the cardinal or the Q CAN participate in the partitive construction in the first place. As Jackendoff (1977: 109-113, cf. his ‘Partitive Constraint’) and Selkirk (1977) argue (also Stavrou 1983 for Greek), the partitive PP must have as its complement a definite noun phrase—this is an independent requirement for the partitive construction. Given the contrast in (43 a-b), it is obvious that it is the QA that can appear in the PP part of the partitive construction, not what is a ‘genuine’ cardinal (or Q). But this very fact proves the point: QA and cardinals/weak Qs are not entities of the same rank. Lingering on the partitive construction a little, it is further interesting to notice, as C & G (op.cit.) do, that it is only Q and cardinals that can select the partitive PP, not QA.17 Thus in (44) below, only the (a) version is a true partitive construction, as the PP selects a definite DP (cf. Jackendoff, ibid.); the (b) version is not:

---

16 We have omitted NumP in (41), just for simplicity of exposition. NumP us assumed to be present in any DP, as it encodes cardinality/Number. However, we are not sure as to whether F1P is above or below NumP, but its exact merging position is not relevant to the point made here. In any case it precedes other adjectives, so it must be quite high.

17 Actually this constraint on QA is one of C & G’s diagnostics for QA status.
In fact that the QA (i.e. a cardinal preceded by the definite article) cannot select a partitive PP can be explained by our claim that a ‘definite’ cardinal does not count but picks up an already counted entity. Crucially, the function of the partitive construction is to pick out (or deduct) from the denotation of the PP a quantity denoted by the indefinite DP that selects the PP (cf. also ex (18) in section 3.2.2).

Finally, in (45) we provide additional syntactic evidence for the different status of cardinals when preceded by the definite article, i.e. when they figure in structure (41). Consider the following contrast:

\[(45)\]

\[\begin{array}{ll}
\text{a. } & \text{Ida tris protus fitites.} \\
\text{b. } & \text{Ida tus tris protus fitites.} \\
\text{c. } & \text{Ida tus protus tris fitites.}
\end{array}\]

When the numeral is a true cardinal, inside NumP in (35), it has selectional properties; presumably, it does not select an ordinal, hence the ungrammaticality of (45a). But when it is a quantity adjective, as in (41), it is at the specifier of an agreement projection. Therefore, no similar selectional restrictions apply, hence the contrast between (45a) and (45b). We see that the (quantity) numeral can then be followed by ordinals, and, more precisely, the order between quantity adjectives and ordinals appears to be free, (45b)-(45c).

Having argued that the structure in (41) is an appropriate structure for simplex cardinals when they are found in a definite DP, we must now ask what is the structure for complex cardinals in a definite DP; which means what is the definite counterpart of (38). Our answer to this question is depicted in (46):

\[(46)\]

In (46) we see that what in (38) was located at specNum is here in the specifier of a (high) agreement projection, just as in (41) above. Notice that now the higher D is def,
and hosts the definite article, whereas the D of the DP which is the specifier of F1P is empty, hence indefinite. Once again the DP in the specF1P is a pseudopartitive structure (36). Below we give four DPs which constitute conclusive support for the structures we have proposed so far, which crucially distinguish between indefinite and definite cardinals, or between cardinals and QA.

5.4 Agreement and complex cardinals

Section 2.3 demonstrated that simplex cardinals, just like adjectives, agree with the lexical noun in all phi-features. For complex cardinals involving numerical nouns a special mention must be made. Notice the gender mismatches in (34), which arise between the lexical/head noun and the numerical noun in Spec, Num, (33a), or in Spec, F1P, (33b).

(33) a. [NumP [ DP tris xiljades] [ NP vivlia ]]
   three thousand. fem.pl books.neut.pl
   ‘three thousand books’

   b. [ DP [[D tis] [ AP dio ekatomiria] [N jinekes]]]
   the two million. neut.pl women.fem.pl
   ‘the two million women’

(34) Numerical noun [fem]—> lexical noun [masc/fem/neut]
Numerical noun [neut]—> lexical noun [masc /fem/neut]

We assume that the mismatch in gender between numerical and lexical noun is due to the fact that gender is an inherent feature of nouns, considered interpretable (for nouns). Since the numerical noun is morphologically a noun, it has its own gender feature (which is interpretable, therefore, does not have to match the gender feature of the lexical noun via Agree in order to erase). As a result, such a mismatch does not cause the derivation to crash.

On the other hand, there is always full agreement between numerical and lexical noun in case and number. No mismatches in number and case are tolerated.

6 English numerical expressions

Kayne (2006) discusses the following two types of English numerical expressions:

(35) hundreds of books
(36) three hundred books

He proposes that numerals such as in (35) involve an unpronounced nominal suffix -AINE, which attaches to the multiplicand ‘hundred’ and contributes the interpretation of approximation. On the other hand, numerals as in (36) involve a different nominal suffix, -NSFX. The proposed structures appear below:

(35’) hundred-AINE-s of books
(36’) three hundred-NSFX books

18 We should note here that we do not think the approximative interpretation Kayne (2006) attributes to the expression in (35) is accurate, but this is not immediately relevant for the present discussion.
Several differences between the above two instantiations of the same English lexical item, i.e., ‘hundred’ are noted, for which no straightforward account is provided in Kayne (2006):

(37)  
a. (35) requires the preposition ‘of’, while (36) does not accept it.
b. (35) requires a plural morpheme, while (36) does not accept it.

If we extend our claims we based on Greek facts to the above English numerical expressions, we are in a position to account for the behavior in (37). In Stavrou & Terzi (2007) we discuss another type of Greek numerical expression, which we associated with High Number interpretation, (35).

(35)  
a. Ekane dekades/ekatondades/xiljades lathi.
    made-3s ten-ades/hundred-ades/thousand-ades mistakes
    ‘He made tens/hundreds/thousands of mistakes.’
b. Ekatondades/xiljades orgismeni diadilotes emfanistikan.
    hundred-ades/thousand-ades angry demonstra
    ‘Hundreds/thousands of angry demonstrators appeared.’

For the above Greek numerical nouns we have assumed to be like weak Qs (but with no [card] feature). We consider them to also head a PsP construction (but that they raise to D and then to Foc, where they get their focal stress).

⇒ If we take (35) to be the counterpart of the Greek numerical expression in (35), then we have to assume that it also introduces a PsP construction. It then comes as no surprise that the preposition ‘of’ is indispensable. Moreover, the plural morphology is expected, as the PsP is introduced by a (semi-lexical) noun. By contrast, we have no indication that ‘hundred’ in (36) is a noun (unlike its Greek counterpart in (7)=(30)). If it is adjectival, as we have proposed to be the case with Greek simplex cardinals, the lack of plural morphology is expected. Naturally, there is no reason to expect the presence of the preposition ‘of’ either.

A conjecture Kayne (2006) makes is that the -NSFX suffix proposed for (36) may have the SET interpretation we see in (37) below.

(36) They entered the room in threes. (Kayne’s (124))

Our proposals do not support this conjecture. We agree that threes in (36) has a SET interpretation, which, according to our claims, is contingent upon a PsP structure introduced by a (semi-lexical) noun, hence its plural morphology. There is no indication, however, that the complex numeral in (36) demonstrates any of these properties. We believe that the -NSFX suffix Kayne (2006) proposes for complex numerals as in (36), if indeed present and if indeed nominal, is simply the

---

19 In Stavrou & Terzi (2007) we note a few more isolated instances in English in which the SET interpretation appears (to be precise, it is actually a more of a container interpretation), with the associated property of the PsP, hence containing the preposition ‘of’ as well.

(i) a six of beer
(ii) a six/sixer of cigarettes
unpronounced counterpart of the Greek suffix –ada/ades in (7)=(30), in the sense that it does not contribute some particular interpretation.

7 Conclusions

Starting from the distinction between one-word, or simplex cardinals and two (or more)-word, or complex cardinals of the multiplicative type we proposed a syntactic analysis of both of these types. We showed that cardinals are morphologically like adjectives and at the same time they share with weak Qs basic semantic properties, most importantly existential force. We proposed that cardinals constitute a subclass of Qs, endowed with the feature [card], and by virtue of this feature they are located in the specifier of Number Phrase. Being at a specifier position, they function as modifiers of the noun.

Complex cardinals have the internal structure of a pseudpartitive DP. It is the entire PsP that occupies specNum.

Other numerical expressions, which also involve numerical nouns, but do not have cardinal interpretation, have been identified in earlier work as involving a semi-lexical noun that introduces a PsP construction.

We also distinguished between ‘true’ cardinals and weak Q with existential interpretation on the one hand and the same items on the other when following the definite article, and claimed, in the spirit of Cardinaletti & Giusti, that they are QA (Quantity denoting adjectives). As such they are specifiers of an agreement projection, not at NumP. Certain important facts were shown to follow from this distinction.

- The above claims are able to explain some English puzzling facts:
  a) the appearance of plural morphology and of the preposition ‘of’ in numerical expressions with high number/approximative interpretation,
  b) the impossibility of plural morphology when the very same English numerals are part of multiplicative complex cardinals.

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