1. Introduction

Based on novel empirical evidence from Lebanese Arabic and Standard Arabic, this paper argues that complex numerals are formed prior to merging with a DP, and that they are formed through numeral-specific operations not involving general linguistic means like coordination and modification.

I specifically argue that additive complex numerals, like (1b) do not involve coordination of any usual kind. Specifically, they do not involve DP coordination, NP coordination, or coordination of the numerals as modifiers. I argue that numerals are not modifiers of type <<e,t>,<e,t>> (Ionin and Matushansky 2004, 2006). Rather, I argue for the proposal that they are arguments of their own type, n, which require mediating functions in order to compose with the rest of the DP (Zabbal 2005, Scha 1981, Ouwayda 2010, 2012, 2014).

(1) a. Three hundred children
    b. Fifty-four apples
    c. Four hundred and nine stories

The following section briefly describes the two opposing views. Section 3 presents the core evidence presented in favor of the dedicated function view supported in this paper. Section 4 discusses evidence in favor of the coordination view. Section 5 concludes.

2. Two views

As Ionin and Matushansky (2006) point out, complex numerals cannot be formed entirely outside of the linguistic system: This possibility is
straightforwardly ruled out by the fact that numerals interact very directly with case assignment, which is a purely linguistic phenomenon: We already know that in a lot of languages, complex numerals as well as their sub-parts are case marked according to what precedes them, and they assign case marking on the words that follow them. This is illustrated in (2) in Standard Arabic. As the example shows, not only do parts of speech other than numerals assign case to numerals and vice versa, but different parts of a complex numeral receive case assignment based on the structure of the complex numeral. Specifically, the first part of the numeral multiplicative, *mi’at-a* ‘hundred’ in (2), is accusative marked, which is the case marking expected for the DP containing it because it is the object of the verb *ra’aytu* ‘I saw’. Moreover, the noun *fataat-in* is genitive marked due to the presence of the numeral. But like the noun following the numeral, the second half the multiplicative numeral, *alf-i* ‘thousand’, is genitive marked, as it follows *mi’at-a* ‘hundred’.

![Diagram of case assignment](image)

Taking as established the fact that the language faculty (specifically syntax) plays at least a partial role in the formation of complex numerals as they occur in language, we are left with two views, one in which the formation of complex numerals is purely linguistic, and one in which it is only partially linguistic. So the question becomes: To what extent is the formation of complex numerals linguistic? And if complex numeral formation is partly or wholly linguistic, when in the formation of a numeral containing DP does it take place?

One way to look at complex numerals is to assume that they are a combination of addition and multiplication of simple numerals, resulting in multiplicative complex numerals (1a), additive complex numerals (1b), and combinations of the two (1c).

Arguing that all numerals are modifiers of type <<e,t>,<e,t>>, Ionin and Matushansky (2004, 2006) propose that multiplicative complex numerals are the result of iterative modification (3), and additive complex numerals are the result of DP coordination (4). Thus, the formation of complex numerals takes place alongside the formation of the DPs that contains them. In this sense, Ionin and Matushansky place the formation of complex numerals completely in the linguistic system, with general linguistic functions (modification and coordination) at play.
A competing view treats numerals as their own type, $n$, needing a mediating function to merge into a DP (Scha 1981, Zabbal 2005, Ouwayda 2012, 2014). In this view, complex numerals are formed through dedicated additive and multiplicative functions, separate from coordination and modification, and which operates on numerals independently of any other parts of speech. This view is consistent with both a purely linguistic view and a partly linguistic view, as these functions can be semantic functions ‘+’ and ‘×’ with $n$-type arguments, and whose denotation is exactly that of addition and subtraction, as illustrated in (5), (6), and (7). Or they can be purely mathematical, non-linguistic functions, occurring before the numeral’s merger into syntax. In either case, importantly, the composition of a complex numeral occurs prior to its merger into the DP, and does not involve any other parts of the DP.
3. Decisive evidence

In this section, I provide new evidence that additive complex numerals occurring in DPs are formed in two different ways, one that indeed involves DP coordination, and another in which components of the complex numeral compose with each other prior to merging with the rest of the DP. I do this by showing that additive complex numerals cannot always be reduced to multiple coordinated DPs with PF-deletion deletion of the noun. Crucially, I show that
additive complex numerals do not trigger agreement the same way that coordinated DPs do.

3.1. Agreement and numerals in Lebanese Arabic

First, I briefly review how agreement works, specifically in Lebanese Arabic. In SVO word order, in Lebanese Arabic, verbs must always agree in number with the subject, so if the subject is plural, as in (8a), the verb has to also be plural. If the subject is singular, as in (8b), “the boy arrived”, the verb has to also be singular. So in Lebanese Arabic, plural DPs trigger plural agreement on the verb, and singular DPs trigger singular agreement on the verb. Unsurprisingly, when the subject consists of two coordinated DPs, the verb has to always be plural marked, even if each conjunct is singular, as illustrated in (9a). This is also true for English, as shown in (9b).

(8) a. l-wleed weSl-uu/*∅
   the-boy-pl arrived-pl/*sg
   ‘The boys arrived’
 b. l-walad weSel/*-uu
   the-boy-sg arrived-sg/*pl
   ‘The boy arrived’

(9) a. [rejeel w walad] weSl-uu/*weSel
   man-sgand boy-sg arrived-pl/*arrived-sg
   ‘A man and a boy arrived’
 b. A man and a woman come/*comes here every day

As (10) illustrates, nouns that follow numerals larger than 10 in Lebanese Arabic are not plural marked. Verbs following such DPs are either plural or non-plural (Ouwayda 2012, 2014). This is illustrated in (11).

(10) a. xamsiin walad
    fifty boy-sg
    ‘fifty boys’
 b. *xamsiin wleed
    fifty boy-pl

(11) a. xamsiin walad weSel
    fifty boy-sg arrived-sg
    ‘fifty boys arrived’
 b. xamsiin walad weSl-uu
    fifty boy-sg arrived-pl
Based on this data, and associated semantic effects, Ouwayda (2012, 2014) argues that the verb can be singular because the presence of a numeral in a DP is not sufficient for the DP to be plural. Rather, there are two possible mediating functions that allow the merger of a numeral into the DP: # and $\exists_n$, and only one of them, #, is a syntactic and semantic pluralizer, and $\exists_n$ is not.

### 3.2. The evidence: agreement unlike coordination

Like other numerals larger than ten, additive complex numerals larger than ten also do not necessarily trigger plural agreement. So unlike coordinated DPs in (9a) which do not allow a singular marked verb, additive complex numerals larger than ten in Lebanese Arabic allow both singular agreement and plural agreement (12). Therefore, additive complex numerals behave syntactically differently from coordinated DPs with the first noun deleted, and thus cannot always be reduced to DP coordination as Ionin and Matushansky (2006) argue.

(12) a. miyyeh w xamsiin walad weSel
   hundred and fifty boy-sg arrived-sg
   ‘A hundred and fifty boys arrived’

  b. miyyeh w xamsiin walad weSel uu
   hundred and fifty boy-sg arrived-pl
   ‘A hundred and fifty boys arrived’

### 3.3. Not any other kind of coordination, either

Also, as Ionin and Matushansky (2006) point out, additive complex numerals do not behave like noun coordinations or smaller NP coordinations (14), thus treating (13) like the example in (15) discussed in Heycock and Zamparelly (2005). In these coordinated NPs, two smaller chunks, “friend” alone, and “colleague” alone, are coordinated before the merger of the determiner, and these DPs allow singular agreement. But (15) has to mean that one person is simultaneously a friend and at the same time is a colleague and he or she visits me in August. (13), however, does not mean that my friends, who are at the same time fifty people and they are also three people, arrived. With the same logic, the additive numerals cannot be reduced to regular modifier coordination (16), as this option would also predict an overlap in reference, as is the case in (17).

(13) My twenty five books arrived ≠ My books which are simultaneously twenty and at the same time they are five, arrived
(14) a. 

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(15) My friend and colleague visits me in August. = One person who is simultaneously a friend and a colleague visits me (Heycock and Zamparelli 2005)
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(16) a. 

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(17) My nice and handsome friend visits me in August = One friend who is simultaneously nice and handsome visits me
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(18) a. \[\text{[twenty and five]} = \lambda y . \exists S_\epsilon . [\pi(S)(y) \land |S| = 20 \land \forall s \in S \text{books(s)}] \land \lambda z . \exists S_\epsilon . [\pi(S)(z) \land |S| = 5 \land \forall s \in S \text{books(s)}] \]

b. \[\text{[twenty and five books]} = \lambda y . \exists S_\epsilon . [\pi(S)(y) \land |S| = 20 \land \forall s \in S \text{books(s)}] \land \lambda z . \exists S_\epsilon . [\pi(S)(z) \land |S| = 5 \land \forall s \in S \text{books(s)}] \]

d. Prediction: \[\text{[the twenty and five books arrived]} = 1 \text{ iff there is a unique individual x, and x can be partitioned into 20 parts each of which is a book, and x can be partitioned into 5 parts each of which is a book, and that individual arrived} \]

So we can also rule out any variations on the DP coordination theory, such as modifier coordination or NP coordination.
We also know that the internal composition of the two components of the additive complex numerals must, at least in some cases, take place prior to merging with the noun. One possible such structure is the one in (5), argued for by Zabbal (2005) and Ouwayda (2012, 2014), where there is a dedicated addition function that sums the two numerals first, and then the whole complex numeral merges into the DP as one unit.

4. Some additive complex numerals are coordinated DPs, and that’s not surprising

As Ionin and Matushansky (2004, 2006) point out, many languages have at least some additive complex numerals that visibly involve DP coordination. They list Luvale, Welsh, and Biblical Hebrew. This, in fact, is also true in Arabic, for numerals 101 and 102, as illustrated in (19)-(20) for Lebanese Arabic. In fact, they can only have this form – as illustrated by the ungrammaticality of the [numeral and numeral] noun form in (21). This is arguably because weeHed ‘one’ and tnein ‘two’ in Arabic are adjectives rather than numerals, as argued by (Shlonsky 2004). Since they are adjectives, they cannot precede the nouns, and they cannot compose with other numerals.

(19) a. miit kteib w kteib
    hundred book-Ø and book-Ø
    ‘a hundred and one book’
b. miit kteib w kteib-ein
    hundred book-Ø and book-dl
    ‘a hundred and two books’

(20) a. miiyeh w kteib
    hundred and book-Ø
    ‘a hundred and one/two books’
b. miiyeh w kteib-ein
    hundred and book-dl
    ‘a hundred and one/two books’

(21) a. *miyyeh w weeHed kteeb/ketob
    hundred and one book-Ø/book-pl
    ‘A hundred and one books’
b. *miyyeh w tneen kteeb/ketob
    hundred and two book-Ø/book-pl
    ‘A hundred and two books’
The difference between (19)-(20) which appear to be DP coordination, and (12), which the previous section showed cannot be DP coordination is structural and not just a superficial effect. This is shown in two ways: First, unlike (12), agreement on verbs following the DPs in (19) or (20) must be plural, despite the fact that the noun is also non-plural in some of these cases. This is shown in (22)-(23).

(22) \[[
\text{miim kteib} \quad w \quad [kteib] \]
weSI-uu/*weSel
\text{hundred book-ø and book} \quad \text{arrived-pl/*sg}
\text{‘a hundred and one books arrived’}

(23) \[[
\text{miyyeh w xamsiin} \quad kteib] \quad weSel/weSI-uu
\text{hundred and fifty book-sg} \quad \text{arrived-sg/pl}
\text{‘A hundred and fifty books arrived’}

Second, while nouns following numerals in standard Arabic are obligatorily marked accusative or genitive, depending on the numeral as (24) shows, the case marking on the second noun in the visibly conjoined forms is always the DP’s case. Here it is nominative, because the DP is a subject. This strongly suggests that “book” in this sentence is structurally at the same level as ‘hundred’.

(24) \text{mi’at-u kitaab-in wa kitaab-on waSal-uu}
\text{hundred-nom book-gen and book-nom arrived-pl}
\text{‘A hundred and one books’}

So numerals like 101 and 102 in Arabic must have a structure like that proposed by Ionin and Matushansky (2006), where there are two separate DPs “a hundred book” and “one book”, which are coordinated. While this is the case, I believe that this is not surprising. The coordinated DP form for complex additive numerals is simply a periphrastic way of expressing additive numerals in languages or syntactic environments that lack the direct way of doing so, either because of the way the simple numerals are, as in the Arabic numerals “one” and “two”, or because there is a parameter in that language that is not set. This is not the only place where this happens. Similar to this, a lot of languages have classifier systems, which are entirely built into their DP systems, like in Mandarin Chinese (25). In some other languages like English, however, there are no classifiers in the same sense. Instead, measure phrases like in (26) are used to express the meaning of classifiers in languages that lack them. While they express the same meanings, partitives/measure phrases have different syntactic properties (e.g. can be modified by adjectives and separated from the noun in ways classifiers cannot), and are analyzed as different syntactic objects from classifiers (Borer 2005, Cheng and Sybessma 2005, Doetjes 1997, among others)
5. Conclusion

While conjoining multiple DPs is one possible way to express additive cardinality, and that option is attested in some languages and some syntactic contexts, there is a dedicated function that allows for complex numerals to compose internally prior to merging with the rest of the DP. The semantics of the additive operation is different from that of coordination, as it behaves differently from coordinations of nouns, adjectives, and DPs.

References


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