The Morphological Derivation of Numerals

Bachelor Thesis

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Date: 29-06-2015

Abstract

The numerals that exist in natural languages can be divided into different classes of numerals, of which the most common are cardinals, ordinals, fractionals, multiplicatives, approximatives, collectives and distributives. Often in studies on numerals, it is (implicitly) assumed that the numeral classes, if morphologically derived, are universally derived from cardinals, and the exceptions to this are overlooked or ignored. In this thesis the numeral classes are morphologically analysed in a sample of five structurally and genetically unrelated languages: Dutch, Bulgarian, Hungarian, Japanese and Adyghe.

What patterns of derivation can be observed? And what can these patterns tell us about the morphology and meaning of numerals of different classes?

The results do not support the 'naive' picture. Ten non-typical derivation paths were attested. Four of them connect the fractional denominator and the ordinal numerals. Four others connect the multiplicative to cardinals, ordinals, approximatives and distributives respectively. Two of them connect the multiplicative and the fractional denominator.

Cognitively, the numerals below 4 are processed by the Object Tracking System (OTS), and the numerals 5 and higher are processed by the Approximate Number System (ANS), according to Spelke (2011). Ordinal and fractional constructions in my sample seem to reflect this distinction: only the forms involving lower numerals have suppletive forms. It is also reflected in the numeric scope of the derivational rules for multiplicatives and collectives.

As my sample does not exhaust all derivational possibilities. Future research may discover more 'exotic' derivations.

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1. Introduction and Problem Statement

In every language, a numeral system can be found. Hurford (1975) states: “Every known language has a way of naming at least a few numbers. The concept of numerosity is universal” (2). These numeral systems have been the subject of many linguistic studies. In Fradin’s chapter “Denumeral categories”, published in 2013, he discusses the ways in which numerals can be derived into morphologically complex lexemes.

The most well-known numeral classes are cardinals, ordinals and fractionals, illustrated for English in (1). According to Fradin (2013) they form infinite series without gaps and can be used for counting and mathematical operations.[1]

(1) Cardinals: *one, two, three, four*

Ordinals: *first, second, third, fourth*

Fractionals: *half, one third, a fourth*

Typically, fractionals are made up of a numerator and a denominator. Other numeral categories like those in (2) are less strictly number-based. Unlike the numerals in (1), they form gapped, finite series, and they are not attested in all languages (Fradin, 2013).

(2) Multiplicatives: *once, twice*

Approximatives: *desetína* ‘approximately ten’ (Bulgarian)

Collectives: *dváma* ‘a group of two, a pair’ (Bulgarian)

Distributives: *san-satu-zutu* ‘three (books) each’ (Japanese)

In most studies on numerals, it is (at least implicitly) assumed that all of these numeral classes are directly derived from cardinals. This ‘naïve’ view is illustrated in Figure 1.

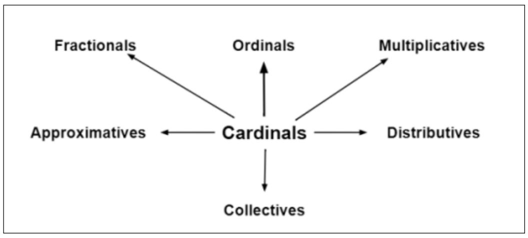


Figure 1. The ‘naïve’ picture (Bylinina, 2014)

It is true that in most languages, different categories of numeral classes are indeed directly derived from cardinal forms. In Dutch, for example, the ordinal *vierde* ‘fourth’ is directly derived from the cardinal numeral by adding an ordinal suffix:

(3) Vier-de

4-ORD

‘Fourth’

In Hungarian, however, a remarkable pattern of derivation is attested. Hungarian ordinals are not derived directly from the corresponding cardinal numerals. Instead, the form of the fractional

[1] The infinity of these classes of numerals is not a cross-linguistic universal - see for example Pica and Lecomte’s (2008) work on Munduruku ,and Everett’s (2004) work on Pirahã.

denominator is used as a base for the derivation of ordinals. The cardinal *tíz* ‘ten’ becomes *tized* when used as a fractional denominator, and the ordinal numeral is *tizedik*:

(4) *Tíz-ed-ik*
10-FRAC-ORD
‘Tenth’

This pattern of derivation applies to most ordinals in Hungarian, but there are also exceptions. The ordinal for ‘one’ is *első* - not the regularly derived **egy-ed-ik* (the asterisk indicates ungrammaticality). We call this *suppletion.*

(5) Első
First.SUPPL
‘first’

Similar issues - patterns of morphological derivation and their (ir)regularity - have been studied by Bobaljik (2012) in the domain of gradable predicates.

He observes that the comparative forms ‘better’ and ‘worse’ stand in a suppletive relation to ‘good’ and ‘bad’. The superlatives ‘best’ and worst’ are in turn derived from these comparative forms, not from the positive, or unmarked, ones. This is an ABB pattern of comparative suppletion, as can be seen in (6).

(6) *Good* - *better – best (ABB)*
Bad - *worse – worst (ABB)*

According to Bobaljik’s (2012) typological study, other patterns like ABA and AAB are absent in comparative suppletion. The analysis of morphological patterns can thus lead to the discovery of significant regularities in seemingly the most irregular morphology. Bobaljik (2012) argues that morphological theories, particularly those concerning suppletion, should be able to predict the absence of unattested patterns, as well as describe what is already attested. Universals of morphological structure need to be discovered and explained (Bobaljik, 2012).

In line with Bobaljik’s study, the aim of my thesis is to describe patterns of derivation. When a morphological pattern of derivation is frequently attested, it could lead to generalisations which may be able to predict what is and what is not possible in the derivation of numerals. Simultaneously, rarely attested patterns of derivation pose an even more serious challenge for a typological study, as, on the one hand, they tend to be overlooked in typological work, while, on the other hand, these facts directly affect our understanding of the space of derivational possibilities in natural language.

The main research question I aim to answer in my thesis is: “What are the morphological derivation patterns for numerals, and what can these patterns tell us about the morphology and meaning of numerals of different classes?” I will focus on languages exhibiting typologically rare derivational patterns in the domain of numerals, thus adding important data to the discussion of derivational morphology in the numeral domain.

In Chapter 2, I will explain what methods I used to answer my research question. In Chapter 3 I will introduce the project 'Language and Number' this work is closely related to. Chapter 4 forms the heart and the biggest part of my thesis: every numeral class mentioned in example (1) and (2) above will be analysed in terms of their morphological derivation patterns in five languages (see Chapter 2). My conclusions and can be found in Chapter 5.

2. Methods

To answer the main research question, the derivations of numeral classes will be analysed in five different languages: Dutch, Hungarian, Bulgarian, Japanese and Adyghe. Although this is a very small sample of the world's languages, it includes languages that are very different structurally and genetically, see Table 1 below. For clarity all examples will be written in extended Latin script.

Language	**Language family**
Dutch	Indo-European, Germanic, West, Low Saxon-Low Franconian, Low Franconian
Bulgarian	Indo-European, Balto-Slavic, Slavic, South-Eastern
Hungarian	Uralic
Japanese	Japonic
Adyghe	North Caucasian, West Caucasian, Circassian

Table 1: Language families. ***(Lewis et al. 2015, Ethnologue)***

Information about the numeral systems of these languages was collected from grammatical descriptions of different languages, and other written sources such as articles. As written sources turned out to be not enough, questionnaires were sent to speakers of Bulgarian, Hungarian, Japanese and Adyghe. This questionnaire consisted of a translation task. The informants were asked to give as many translations as they knew, and if possible morpheme-by-morpheme translations.

3. The project 'Language and Number'

My thesis was inspired by the project Language and Number as conducted at the Meertens Instituut in Amsterdam. The project Language and Number is part of the Horizon Project "Knowledge and Culture". This project is based on the assumption that humans and non-human animals are born with 'core knowledge systems': small sets of hard-wired cognitive abilities that are able to build mental representations of objects, persons, spatial relationships and numerosity (Spelke, 2003). Unlike animals, humans also have species-specific cognitive abilities like language and music. It is assumed that some cognitive abilities are innate.

The subproject "Language and Number" poses the following question. How can linguistic investigations of number shed new light on our understanding of the core knowledge system for number?

Spelke (2011) has shown that the core knowledge system of number is made up of the Approximate Number System (ANS) and the Object Tracking System (OTS), which are attested in both new-born infants and animals. ANS is imprecise, only able to distinguish between sets with a ration of two or higher. OTS is precise. It can distinguish 2 and 3, but it does not work on sets larger than 4. The differences between the two systems are shown in the schema below.

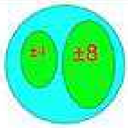
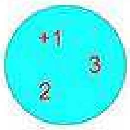
System	Precision	Successor function (+1)	1 vs 2	2 vs 3	4 vs 8	
ANS	Approximate cardinal values	--	√	--	√	
OTS	Numerically distinct individuals	√	√	√	--	

Table 2: Approximate Number System vs Object Tracking System
(*source: "Subproject 2, Language and Number")*

According to Spelke (2011), the language faculty may have a crucial role in the integration of the two systems ANS and OTS. The project 'Language and Number' studies this relation between the core system of number and the language faculty. People are interested in seeing reflections of the ANS/OTS distinction in language, looking for the ways in which languages make a distinction between different sub-intervals on the number line. A large part of the project is therefore focused on so-called *numeric scope*. Two different methods are adopted. The first is a typological study designed to shed light on universal and variable properties of the systems, and the second method compares how the systems develop in children.

At the Meertens Instituut in Amsterdam, my work is part of the typological study. The morphosyntactic properties of numerals are examined in relation to the number line, for a representative sample of the world's languages. The main result of this is the 'Typology of Number Systems' database, which we fill with our findings on the morphology and syntax of the numeral systems of different languages.

4. Numeral classes and their derivations

4.1 Cardinals

Cardinal numerals express the cardinality of sets. They can be used attributively ('three horses') and as a head of a phrase ('I saw three of the horses'). They can also occur in phrases that function more like proper names: 'line 5 of a bus network' or 'the year 2015' (Booij, 2010). The contexts where cardinals are used are subject to crosslinguistic variation: in Bulgarian, years like 2015 are expressed by ordinals instead of cardinals (Leafgren, 2011). When different structures are possible the structure that is used can depend on cultural and pragmatic conventions (Booij, 2010). In English for example, the year 1654 is preferably referred to as 'sixteen hundred fifty-four' or 'sixteen fifty-four', rather than 'one thousand six hundred fifty-four'.

Cardinals can be divided into two categories: simplex cardinals and complex cardinals. When a cardinal numeral is not a combination of other numerals, it is called a simple or simplex cardinal (Fradin 2013, Stump 2014). This class of simplex numerals is normally quite small. In English there are only fourteen simple numerals: one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, hundred, and thousand (Stump, 2014). Complex cardinals are combinations of the simplex cardinals. They can be both morphological compounds and syntactic phrases (Stump, 2014).

(7) fifteen (5 + 10)

(8) thirty-five (3x10 + 5)

(9) two hundred and one (2x100 + 1)

Complex cardinals like (7) and (8) above seem compounds, while (9) seems a syntactic phrase, since it uses the conjunction 'and'. The use of coordination elements like 'and' is different for every language. Example (7) is a combination of the simplex cardinals 'five' and 'ten' which are in a relation of addition. 'Five' has phonologically changed to 'fif' and 'ten' has changed to 'teen'. In example (8) we see the simplex cardinal 'ten' again, but this time its form is 'ty' and it is in a relation of multiplication with 'three'. Stump (2014) suggests that *–teen* and *–ty* are *alternants* for the same simplex cardinal 'ten', *-teen* is used for 10 for addition and *–ty* is used for multiplication.

Now let's turn to the discussion of my findings about complex cardinals.

4.1.1 Descriptive analysis of cardinals in the five languages selected

In **Dutch**, the simplex cardinals in Dutch are those from 1 to 12 and *honderd* (100), *duizend* (1000), *miljoen* (1000.000) and *miljard* (1000.000.000). *Elf* 'eleven' and *twaalf* ' twelve' are not transparent anymore morphologically. Apparently they are the remains of a duodecimal system (Philippa e.a. 2003-2009, etymologiebank.nl). Etymologically they seem to be formed from the cardinals '*een*' and '*twee*' combined with Proto-Indo-European *leik^{w}- which means 'leave over', as in: 'the one left over ten', which is based on a pattern attested in Lithuanian (Philippa e.a. 2003-2009). There are other etymological theories about the origin of *elf* and *twaalf* – the etymology is quite inconclusive. In any case, synchronically they belong to the simplex cardinals.

On to the complex cardinals: the numerals 13 to 19 are formed by a construction of addition wherein the low cardinals 3 to 9 are placed first and *tien* 'ten' second, see example (10). The order of the numerals is low-high.

(10) *zes-tien*,
6-10
'sixteen'

The constructions for the tens 20-90 are formed by adding -*tig* (the *alternant* for multiplication of '*tien*') to the numerals 2 to 9.

(11) Vijf-tig
5-10
'fifty'

There can be some discussion on whether the base part of 13 (*der-tien*), 14 (*veer-tien*) and 20 (*twin-tig*), 30 (*der-tig*), 40 (*veer-tig*) and 80 (*tach-tig*) are really existing numerals - their form is not predictable (Booij, 2010).

The hundreds 200-900 are formed by a combination of the numerals 2-9 and *honderd* 'hundred' which are in a relation of multiplication, and the order is low-high. The same construction is used for thousands, millions and billions: *twee-duizend* 'two-thousand', *drie miljoen* 'three million', *vier miljard* 'four billion'.

The derivation of 21-99 is based on a relation of addition between the numerals, and requires a conjunction *en* 'and' in between. '*En*' [ɛn] has become a linking element: the ɛ has been reduced to a schwa [ə] and is part of the compound now (Booij, 2010). The order is low-high:

(12) *een-en-vijf-tig*
1-LNK-5-10
'51'

For additive constructions above 100 the order of the numerals switches around to high-low. The coordination element 'en' [ɛn] is optional before the last numeral in additive constructions above 100. This time, the vowel is not reduced to a schwa, and because of that, these constructions can be considered a syntactic phrase (Booij, 2010).

(13)	*acht-honderd*	*(en) vijf*
	8-100	(COORD) 5
	'805'	

In **Bulgarian** the cardinals 1 to 10 are the simplex cardinals, as well as 100, 200, 300 and 1000, 1000.000 and 1000.000.000. The rest of the cardinal numerals are complex. Firstly, for the numeral scope 2-6 (Scatton, 1984) there are special forms that are used for male persons only, for which the suffix -*(í)ma* is added to the normal cardinal: *dvá-ma* 'two' *pet-íma* 'five'. Leafgren (2011) states that this construction also exists for the numeral scope 7-9.

Unlike the Dutch eleven and twelve, the Hungarian cardinals from 11 to 19 are all derived in the same derivational pattern. Bulgarian uses a preposition 'on' in additive constructions like this:

(14) *dva-ná-deset*,
2-'on'-10
'twelve'

The round numbers 20 to 90 that involve multiplication of 'ten' are composed of the appropriate cardinal plus *deset* 'ten', of which the order is low-high:

(15) *dvá-deset,*
2-10
'twenty'

For hundreds from 400 to 900, *stó* becomes *stòtin* in a compound involved in multiplication:

(16) *pét- stòtin*
5-100
'five hundred'

For all additive compound numerals from 21 on, the biggest number comes first and the lowest last, and the coordination element *i* 'and' is added between the second to last and the last numeral.

(17)	*Khilyada*	*osem-stotin*	*sedem-deset*	*i shest*,
	1000	8-100	7-10	COORD 6
	'eighteen hundred seventy-six'			

In **Hungarian** simple cardinals are those 1 to 10, and *húsz* (20), *harminc* (30), *száz* (100), *ezer* (1000), *(egy)millió* (1000.000) and *milliárd* (1.000.000.000). The cardinal numeral *kettő* 'two' has an alternant *ket*, which are absolute and contextual forms respectively (Greenberg , 1978).[2] Like English, *tíz* 'ten' has an alternant for additive constructions in the numeral scope of 1 to 19, which is *tizen.* The order of additive compounds is large-small:

(18) *tizen-egy*,
10-1
'eleven'

Interestingly, *húsz* 'twenty' also has suh an additive alternant which is *huszon*.

(19) *huszon-kettő*
20-2
'twenty-two'

The compounds that involve multiplication of ten, 40 to 90, are formed by adding -*ven*/-*van* (depending on vowel harmony) to the cardinals 4 to 9. Adopting Stump's (2014) analysis of 'ten' and 'ty', -*ven* could be seen as the alternant of *tíz* 'ten', although they do not resemble each other.

(20) *Negy-ven*
4-10
'forty'

[2]A more elaborate discussion on the use of *kettő* versus *ket* can be found in Kenesei (1998).

The compounds that involve other multiplication other than ten also have the order low-high.

(21) *Tíz-ezer*
10-1000
'ten thousand'

In **Japanese**, cardinals are always accompanied by a classifier. This classifier provides information about the things you are counting. Classifiers refer for instance to the shape of the object (thin and long, thin and flat, small things) and more specific things, like age, order, books, clothes, frequency, shoes and socks, houses. (Ogawa, 1998) The form of the cardinal does not stay the same, as can be seen in (22) and (23).

(22) *hito-tsu*,
1-CL
'one (thing)'

(23) *is-satsu*
1-CL
'one (book)'

In Japanese, the numerals 1 to 10 are simple cardinals, as well as 100, 1000, 10.000 (which requires 'one' in front) and 1000.000.000. In Japanese 1000.000 is expressed as a hundred times 10.000:

(24) *hyaku-man*,
100-10.000
'a million'

The order of the numerals is low-high for complex cardinals that involve multiplication:

(25) *hon san-jus-satsu*
book 3-10-CL
'thirty books'

And for complex cardinals that involve addition the order is large-small:

(26) *hon juu-go-satsu*
book 10-5-CL
'fifteen books'

The last language I discuss is **Adyghe**. The information about the cardinals in Adyghe are based on a schema by Moroz (2011). The cardinals 1 to 10 and 50, 100 and 1000 are simplex cardinals. The tens 20 and 30 are a combination of the multiplicatives of 2 and 3 and *č* which is an alternant for 10 in a multiplication, see example (27), the order is thus low-high for 20 and 30. The cardinals 40, 60 and 80 are expressed as multiples of twenty. In example (28), it can be seen that 'sixty' is formed by 20, and 3 linked to it, which means three times twenty. The order for this construction of multiplication the order is high-low ('Three' is placed *after* 'twenty'). For hundreds and thousands, the order is high-low as well, which can be seen in example (29).

(27) *tw-e-č'*
2-MULT-10
'twenty'

(28) *tw-e-č'* *-jə-š'*
2-MULT-10 -LNK-3
'sixty'

(29) *š-jə-tw*
100-LNK-2
'two hundred'

The complex cardinals from 11 to 19 consist of the cardinal 10, a linking element, and a simplex cardinal from 1 to 9. The order for this additive construction is, as can be seen in (30), high-low.

(30) *pšə-kwə-tw*
10-LNK-2
'twelve'

All constructions that involve addition other than those from 11 to 19 require coordination elements on both constituents. From 21 onwards the cardinals are formed like (31) below. The cardinals 70 and 90 are expressed as 60 plus 10 and 80 plus 10 respectively. When cardinals are in relation of addition to each other in Adyghe, the order in which they appear is high-low.

(31) *tw-e-c'ə-re* *zə-re*
2-MULT-10-COORD 1-COORD
'twenty-one'

(32) *tw-e-č'* *-jə-š'-re* *-pšə-re*
2-MULT-10 -LNK-3-COORD -10-COORD
'seventy'

	Simplex cardinals	Complex cardinals addition	Complex cardinals multiplication	Special comment
Dutch	1-12, 100, 1000, 1000.000, 1000.000.000	13-19 low-high 21-99 low-LNK-high 101 and up: optional 'and' before last numeral high-(CONJ)-low	Order: low-high Alternant for 10 when used in multiplication	Switch of additive construction from low-high to high-low at 100.
Bulgarian	1-10, 100, 200, 300, 1000, 1000.000, 1000.000.000	2-9: suffix for referring to male humans 11-19: Low-on-high 21 and up: 'and' before last numeral. Order: high-CONJ-low	Order: low-high Alternant for 100 when used in multiplication.	Switch of additive construction from low-high to high-low at 20.
Hungarian	1-10, 20, 30, 100, 1000, 1000.000, 1000.000.000, (1000.000.000.000)	Order: high-low Alternant for 10 and 20 when used in addition.	Order: low-high Alternant for 10 when used in multiplication.	Alternative form for 2 contextual /absolute
Japanese	1-10, 100, 1000, 10.000 and billon	High-low	Low-high	Classifier language
Adyghe	1-10, 50, 1000	11-19 high-LNK (kwe) -low 21 and up: high-COORD-low-COORD, coordination elements must be added to all constituents that are in a relation of addition	20 and 30: low-MULT-high Other multiplicative constructions: high-LNK (je)-low Alternant used for 10 when in multiplication	The tens are expressed as multiples of 20

Table 3: Overview of the cardinal constructions

4.1.2 Discussion of the cardinal derivational patterns of complex cardinals

Overall tendencies that can be seen on simplex numerals are that the numerals 1 to 10 are simplex cardinals in every language I discussed. This might be universally true, although for example a numeral system based on four could possibly be able to express eight as two times four. Dutch is the only language in my sample that has simple forms for eleven and twelve. This is a pattern that can be observed in other Germanic languages like English, German (*elf* , *zwölf*), Danish (*eleve*, *tolv*) and Jiddish (*elf*, *tsvelf*). According to Hurford (1975), forms like eleven and twelve were formerly derived complex numerals in an older stage of the language, and could be analysed as two morphemes (this is in agreement with the most plausible etymology I mentioned for Dutch). But synchronically they are no longer transparent, because of "sweeping phonological changes" (Hurford, 1975, p 63). They are now reanalysed as one morpheme, and belong to the simplex cardinals, though they were complex numerals once.

As for the rest of the teens, they tend to be additive constructions. In Dutch and Bulgarian the order is low-high, in Hungarian, Japanese and Adyghe the order is high-low. Bulgarian switches to large-small at 21, like English (compare '*nine-teen'* and '*twenty-one'*). Dutch only switches from low-high to high-low at 101. Hurford (1975) calls this word formation transformation 'Switch'. Greenberg (1978) proposed universals about the Switch:

> "*26. If in a language, in any sum the smaller addend precedes the larger, then the same order holds for all smaller numbers expressed by addition. 27. If in a language, in any sum the larger addend precedes the smaller, then the same order holds for all larger numbers expressed by addition*" (273).

It seems the location of the Switch does not follow any pattern. Based on my sample of languages one could think that the Switch only takes place after a multiple of ten (20, 100 etc.), but this is not true for Italian: Switch takes place after 16 in Italian (Hurford, 1975).

Another rule Hurford (1975) describes is 'I-deletion', which takes place before Switch. This rule explains why **hundred* in English is not a wellformed numeral and *honderd* in Dutch is: the 'one' is deleted in Dutch before *honderd*, so that **eenhonderd* is ungrammatical, but *tweehonderd* is not. In my sample, the I-Deletion rule does not apply in Japanese for 10.000, because it requires *ichi* 'one' in front: *ichi-man*. In Hungarian *egy* 'one' is optionally deleted in 1000.0000: *(egy)millió*.

The numeral for 100 is always a simplex numeral in my sample. Japanese is the only language on the five languages that has a simplex numeral for 10.000 (*man*), and not for 1000.000, which is expressed as a hundred times 10.000: *hyaku-man*, 100-10.000, 'a million'.

As for complex cardinal constructions based on multiplication, the order of the numerals seems to be universally low-high, except for Adyghe, which always uses high-low always.

For both addition- and multiplication-based complex cardinals, there can be alternants for certain numerals like 10, 20 or 100. Stump (2014) took the English in which *ten* changes into *–ty*, and called *–ty* an alternant for *ten*. I have borrowed the term to categorize these numerals. The multiplicative 'alternants' for *ten* in Dutch (*tien* → *-tig*), Hungarian (*tíz* → *-ven/-van*) and Adyghe (*pš* → *-č̌*) do not resemble each other, however, and treating them as variants of one lexical item or separate lexical items is a matter of theoretical point of view.

In Adyghe the formation of 20 and 30 uses a multiplicative form. In later chapters it will become clear that multiplicatives occur very often in the numeral system of Adyghe.

Hurford (1975) and Fradin (2013) are both of the opinion that numerals are syntactic in nature. But synchronically, Booij (2010) argues, the nature of Dutch numerals is not syntactic. According to him, numerals below hundred are clearly words, and numerals larger than 100 can be called phrases because they allow the coordination element in its non-reduced form, but "the specific coordination pattern involved is lexicalized, however, in the sense that it applies to numerals only" (13).

So in conclusion, Greenberg's (1978) universals about the order of low and high numerals in complex cardinals based on addition are obeyed, but how the morphosynax of complex cardinals depends on morphosyntax of the languages is unknown. Hurford's (1975) I-deletion and Switch rules can explain some of the variation that is found in cardinals, but the application of these rules is not predictable. The ANS/OTS distinction is not observed in cardinals. In general, given the scarce typological knowledge about this aspect of numeral behaviour, the data on complex cardinals is not particularly informative, unlike the findings on the derivations of other numeral classes, to which we now turn.

4.2 Ordinals

Semantically, ordinals indicate the rank some object is occupying in a given series. Ordinals are generally formed by adding a suffix to another numeral class which functions as a stem. If the base of the derivation is a complex numeral, it depends on the language whether this suffix is added to every constituent of the numeral or only to the last one. Stump (2014) mentions that the lowest natural numbers are often suppletive. In English the suppletive forms also appear in compound ordinals, while in French the ordinal 'premier' 'first' is not used in compounds: for *vingt et un* 'twenty-one' the ordinal is *vingt-et-unième* instead of **vingt-et-premier*. In Stump's (2010) paper on the derivation of ordinals, he concludes that "the rules of composition involved in the derivation of ordinals from compound numerals are highly variable across languages" (229). In the World Atlas of Language Structures, data on the derivation and suppletion of ordinals can be found based on Stolz and Veselinova, 2013. I will compare their findings with my own.

In **Dutch**, ordinals are derived from cardinals. Two different suffixes are used for the derivation of ordinals: *-de* and *-ste*. The suffix *-de* is used after 2-7, 9, 10 and complex ordinals that end in these numerals. The suffix *-ste* is added after *acht* 'eight', after the suffix *-tig* and after the numerals *honderd* '100', *duizend* '1000', *miljoen* '1000.000', and *miljard* '1000.000.000'. The ordinal *eerste* 'first' also has the suffix *–ste*. Barbiers (2007) argues that *eerste* is not a regular ordinal but a superlative, which occurs in contexts where superlatives can occur, although unlike superlatives the schwa at the end is always preserved like in ordinals. According to Barbiers' (2007) analysis, the *-ste* affix in *eerste* is a superlative affix. The ordinal of drie 'three' is not **drie-de* but *der-de* which is not morphologically suppletive but has been subject to r-metathesis (Philippa et al 2003-2009, etymologiebank.nl). Stolz and Veselinova have put Dutch in the category 'first, two-th, three-th': *eerste* 'first' is treated as irregular, and *derde* 'third' is not. *Eerste* and *derde* are both also used in compound numerals. Booij (2010) notes that ordinal formation is a head operation (as discussed in Hoeksema, 1988). This means that only the last numeral, the head, is derived to be an ordinal.

(33) *vier-en-twintig-ste*
4-LNK-20-ORD
'twenty-fourth'

In **Bulgarian**, ordinals agree in gender and number with the nouns they modify. Ordinals are formed adding a suffix *-i*, *-a* or *-o* to the appropriate cardinal numeral, depending on the gender of the noun.

(34) *Pet-a kniga*
5-F.SG book
'the fifth book'

Bulgarian only exhibits a suffix specific for ordinals in hundredth, thousandth, millionth and billionth. The ordinal of *stó* 'hundred' for instance, is *stót-en*. The feminine version is *stotna*.

The exceptions to these rules of derivation are the ordinals from 1 to 4, which are suppletive according to Scatton (1984). to Stolz and Veselinova (2013), however, the ordinal tréti 'third' is formed regularly: they have sorted Hungarian into the category 'first second three-th'. Scatton (1984) states that 3rd does show a suppletive stem change: /i/ to /et/. Table 4 below shows the cardinal forms and the ordinal forms. (The cardinal 'one' is the only cardinal that is inflected for gender.)

	Cardinal	**Ordinal**
1	edín (M.SG)	pŭrvi/ prŭv (M.SG)
2	dvá	vtóri (M.SG)
3	trí	tréti (M.SG)
4	čétiri	četvurti (M.SG)

Table 4: The Bulgarian suppletive ordinals in masculine singular with their cardinal counterparts

In complex ordinals, only the last numeral appears in ordinal form, which leaves the preceding numerals as cardinals. The suppletive forms are used in compounds.

(35) *Dva-deset i vtór-a kniga*
2-10 COORD 2-F book
The twenty-second book

In **Hungarian**, ordinals are derived from fractionals, according to Fradin (2013).

	Cardinal	**Fractional (denominator)**	**Ordinal**
3	három	harm-ad	harmad-ik
10	tíz	tíz-ed	tízed-ik
30	harminc	Harminc-ad	Harmincad-ik

Table 5: The derivation of ordinals in Hungarian (Fradin, 2013)

The Hungarian Grammar by Rounds (2009), analyses fractionals as derived of ordinals by deletion of '-ik'. This would mean that ordinals are derived from cardinals by –dik. Kenesei (1998) agrees with her: "Ordinal numerals are derived from cardinals by the suffix –dik, which is connected to the stem by a linking vowel" (343) So instead of Fradin's (2013) derivation cardinal → fractional → ordinal, the derivation would be cardinal → ordinal → fractional. Still, Fradin's additive construction makes more sense. The reason to prefer this construction comes from the consideration that deletion is a marked phenomenon, as discussed in Dressler (2000): "substraction of form contradicts addition of meaning" (585). Saying that one thing is derived from the other suggests that there is a component of the source in the result, including the meaning component. If Hungarian fractionals were derived from ordinals, the (full) ordinal would be expected to be included, but this is not the case. Therefore I will follow Fradin's analysis. As can be seen in Table 5 above, the source of the derivation is maintained in the result of the derivations. Only the last numeral in a compound is in ordinal form

The derivation of the ordinals is suppletive for egy 'one', which changes into *első* 'first' and *kettő* 'two' which changes into *masodik* 'second'. This is in accordance with Stolz and Veselinova's (2013) categorization: 'first, second, three-th'. In compound ordinals, not the suppletive forms but the regular numeral stems are used (Kenesei, 1998).

(36) Huszon-kett-ed-ik
20-2-FRAC-ORD
'twenty-second'

In **Japanese**, ordinals can take many forms. In total, there are three different ways of deriving an ordinal, illustrated in the examples below. Every construction can also have dai- in front of it. The meaning of *dai*- is not clear. The morpheme –me is probably an ordinal marker. The fourth construction using 'saisho' is only possible for 'first'.

(37) *(dai-)ichi-ban-me-no hon*
(?-)1-'number'-ORD-GEN book
'the first book'

(38) *(dai-)ik-kan-me-no hon*
(?-)1-'volume'-ORD-GEN book
'the first book'

(39) *(dai-) is-satsu-me-no hon*
(?-)1-CL-ORD-GEN book
'the first book'

(40) *saisho-no hon*
first-GEN book
'the first book'

The only suppletive form is *saisho.* This ordinal construction only exists for 'first', not for 'second' or any other ordinal. Assuming that the classifiers that are always present in a cardinal construction are not part of the cardinals themselves, the constructions in (36), (37) and (38) are derived from the cardinal numerals. Stolz and Veselinova (2013) list Japanese as completely regular: 'one-th, two-th, three-th'

In **Adyghe**, ordinals are derived from the fractional denominator, like Hungarian. The ordinal would be derived by adding the suffix *-re(j)* (plus an agreement prefix for a comparison class). However, the synchronic status of this derivation is not clear, as *–ne* fractionals tend to be replaced in everyday speech by forms borrowed from Russian and analytic constructions. If this means that the fractional suffix is not interpreted as such anymore. The ordinals would be formed from multiplicatives using the suffix *-nere(j).* (Because the fractional is derived from the multiplicative, see section 4.3.)

(41) *ja-bʁw-e-ne-re(j) klas*
3PL.POSS-9-MULT(-FRAC)-ORD grade
'ninth grade'

For the ordinal 'first', Adyghe has a suppletive form: *apere*. Stolz and Veselinova (2013) have no account of Adyghe in their report.

(42) *apere bzəλfəʁ-ew*
first woman-ADV
'(became) the first woman'

Alas, I do not have any information on complex ordinals in Adyghe.

Ordinals	**Derivation**	**Suppletive/irregular forms**
Dutch	From cardinal, ordinal affix -de /-ste	1
Bulgarian	From cardinal, gender agreement –i/a/o and suffix –en for 100, 1000, 1000.000	1, 2, 3, 4
Hungarian	From fractional denominator, affix -ik	1, 2
Japanese	From cardinal, three constructions with optional dai- Fourth construction: *saisho* 'first'	1 (not always, only in one construction)
Adyghe	From fractional denominator, affix –re(j) or from multiplicative, affix –nere(j)	1

Table 6: The derivation of ordinals

4.2.1 Discussion of the ordinal derivation patterns

What is striking about the derivation of ordinals is that the ordinal for 'one' is always irregular, except for Japanese. But there is an extra construction for 'first' in Japanese, that does not resemble the other constructions. In Dutch, *eerste* 'first' is linked with superlatives, and not with ordinals (Barbiers, 2007). Overall, the irregular forms are always concerned with low numbers, supporting the ANS/OTS distinction.

The suppletive ordinals are used in complex ordinals in Dutch and Bulgarian. In Hungarian, like in French, regular ordinals are used in complex ordinals. The suppletive numerals do not appear in higher ordinals. Japanese *saisho* would logically not be used in ordinal compounds, because this construction does not extend to any other value. In Dutch, Bulgarian, Hungarian and Japanese, only the last constituent exhibits ordinal morphology. Nothing can be said about complex ordinals in Adyghe, because I do not have any information about them.

Dutch has two ordinal suffixes, Hungarian and Adyghe have one and in Japanese the morpheme *–me* seems to be the ordinal marker. Bulgarian is the odd one out here, as most Bulgarian ordinals have no ordinal suffix. In Bulgarian, ordinals are characterised by their inflection for gender. The ordinals agree with the noun like Bulgarian adjectives do. Only for hundred, thousand, million and billion the stem receives an ordinal marker.

Although ordinals are derived from cardinals in most languages, the ordinals in Adyghe and Hungarian are not. There is an interesting similarity to be observed between these two languages, if we assume that the fractional affix still exists in Adyghe. It would mean that the ordinals are derived from fractional denominators in both languages. What would this mean for the morphology and meaning of fractional and ordinals? The interesting and apparently tight relation between fractionals and ordinals will be discussed in further detail in the next section about fractionals.

4.3 Fractionals

Fractionals consist of two parts: a numerator and a denominator. According to Fradin (2013), the numerator is always a cardinal and the denominator is constructed either on a cardinal or on an ordinal. I will take a closer look at the five languages now, to test this generalisation, and look for a pattern in the derivation of fractionals.

In **Dutch**, fractional numerals are based on a cardinal as a numerator, which preceeds an ordinal as a denominator. ½ is *een half* 'a half' like in English, though the regular *één tweede*, 'one two-th' exists as well but only in mathematical contexts (Booij, 2010). ¼ can be called *een kwart* 'a quart', though the regular *één vierde* 'one fourth' is widely used as well. Fradin (2013) mentions that the suppletive fractional can frequently be used for the formation of other fractionals, which is the case in Dutch: ¾ can be expressed as *drie-kwart*. When *half* is used after a cardinal, it can be used in a numerical expression in which the conjunction is optional (Booij, 2010):

(43) *drie(-[ɛn])-[ən]-half*

3(-CONJ)-DET- ½

'3 ½'

For 1 ½ , a lexicalized compound is used: *ander-half* lit. 'other half' (Booij, 2010). Ordinals can function as fractionals when combined with a determiner: *een achtste* 'an eighth'. In that case, the numerator is presumed to be 'one' and only the denominator is expressed.

In **Bulgarian**, fractions are also made up of a cardinal as a numerator and an ordinal as denominator, in that order. The gender of the ordinal is always feminine, because it has to agree with the implicit noun *čast* which means 'part' (Scatton, 1984; Leafgren, 2011). This conforms to category e) in Fradins analysis of the patterns in phrases expressing fractionals: "The fractional numeral is an NP whose head (= part) has been elided but whose constituents nevertheless agree according to the rules in force with numerals" (8). For example:

(44) *edna tret-a*

1 3-F.SG

'one third'

A suppletive form for 'half' is *polovína*, but the regular *edna vtora* also exists. Other fractionals only used conversationallu are *tretína* 'third' and *četvŭrt(ína)*'fourth' (Scatton, 1984).

Hungarian is a language that bases its fractional denominator on a cardinal. The derivational suffix *–d* is added to the cardinal stem, and connected to it by a linking vowel (Kenesei, 1998):

(45) két-hat-od

2-6-frac

'two sixths'

Hungarian is not the only language that bases the fractional denominator on a cardinal, this also happens in Basque, German, Czech and Welsh (Fradin, 2013). As has been discussed in section 4.2, Rounds (2009) says that fractionals are formed from ordinals by deleting –ik. We have argued that this is morphologically not very likely. If you were to assume that the fractionals are derived from ordinals, this would make 'two' an exception: 'two' has a suppletive ordinal, *masodik*, but the fractional denominator is *ketted*. When taking on Fradins analysis, the denominator of 'two' does not have to be an exception, it is simply derived from the cardinal *ket(tő).* The order of numerator and denominator is the same as in Dutch and Bulgarian. According to Rounds (2009), Hungarian also has a special word for ½, which is *fél* , but the regular form *egyketted* is also mentioned.

In **Japanese**, the order of numerator and denominator is different. The fractional construction begins with the denominator, which is connected to *bun* which can be roughly translated as 'part', and then it is inflected for genitive case. The numerator appears in last place.

(46) sono hon-no san-bun-no ichi

that book-GEN 3-'part'-GEN 1

'one third of the book'.

Japanese seems to use the cardinal form as a base for both numerator and denominator - no ordinal construction is visible.

Fradin's generalisation that all languages will always use a cardinal as a numerator does not hold true for **Adyghe**: the numerator in the construction in question cannot be expressed and is always presumed to be 'one'. Only the denominator is expressed. The denominator is derived from a multiplicative form by adding the affix *–ne*.

(47) bʁw-e-ne
9-MULT-FRAC
'one ninth'

Apparently the fractional construction is slowly becoming archaic: the fractionals are replaced by borrowed forms and more descriptive constructions (Moroz, 2011).

Fractionals	**Derivation of the Numerator**	**Derivation of the Denominator**	**Order of numerator and denominator**	**Special forms/ suppletion**
Dutch	Cardinal / omitted	Ordinal	Num-Den / Den (Num=1)	½ , optional ¼
Bulgarian	Cardinal	Ordinal(fem)	Num-Den	optional ½ , 1/3, ¼ .
Hungarian	Cardinal	Cardinal + suffix -d	Num-Den	optional ½
Japanese	Cardinal	Cardinal + affix -bun	Den-Num	(none given by the speakers)
Adyghe	Always omitted	Multiplicative + suffix -ne	Den (Num=1)	(none given by the speakers)

Table 7: The derivation of fractionals

4.3.1 Discussion of the derivational patterns of fractionals

In Dutch and Bulgarian, the fractional denominator is formed by ordinals. As we have seen previously, the reverse derivational pattern can be found as well: ordinals can be formed from fractions, in Adyghe and in Hungarian. Ordinals and fractionals are clearly very closely related. The ordinal on its own can represent a fractional, in Dutch and in English as well. Stump (2014) discusses ordinals used as fractionals, suggesting a historical explanation: "it is suggested that ordinal morphology is a specialisation of morphology that once had a different function" (335). However, the source function and the path of this historical development is not made clear.

In Adyghe, the fractional numerator cannot be expressed. In Dutch, the numerator can be omitted when it is 'one', which is grammatical in English and Russian as well.

Fractionals with lower numerals like ½ and ¼ can be suppletive. Their numerator is also 'one', which could be an instance of the same phenomenon as the omitting of the numerator in Dutch and Adyghe. Suppletive forms only seem to exist for fractionals with lower numerals. In my sample, there are no suppletive fractionals for a fractional denominator value 5 or higher. This observation, again, is in line with the relevance of the ANS/OTS distinction in natural language.

Japanese is the only language of my sample that used numerator and denominator in reverse order. Further investigations are needed to link these properties to other morphosyntactic properties of the languages in question.

A feature that I have not discussed is the plurality of the denominator, which can depend on the value of the numerator. In Dutch, the denominator is never in plural: *éénderde* 'one third', *tweederde* 'two thirds'. In English and Bulgarian, however, the number of the denominator depends on the value of the numerator: when the numerator is 'one', the denominator is singular, whereas if the numerator has a value more than one, it is plural: *one third*, *two third-s* / *edna tret-a* (1 3.SG), *dve tret-i* (2 3.PLU). This could be investigated further in future research on crosslinguistic variation in this domain.

The multiplicative in Adyghe seems to have a special status, as it has been mentioned as the source for many numeral classes. This will be discussed in further detail below.

4.4 Multiplicatives

A multiplicative expresses <number> times, like for example the English *once* and *twice* express 'one time' and 'two times', which are derived from a 'special' stem of cardinals (Fradin, 2013). The semantic domain of multiplicatives is a temporal one. Stump (2014) also mentions *twofold* and *quadruple* as examples of English multiplicatives, which he uses to illustrate how multiplicatives can be formed on Latinate as well as native grounds.

In most **Dutch** grammars, multiplicatives are not mentioned. As a speaker of Dutch, I always thought that Dutch did not have multiplicatives like 'once' and 'twice', but Fradin (2013) mentions the forms *twee-maal* and *twee-voud*, which both could be translated with 'twofold'. These forms do exist, though I think they are becoming slightly old-fashioned in everyday speech. A very rare suffix is -werf, which has the meaning of repetition: *drie-werf hoera* 'three times hooray'. This affix is only used for 2 and 3, and in the Dutch 'Van Dale' dictionary, *tweewerf* and *driewerf* are categorized as archaic.

The suffix -voud can be used to derive multiplicatives taking the cardinal as a base. The result is a noun. It does not have a temporal meaning: to print something *in twee-voud* 'two times' means you should hand in two copies of the same thing. So the multiplicative in *-voud* is not used to express something happening a number of times in a temporal sense, but rather that there are two instances of the same thing. The temporal meaning is only available in specific contexts: *vijf-voudig wereldkampioen* 'fivefold world champion' in which the suffix *-voudig* is the equivalent of *–voud* to form an adjective. The Dutch 'Van Dale' dictionary gives the following examples (among others): *achtvoud* '8-voud', *dertienvoud* '13-voud', *achtendertigvoud* '38-voud', *veertigvoud* '40-voud', *duizendvoud* '1000-voud', *negenennegentigvoud* '99-voud'. The suffix *–voud* can thus be used on a variety of cardinals, simplex cardinals and complex cardinals alike. Only the cardinal ‘one’ is excluded, because *eenvoud* has another meaning, namely ‘simple’.

The suffix –maal can be used to form a multiplicative adverb from every cardinal. This multiplicative does have a temporal meaning: *twee-maal daags* ‘twice a day’.

In **Bulgarian**, there are three forms that represent the multiplicatives. They are *vednyz, dvaz,* and *triz*, which mean ‘once’, ‘twice’ and ‘thrice’ respectively. They seem to be suppletive multiplicatives. However, Kayne (2014) has analysed the English suppletive multiplicatives *once* and *twice*, and he concludes that they are complex phrases: on-ce and twi-ce, with a silent morpheme for TIME. With some difficulty, Bulgarian ‘one’ *edin* can be found in *vedny-z*, and the cardinals *dvá* ‘two’ and *trí* ‘three’ are easily found in *dva-z* and *tri-z*. Further investigations in line with Kayne’s (2014) work could possibly lead to new insights into the Bulgarian multiplicatives. They might be complex phrases like the multiplicatives in English, containing two morphemes and one silent one for TIME.

In **Hungarian** multiplicatives do not seem restricted to a certain numeric scope. Kenesei (1998) sates that the suffixes -*szor*, -*szer*, and -*ször* that mark multiplicatives can be attached to the cardinal numerals in one construction and to the ordinal numerals in a second construction. However, as I have adopted Fradin’s analysis on the derivation of fractionals and ordinals in Hungarian, the base of the second construction is not the ordinal numeral, but the fractional numeral instead. The two constructions are shown in the examples below. They are taken from Kenesei (1998, p. 345).

(48) *Már három-szor csenget-t-em.*
Already 3-MULT ring.bell-PAST-INDEF.1SG
‘I rang the bell three times already.’

(49) *Negy-ed-szer is csenget-t-em.*
4-FRAC-MULT also ring.bell-PAST-INDEF.1SG
‘I rang the bell for the fourth time, too.’

The second construction of example (49) above is like a multiplicative in that it quantifies over events. However, it is not clear whether it should in fact be classified as a multiplicative construction, because it does not conform to the characterisation of multiplicatives “<number> times”.

In **Japanese**, there are two different constructions for multiplicatives: a construction that uses the suffix -*kai*, which roughly means ‘round’, and the second construction uses the suffix -*do*, which roughly means ‘time’. Both constructions use the cardinal as a base. They do not have a specific scope – both suffixes can be used to derive multiplicatives from all cardinals.

(50) *ni-kai*
2-‘round’
‘twice’

(51) *ni-do*
2-‘time’
‘twice’

We have encountered the **Adyghe** multiplicative before in cardinals, fractionals and ordinals – it is clear that the language has a lot of uses for the multiplicative. The multiplicative markers are the suffixes *-e* and *-re*, which are added to a cardinal base (Moroz, 2011). The two suffixes are used in different environments. The suffix *-e* is used on cardinals 1-10 and non-round complex numerals.

(52)	*tf-e*
	5-MULT
	'five times'

The suffix *-re* is attached to the cardinals eleven and higher. It is also a coordinating conjunction, as can be seen in section 4.1 (example 31 and 32), but as a coordinating conjunction is appears on both conjuncts, whereas as a multiplicative marker it appears only once, on the cardinal numeral.

(53)	*mašəne-r*	*tw-e-č'ə-re*	*qe-wəcwə-ʁ*
	car-ABS	2-MULT-10-MULT	DIR-stop-PST
	'The car stopped twenty times'		

Multiplicatives	Derivational patterns	Scope
Dutch	Cardinal+ suffix -maal, -voud(ig) or (archaic) -werf	For -werf, only 2 and 3
Bulgarian	Suppletive	1, 2 and 3
Hungarian	Cardinal (or fractional) + suffix -zsor, -szer, -ször	
Japanese	Cardinal + suffix -kai or -do	
Adyghe	Cardinal + suffix -re Cardinal + suffix -e	11 and up 1-10 and complex non-round numerals

Table 8: The derivation of multiplicatives

4.4.1 Discussion of the derivational patterns of multiplicatives

The multiplicatives of the languages in my sample are based on cardinals. In Hungarian the multiplicative suffix can also be attached to a fractional, but whether this construction is still a multiplicative is debatable. The Bulgarian multiplicatives are suppletive, though further investigations in line with the work that Kayne (2014) did on English multiplicatives might lead to the analysis of the multiplicatives as derived forms. Japanese uses two different suffixes, attached to a cardinal base, not restricted to a certain numeric scope. In Dutch, *-maal* derives an adverb, *-voud* derives a noun, and *-voudig* derives an adjective. They do not seem to have a specific numeric scope.

The derivation of a multiplicative with the archaic suffix *-werf* does have a restricted scope: 2 and 3. In Bulgarian, the multiplicatives are restricted to the numeric scope 1-3, just like English. The multiplicatives that exist only for lower numerals in Dutch, Bulgarian and English are in line with the ANS/OTS distinction. The numeric scope of the multiplicative constructions in Adyghe, however, is not focused on the lower numerals. Adyghe uses multiplicatives as a base for many numeral derivations. The meaning of the Adyghe multiplicative may be special, or Adyghe might show that our picture of what multiplicatives can and cannot do is wrong, because our view is based on a sample of languages that does not let us see the full range of the behaviour of these morphemes.

4.5 Approximatives

The meaning of approximatives is predictable from the name: they indicate approximate number.

Dutch does not have dedicated morphological forms for approximates, unless forms like 'drie-vier', the combination of two cardinals which means 'three to four', can count as approximative. The restrictions on this construction are discussed in Pollman and Jansen (1996) and Eriksen et al. (2010).

In **Bulgarian**, approximates are formed by adding -(t)ína to a cardinal stem. These are only used for tens, teens and one hundred (Scatton, 1984).

(54) d*eset-ina knig-i*
10-APPR book-PLU
'approximately ten books'

Apparently adding two successive cardinals together without conjunction gives the approximate meaning effect, 'approximately the highest number' (Ginina et al., 1965):

(55) *dve-tri*
2-3
'approximately three'

In **Adyghe**, the base for an approximative for numbers 1 to 10 is a multiplicative:

(56) zə-je-tw-a-je
1-or-2-MULT-or
'several, one or two'

The affix involved is a double disjunction marker. The same marker is used for regular nominal disjunction, but in nominal disjunction only one instance of the disjunction marker is used. Approximatives have a double marker, which makes it a special construction. For the numbers 2-10, (which overlaps with the first approximate construction) cardinals are used to form approximatives, using the cardinal *zə* 'one' in front of the two cardinals that express the range of the approximation.

(57) zə-tfə-zə-x
1-5-1-6
'approximately five or six'

Hungarian and Japanese do not seem to have any dedicated morphologically derived approximative numerals.

Approximates	Derivational patterns	Scope
Dutch	Two successive cardinals with a hyphen	
Bulgarian	Cardinal + suffix *(t)ina* Two cardinals joined without conjunction	tens, teens and 100
Hungarian	*	
Japanese	*	
Adyghe	Multiplicative form of the second numeral and a disjunction marker after every numeral Two cardinals with cardinal 'one' in front	1-10 2-10

Table 9: The derivation of multiplicatives

4.5.1 Discussion of the derivations of approximatives

The languages in my sample all use cardinal numerals as a base, except for the multiplicative form in Adyghe, which again confirms the special status of multiplicatives in Adyghe. I have not found any approximatives in Hungarian and Japanese.

Bulgarian seems to be the only language in my sample that has a suffix dedicated to the derivation of approximatives. Fradin (2013) says that approximates of this kind are found in Romance languages (e.g. French), and in some Slavic languages (e.g. Czech and Serbian).

The rest of the approximate constructions in Bulgarian, Adyghe, and Dutch use two cardinals to express a range of approximation. This kind of approximative is not mentioned by Fradin (2013), and actually mentioned very little in literature in general. In Dutch and Bulgarian, it is debatable whether it is really a matter of derivation, or if two numerals are just mentioned after each other. If there is a specific numeric scope for this construction, however, like there seems to be in Dutch, this would be an argument in favour of regarding it as a product of derivation - and thus as an approximative numeral. Adyghe approximatives are clearly derived with special rules. They are formed in a distinct way: never in any other construction in Adyghe is the disjunction marker used twice, and the construction mentioning the cardinal 'one' in front of every numeral is remarkable.

4.6 Collectives

As cardinals denote combinations of individual entities, collectives do the same for groups of entities (Ojeda, 1997). Collectives can be used counting groups of individuals like 'two pairs of someting' but also for counting individuals belonging to the same group or same kind, for example 'a group of seven people'. Morphological collectives are found in Icelandic and Balto-Slavic languages, where they can be restricted to pluralia tantum or humans (Fradin, 2013). Fradin says that "the derivational nature of collective numerals can be ascertained only if they form long enough series and present a recurring pattern of affixation" (9). This contradicts Stump's (2014) analysis of numeral collective nouns that have idiosyncratically narrowed meaning like *foursome* and *quartet* that both refer to groups of four people (one used for competing pairs in golf and the other used to refer to four musicians). Fradin does not mention these English examples at all, and I would say that he does not see them as true (derived) collectives.

Corver and Kranendonk (2009) have studied Dutch collective numerals. According to them, **Dutch** does have collective numerals:

(58) *wij twee-en*
we 2-COLL
'the two of us'

(59) *ons twee-en*
us 2-COLL
'the two of us'

(60) *met z'n negen-en*
with POSS.PRON 9-COLL
'the nine of us'

The collective numeral seems to be derived with the suffix –en. This is also the plural suffix, but here it does not express plurality - the plural of *negen* 'nine' is not *negen-en*, it is *negen-s*. Corver and Kranendonk (2009) reason that there must be a silent noun:

> *"(…) the constructions under discussion contain a silent PERSOON/PERSON. This silent noun is licensed by an antecedent in its extended projection with the feature [+human]. It serves as the host for the plural morpheme – en, which is spelled out in Northern Standard Dutch (contrary to the noun itself). Dialects of Dutch display several variants of these constructions."* (Corver and Kranendonk, 2009 p.38)

Dutch uses the Latin collectives for musicians as well: duet (or duo), trio, quartet, quintet, etcetera.

According to Lord (1962), there are derived collectives in **Bulgarian**. The suffix *-ma* is attached to the cardinal, for numerals 2 to 5. Rarely this derivation is also used for 6-9. Forms derived with suffix *–mina* also exist for 2-9 but they are very rare. According to Lord (1962) Bulgarian collective numerals can refer only to masculine persons. However, Fradin (2013) states that Bulgarian collectives in *–mina* are also used to refer to sexually mixed groups of persons but exclude a female-only group. Scatton (1984) and Ginina et al. (1965) do not mention Bulgarian collectives.

(61) *dvá-ma*
2-COLL
'group of 2 persons'

Adyghe, Hungarian and Japanese seem to lack morphological collectives, though this might depend on the definition of collective.

Collectives	Derivational patterns	Scope
Dutch	Cardinal+silent N+ suffix -en Latin for groups of musicians	 2-10
Bulgarian	Cardinal(?) + suffix -ma (Cardinal(?) + suffix –mina)	2-5 (6-9) (only masculine persons) (2-9) (only masculine persons)
Hungarian	*	
Japanese	*	
Adyghe	*	

Table 10: the derivation of collectives

4.6.1 Discussion of the derivational patterns of collectives

Apparently the definition of collectives that is assumed determines how many cases of collectives you will find. According to Fradin (2013), only Icelandic and Balto-Slavic languages have collectives. Bulgarian is one of them, and indeed has derived collectives, though they are apparently rarely used.

Dutch is not an Icelandic or Balto-Slavic language, but still, it has a collective construction according to Corver and Karnendonk (2009). The plural suffix *-en* is used on a silent noun which has the feature [+human], which occurs after a cardinal numeral. These collective constructions refer to groups of people. According to Stump (2014), names for groups that find their roots in Latin are also collectives. They are only used to denote certain kinds of groups. In Dutch (and English) Latinate collectives refer to groups of musicians.

In general, the languages in my sample that have collectives derive them from cardinal numerals. If it is assumed that the construction is synchronically only used for numeric scope 2-5, the ANS/OTS distinction is visible in the collectives of Bulgarian,

4.7 Distributives

Distributives have the meaning: <number> apiece or each. In a sentence like “The two boys carried three suitcases”, it is not clear whether each of the boys carried three suitcases (six suitcases in total) or that the boys carry three suitcases in total. The first interpretation can be made clear by using a distributive numeral of ‘three’: “The two boys carried three.DIST suitcases (each)”. The derivation of distributives has been studied by David Gil (2013), of which the results are available in the WALS: Feature 54A: Distributive Numerals.

In **Dutch** there are no morphological distributives. Although with the Adyghe distributive constructions (described below) in mind, Dutch does have a phrase *twee-aan-twee* , ‘in pairs’, but this construction is restricted to ‘two’.

Bulgarian does have distributives: in Gil (2013), Bulgarian is sorted into the category “marked by preceding word”. This is not a morphological derivation, however, and therefore not relevant for this study.

In **Hungarian**, the distributives are marked by reduplication. Although the Hungarian grammars of Rounds (2009) and Kenesei (1998) do not mention distributives, in Gil (2013) Hungarian falls into the category 'marked by reduplication'. An example is found in Farkas (1997):

(62) *Minden gyerek olvasott hét-hét könyv-et.*
every child read 7-7 book-ACC
'Every child read seven books.'

Japanese is sorted into the category 'marked by suffix' in the WALS. Distributives in Japanese have the suffix *-zutu*:

(63) *San-satsu-zutu hon-o*
3-CL-DIST book-ACC
'(they read) three books each'

Adyghe is not included in Gil's study on distributives in the WALS. There are three possible derivations, according to Moroz (2011). The first construction can be seen as derived by reduplication, with a distributive infix *-rə-*. This construction is possible for the numeric scope 1-10.

(64) *twə-rə-tw*
2-DISTR-2
'two by two (in pairs)'

A second construction uses one multiplicative and one cardinal as a base, again using *-rə-* as an infix. The numeric scope or this construction is also 1-10.

(65) *f-e-rə-tf*
5-MULT-DISTR-5
'five by five (in groups of five)'

For all numerals above 10 except for 100, there is a third distributive construction. Its derivational source is a cardinal and it is derived by reduplication. The distributive affix is not used in this construction.

(66)	*Tw-e-č'-jə-š'-re*	*twə-re -*		*tw-e-č'-jə-š'-re twə-re*
	2-MULT-10-LNK-3-COORD	2-COORD	~	:RDP
	'in groups of 62'			

Distributives	**Derivational patterns**	**Scope**
Dutch	(twee-aan-twee)	(2)
Hungarian	Cardinal reduplicated	
Bulgarian	*	
Japanese	Cardinal + CL + suffix -zutu	
Adyghe	Cardinal reduplicated with infix *-rə-* One cardinal one multiplicative with infix *-rə-* Cardinal reduplicated	1-10, 100 1-10 above 10 except 100

Table 11: the derivation of Distributives

4.7.1 Discussion of the derivational patterns of distributives

Distributives exist in Hungarian, Japanese and in Adyghe. In both Hungarian and Adyghe, the derivation of distributives involves reduplication. A construction like the first construction in Adyghe, the reduplication of a cardinal with an infix, is present in Dutch as well, but it is only used for the cardinal *twee* ‘two’. The distributives in my sample are all derived from cardinals, except for the second construction in Adyghe, which involves a multiplicative.

5. Conclusions

In this thesis I have analysed the patterns of derivation in numerals for cardinals, ordinals, fractionals, multiplicatives, approximatives, collectives, and distributives. My main research question was: what are the morphological derivation patterns for numerals, and what can these patterns tell us about the morphology and meaning of numerals of different classes?

5.1 General overview of attested derivational patterns

What are the morphological derivation patterns for numerals? In Figure 2 below, the different derivation patterns are shown as attested in my sample. The arrows’ starting point is the numeral class that is used as a base of the derivation. The arrow connects this base to the numeral class that is derived from it. The colour of the arrow specifies which language this derivation occurs in.

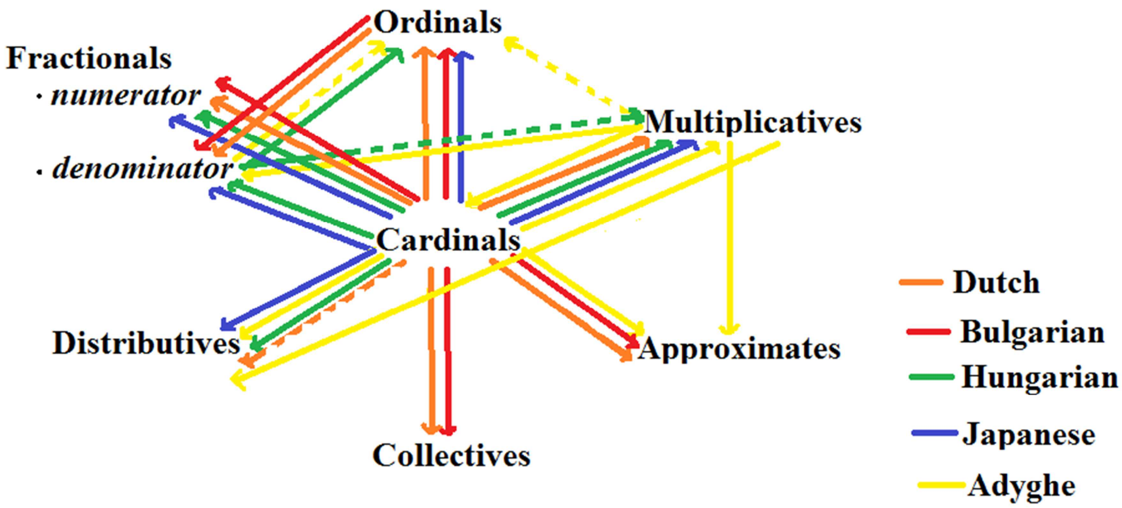


Figure 2: The derivational patterns visualized - every arrow shows a pattern of derivation

5.2 ‘Exotic’ derivations

What can these patterns tell us about the morphology and meaning of numerals of different classes? The assumption that all arrows start at the class of cardinal numerals is proved wrong. Although most arrows start from the cardinal class, some languages exhibit typologically rare derivational patterns: 10 of the 32 arrows in total do not find their roots in the cardinals (dotted arrows included).

Adyghe is responsible for six of the ten ‘exotic’ derivations. The multiplicative in Adyghe seems to have a special status, as it is used as a base for many numeral classes. It could mean that ether Adyghe multiplicatives are a special case, or it means that our picture of what a multiplicative can and cannot do is wrong. This picture that we have of multiplicatives is based on a sample of languages that do not exhibit these derivational patterns that are attested in Adyghe. Adyghe might show us the full range of possibilities of a multiplicative.

The other arrows are connected to the fractional denominator. In Hungarian, ordinal numerals are derived from the fractional denominator and Adyghe ordinals are - depending on our point of view concerning the status of the fractional suffix - derived from the fractional denominator or from a multiplicative. This is why the arrows ‘multiplicative → ordinal’ and ‘denominator → ordinal’ are dotted lines. Fractionals seem related to ordinals, because not only are some ordinals derived from fractionals, the reverse derivational pattern can be found as well: in Dutch and Bulgarian, the fractional denominator is formed from an ordinal. Like the use of multiplicatives in Adyghe, the use of fractional denominators and ordinals in different constructions might show us that we need to see these classes in a new perspective.

The Hungarian arrow from the fractional denominator to the multiplicative a dotted line, because although the output of this derivation is related to the multiplicative, it should probably not be categorized as such. The dotted line signifies a weak relation between the fractional denominator and the multiplicative.

My sample does not exhaust all exotic possibilities. Other languages than those in my sample might show more ‘exotic’ derivations, which can tell us more about the nature of the numeral classes.

5.3 ANS/OTS distinction

Regarding the distinction between ANS and OTS (Spelke, 2011), my sample provides further evidence that it is reflected in natural language. In Table 12 below, the data from my sample relevant for the ANS/OTS distinction are mentioned for every numeral class.

	Arguments in favour of the ANS/OTS distinction
Cardinals	-
Ordinals	Suppletive forms only for numerals 4 or lower
Fractionals	Suppletive forms only or numerals with numerator 1 and denominator 4 or lower
Multiplicatives	When multiplicatives have a specific scope, there are no multiplicatives for numerals higher than 3
Approximatives	-
Collectives	(scope 2-5 for Bulgarian collectives)
Distributives	-

Table 12: Numeral derivations and the ANS/OTS distinction, based on the sample in this study

The distinction between the two systems is most clearly visible in the derivation patterns of ordinals in my sample: in all five languages suppletion only occurs for numerals 4 or lower. In three of the five languages, fractionals have suppletive forms. All of them have numerator 1 and a denominator 4 or lower. Multiplicatives exist only for numerals 3 or lower in Dutch and Bulgarian, which could also be evidence for the ANS/OTS distinction. If it is assumed that synchronically the Bulgarian collective constructions are used for the numeric scope 2-5 only, this would be in line with the ANS/OTS distinction as well.

It can be concluded that the current study adds new evidence to the idea that the ANS/OTS distinction is attested in the grammar of natural language, but because my sample of languages is very small, further investigation is necessary to find out how systematic the observed patterns are.

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7. Appendix

7.1 Questionnaire, short version

	Please translate these phrases to <language>. If there are multiple options, please make sure to note all of them.		
	Please give morpheme-by-morpheme translations, so that I can see what is going on morphologically. (It is okay to abbreviate feminine to 'fem' and plural to 'plu', etc.)		
	If all numerals in a category are all formed in the same way, there is no need to fill everything in: just state 'same as above'. (But the distinction between "doesn't exist" and "same as above" should be clear.)		
	I expect to find a certain numeral scope in which a certain derivation can take place, for every numeral class. Please mention in the comments what the scope of the derivation is, especially if it cannot be deducted from the numerals that are in this questionnaire. (For instance if a derivation is only valid for 1, 10, 100, 1000 or only numerals with the number 2 in it, please comment this.)		
	I have used 'boys' and 'books' to form NPs. But if a certain derivation is only used for a specific Noun, or if it is specific for gender or number, please let me know in the comments.		
	Thank you!		
	Approximates. I am looking for derivations: so one word that would mean 'approximately one', not a direct translation of the word 'approximate'. English does not have approximatives.		
	If it exists in Bulgarian, please mark whether it uses another numeral class as a base and which one (a cardinal, ordinal, fractional, or other numeral class). Please also comment if the form is suppletive.		
	Approximatives	translation(s)	comments
1	Approximately one book		
2	Approximately two books		
3	Approximately three books		
4	Approximately four books		
5	Approximately five books		
6	Approximately six books		
7	Approximately seven books		
8	Approximately eight books		
9	Approximately nine books		
10	Approximately ten books		
11	Approximately eleven books		
12	Approximately twelve books		
15	Approximately fifteen books		
20	Approximately twenty books		
25	Approximately twenty five books		
100	Approximately a hundred books		

	For collectives, again, I am not looking for the translation of the word 'group' in Bulgarian. I am looking for a word that would mean 'a group of two' by a derivation of a numeral from another numeral class, or derived by suppletion.		
	Collectives	translation(s)	comments
2	A group of two boys		
3	A group of three boys		
4	A group of four boys		
5	A group of five boys		
6	A group of six boys		
7	A group of seven boys		
8	A group of eight boys		
9	A group of nine boys		
10	A group of ten boys		
11	A group of eleven boys		
12	A group of twelve boys		
15	A group of fifteen boys		
20	A group of twenty boys		
25	A group of twenty-five boys		
100	A group of a hundred boys		
	Distributives: is there a derivation for the expression 'two each'? In for example: the boys carried two suitcases each. Again, please mark whether it is derived from another numeral class and which one.		
	Distributives	translation(s)	comments
	1/2 book each		
	2/3 book each		
1	one book each		
2	two books each		
3	three books each		
4	four books each		
5	five books each		
6	six books each		
7	seven books each		
8	eight books each		
9	nine books each		

10	ten books each		
11	eleven books each		
20	twenty books each		
	Multiplicatives do exist in English, but only for one and two: 'once' and 'twice'. They are both suppletive. Again, I am not looking for the translation of the word 'times', but a morphological derivation on the numeral.		
	Multiplicatives	translation(s)	comments
1	once		
2	twice		
3	three times		
4	four times		
5	five times		
6	six times		
7	seven times		
8	eight times		
9	nine times		
10	ten times		
11	eleven times		
12	twelve times		
13	thirteen times		
14	fourteen times		
15	fifteen times		
16	sixteen times		
17	seventeen times		
18	eighteen times		
19	nineteen times		
20	twenty times		
25	twenty five times		

7.2 Questionnaire, long version

	Please translate these phrases to <Language>. If there are multiple options, please make sure to note all of them.		
	If you have time, please give morpheme-by-morpheme translations. If there are morphological rather than periphrastic translations, please use the shorter ones.		
	If all numerals in a category are all formed in the same way, there is no need to fill everything in: just state 'same as above'. (But the distinction between "doesn't exist" and "same as above" should be clear.)		
	Thank you!		
	cardinals	translation(s)	
0	zero books		
1	one book		
2	two books		
3	three books		
4	four books		
5	five books		
6	six books		
7	seven books		
8	eight books		
9	nine books		
10	ten books		
11	eleven books		
12	twelve books		
13	thirteen books		
14	fourteen books		
15	fifteen books		
16	sixteen books		
17	seventeen books		
18	eightteen books		
19	nineteen books		
20	twenty books		
21	twenty-one books		
30	thirty books		
40	forty books		
50	fifty books		
60	sixty books		
70	seventy books		
80	eighty books		
90	ninety books		
100	a hundred books		
	ordinals	translation(s)	
0	the zeroth book		

1	the first book		
2	the second book		
3	the third book		
4	the fourth book		
5	the fifth book		
6	the sixth book		
7	the seventh book		
8	the eighth book		
9	the nineth book		
10	the tenth book		
11	the eleventh book		
12	the twelfth book		
13	the thirteenth book		
14	the fourteenth book		
15	the fifteenth book		
16	the sixteenth book		
17	the seventeenth book		
18	the eightteenth book		
19	the nineteenth book		
20	the twentieth book		
25	the twenty-fifth book		
30	the thirtieth book		
40	the fourtieth book		
50	the fiftieth book		
60	the sixtieth book		
70	te seventieth book		
80	the eightieth book		
90	the ninetieth book		
100	the hundredth book		
	fractionals	translation(s)	
	1/2 of the book		
	1/3 of the book		
	2/3 of the book		
	1/4 of the book		
	2/4 of the book		
	3/4 of the book		
	1/5 of the book		
	2/5 of the book		
	3/5 of the book		
	4/5 of the book		
	1/6 of the book		
	4/6 of the book		
	5/6 of the book		

	1/7 of the book		
	2/7 of the book		
	3/7 of the book		
	6/7 of the book		
	1/8 of the book		
	4/8 of the book		
	6/8 of the book		
	1/9 of the book		
	2/9 of the book		
	6/9 of the book		
	1/10 of the book		
	2/10 of the book		
	1/25 of the book		
	Approximatives	translation(s)	
1	Approximately one book		
2	Approximately two books		
3	Approximately three books		
4	Approximately four books		
5	Approximately five books		
6	Approximately six books		
7	Approximately seven books		
8	Approximately eight books		
9	Approximately nine books		
10	Approximately ten books		
11	Approximately eleven books		
20	Approximately twenty books		
25	Approximately twenty five books		
	Collectives	translation(s)	
2	A group of two boys		
3	A group of three boys		
4	A group of four boys		
5	A group of five boys		
6	A group of six boys		
7	A group of seven boys		
8	A group of eight boys		
9	A group of nine boys		
10	A group of ten boys		
11	A group of eleven boys		
12	A group of twelve boys		

13	A group of thirteen boys		
14	A group of fourteen boys		
20	A group of twenty boys		
25	A group of twenty-five boys		
	Distributives	translation(s)	
	1/2 book each		
	2/3 book each		
1	one book each		
2	two books each		
3	three books each		
4	four books each		
5	five books each		
6	six books each		
7	seven books each		
8	eight books each		
9	nine books each		
10	ten books each		
11	eleven books each		
20	twenty books each		
	Multiplicatives	translation(s)	
1	once		
2	twice		
3	three times		
4	four times		
5	five times		
6	six times		
7	seven times		
8	eight times		
9	nine times		
10	ten times		
11	eleven times		
12	twelve times		
13	thirteen times		
14	fourteen times		
15	fifteen times		
16	sixteen times		
17	seventeen times		
18	eighteen times		
19	nineteen times		
20	twenty times		
25	twenty five times		