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Appellations of Old Bulgarian numbers from one to ten, considering the set theory with references to other Indo-European Languages

Kiril Parvanov Kirilov
PhD, Associated Professor in the Department for Bulgarian Dialectology and Linguistic Geography, Institute for Bulgarian Language "Prof. Lybomir Andreychin", Bulgarian Academy of Sciences, Sofia, 1113, Bulgaria

***Abstract*---**The current article is dedicated to the names of numbers (from 1 to 10) in the Old Bulgarian Language, referencing other Indo-European languages like Latin and Ancient Greek. The research is interdisciplinary as it attempts to reveal algebraic dependencies in semantics, etymology, and word formation in the names of the numbers from 1 to 10. The article is completely different from the traditional research on mathematical linguistics. Their main purpose is the use of mathematical models in the description of natural languages. Our purpose is opposite of theirs - we discover mathematical regularities in the primitive consciousness and primitive language of our ancestors.

***Keywords*---**Linguistic, Set Theory, Old Bulgarian Language.

Introduction

The present article is part of a research cycle in which we try to find the reflection of dependencies typical to natural sciences, psychology, and philosophy, like language phenomena. We witnessed that in the Old Bulgarian word formation, in semantics and etymology of the various lexemes, which call the body fluids кръвь, глѣнъ, жлътаꙗ кроучина and чрьнаꙗ кроучина we find interesting particularities of the human emotional world (Kirilov 2019). We noted the way word formation particularities of Old Bulgarian verbs that call reasoning processes reflect quite precisely the particularities of both thought systems in the way D. Kaneman presents these (Kaneman 2012), (Parvanov (Kirilov) 2020: 254-260). We described the way verbs that call a movement yet that belong to different word formation types follow the particularities of the movement the way it is defined by the science mechanics (Kirilov 2021). In the present article, we will try to see whether, in the

***Corresponding author**: Kirilov, K.P.; Email: Pramakir@gmail.com*
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Old Bulgarian names of numbers, we would find the intuitive presence of mathematical dependencies that were to be found not sooner than the new era.

The research per se is interdisciplinary since it tries to reveal algebraic dependencies in semantics, etymology, and word formation in calling the numbers from 1 to 10 in Old Bulgarian, and if necessary and possible we make comparisons with other languages (Rivero, 2005). Additionally, it stands out among the traditional research when it comes to mathematical linguistics, whose objective is the use of mathematical models when describing natural languages (Batura 2016). In its linguistic part, the article leans mainly on the research work by A. E. Suprun (Suprun 1969) and by O. F. Zholobov (Zholobov, 2006). In the mathematical part, we refer to the set theory by Georg Cantor, presented in the math textbooks by Boyan Petkanchin (Petkanchin, 1968) and D. Petrov (Petrov, 2012). Additionally, we pay attention to the history of mathematical thought according to Yushkevich (Bashmakova et al., 1974), D. Ifrah (Ifrah, 1985), and Partee (Partee et al., 2012).

The research work aims at discovering the mathematical dependencies of the set theory when calling the numbers. The achievement of this abstract objective is possible via the performance of some more particular tasks: explain why the Old Bulgarian numbers from 1 to 4 are adjectives and from 5 to 10 – collective nouns; present the names of numbers as a mathematical set; demonstrate that the ancient person had an adequate notion of a single set, bilateral relation, predecessor and ancestor of elements of the numerical set. The linguistic material was collected from lexical manuals. The observations are made mainly considering the names of numbers in Old Bulgarian whereas comparisons and references are made to Latin and Ancient Greek languages. Mainly the linguistic method has been used, but we have also the comparative method and, of course, mathematical approaches (Herrera & Herrera-Viedma, 2000).

In the linguistic literature scientists share the same opinion that numbers are those ancient lexemes that demonstrate most clearly the kinship between Indo-European languages. All the lexemes that call the names of digits and numbers contain Indo-European roots (Zholobov, 2006). Namely, the names of numbers from *one* to *ten* gave grounds for the first Indo-European scientists to look for closeness between the Indo-European languages on a broader basis, for example:

Indo-European **oino,* Ancient Latin *oinos* > unus, Gothic *ains,* Lithuanian *víenas,* Old Bulgarian юєдинъ.

Indo-European **duuō/*dŭō,* ancient Indo-European *d(u)vā(u),* neuter and feminine *dvé,* Greek *δύω,* Latin *duo, duae,* Gothic *twai,* feminine *twōs,* neuter *twā,* Lithuanian *dù,* Old Bulgarian дъва, feminine дъвѣ.

Indo-European **trei-,* ancient Indo-European *tráy-aḥ,* Ancient Greek *τρῖς,* Latin *trēs, tria,* Lithuanian *trỹs,* Old Bulgarian трьє, триє. etc. (Grammar 1991: 252).

While considering numbers as speech part in the Old Bulgarian the question occurs as to why representatives of the same morphological category have different morphological features. Take into consideration that Old Bulgarian numbers from *one* to *four* are adjectives and they are coordinated with the noun to which they refer and the ones from *five* to *nine* are nouns in the feminine, they are only singular and are inflected on *i*- declension that carries in its morphemic structure indicator of multiple nature. The number десѧть is masculine, it changes in gender and also has forms on *i*-declension (Grammar 1991: 252-255). One could reasonably ask why then we consider them as the same speech part. The answer is provided by Oleg Zholobov who distinguishes purely numerical (arithmetic) and quantitative functions of numbers. In the quantitative function, they change given gender, number, and grammatical case and play the role of definitions (Zholobov, 2006). In the numerical, arithmetic functions the numbers are used individually while making up syntaxis sequence, in which every word has its strict place: ѥдинъ, дъва, триѥ, четꙑре, пѧть etc. In the numerical function, the grammar nature of numbers is not manifested, hence conditionally we could speak of fixation of numbers. In this case, they are just syntax sequences of words that make up pairs пѧть – шесть, седмь – осмь, девѧть – десѧть, whereas the sound image of девѧтъ has fully subordinated the one of десѧть, only distinguished by one sound (Zholobov, 2006). As a criterion for belonging to this speech part, O. Zholobov states the impossibility of оба to replace дъва, even though these are synonyms (Zholobov, 2006).

The condition of the Old Bulgarian numbers somehow resembles the Ancient Greek and Latin ones. In Ancient Greek numbers from *one* to *four* change given gender, number, and grammatical case, and the ones from *five* to *ten* do not change (Milev, 1979). We have similar status in the Latin language. Among quantitative numbers only *unus, duo, tres* are inflexed. *Unus* in turn is a pronoun adjective. The numbers from *five* to *ten* are not inflexed. Just like in Old Bulgarian next to дъва there is оба, in Latin language, in addition to *duo* we have *ambo*. Just like the Old Bulgarian оба could not replace дъва during counting and *ambo* could not replace *duo* (Gandeva, 1975). The three systems are distinguished from the Ancient Indian one whereas numbers change given grammatical case, and some in gender and number (Max, 1901). In other words, the formation of numbers is a continuous process, and the different languages present differing abstraction degrees. A direct indicator of the abstraction degree is the gradual abolishment of their morphological indicators for gender and number (Zholobov, 2006).

Namely, these features brought our interest in searching for the connection of their names with the formation of mathematical reasoning in humans. Let us remind you that the first counting attempts were about the assimilation of the correspondence between two sets – one of the items being counted and some other, already known set (Deschrijver & Kerre, 2003). The first counting etalons were natural like the fingers, pebbles, indents made in a tree or bone, etc. As time passed humans changed this particular counting characterized by elements of various multitudes, with one set being the most convenient for counting. The appearance of abstract etalon of set being the symbol of some number is a prerequisite for the occurrence of the "number" notion (Yushkevich, 1974).
We would attempt on the grounds of the historical development of numbers to find elements of the theory of numbers and sets.

The names of numbers from 1 to 10 as a set

The development of numerical function in numbers allows us to consider these namely as a set. In the numerical function ѥдинъ, дъва, триѥ, четꙑре, пѧть, шесть, седмь, осмь, девѧть, десѧть we have a rhythmic text in which they have lost their grammar features, have a particular place, do not allow to be replaced by their synonyms (Zholobov, 2006). All this allows us to assume that these comprise the set of natural numbers from 1 to 10.

This is how names of numbers would look like as set in Old Bulgarian language:
A ={ѥдинъ; дъва; триѥ; четꙑре; пѧть; шесть; седмь; осмь; девѧть; десѧть}
In the abovementioned example we have the set *A* of the natural numbers from 1 to 10. Its elements are clearly homogenous and distinguishable (Al-Amin 2017). In the same way we could present the names of numbers from 1 to 10 in whatever language.

Archaic features of the names of Old Bulgarian numbers

1. Preserved old indicative nature

The Proto-Slavic and Old Bulgarian numbers keep archaic conditions even though they long time ago turned into abstract notions that have lost their particular meaning (Zholobov, 2006). Maybe behind the fact that in the Old Bulgarian epoch, the numbers from 1 to 4 were adjectives coordinated with the noun and the numbers from 5 to 10 were nouns, there is some weathered archaic subject meaning. Let us look at the history of numbers and see whether we can find a description of this fact. The Latin system, which is addictive and decimal, uses the sign I 'one dash' of the Etruscan writing to designate "one", X "two crossed lines" to designate "ten" and ˅ or ˄ "half X", as the sign "five" etc. (Keyser, 1988). The row of numbers from 1 to 5 in the Etruscan numerical system looks like this:

I – 1, II – 2, III – 3, IIII – 4, V – 5

Noting the number 4 with four dashes or dots grouped in a particular manner is found in the numerical systems of many nations: Shumer, Inkas, and Hindus. The reason behind this is the opportunity for one person to be able to "count" to 4 (Ifrah 1985). The Indo-European ancient language distinguishes between the first four names for numbers and the subsequent ones. And this tells us the Indo-Europeans themselves found it difficult to distinguish among more than four items. In the Indo-European language, the names of the numbers from 1 to 4 were adjectives, and *three* or *four* called some feature, the way it is defined by *light* and *heavy*, *big* and *small*, *red* and *green*, i.e. capacities that are immediately recognizable. The number in this case is like a feature similar to colour and size. Nevertheless, *five* is perceived as an adverb, and *eight* is a noun. This fact is based on the human capability to perceive up to four items (Gerchel, 1962). Quite reasonably we could admit that human capability to distinguish up to 4 features, 4 points are preserved in the adjective nature of Old Bulgarian numbers from 1 to 4.

2. Presence of formal features for a small set

All the Old Bulgarian names of numbers except for the name of *one* somehow convey the idea that they call sets of items. The number дъва designates the property of two items that are based on the closeness between them (Suprun 1969). The others contain *-*i*- which is used for the designation of close, foreseeable items that could be reasoned as a small set. It is associated with part of plural endings -и in Old Bulgarian and -*и* in modern Bulgarian language. The same suffix is held by collective nouns close to one another that make up a natural set (Dobrev 1982: 146-149). This formal feature for sets in numbers in the modern Bulgarian language could not be found.

Singleton Set

Nowadays, it is difficult for math teachers to explain to the students that there is a set of only one element. The number ѥдинъ in ancient languages is included in the numerical system at a later stage since it does not call a number but the item (Gamkrelidze, Ivanov: 844). Its origin is related to the anaphoric pronoun whereas the number has acquired the diacritical particle -*no*- * ed-oyno- > * edinъ (Zholobov 2006). *One* participates in the dichotomy *one: many* and is prehistoric form with which the human presents the quantitative measurements of things. The word ѥдинъ is used when you separate a unit from some multitude of similar elements (Suprun 1969: 18-19). The fact that ѥдинъ has quantitative as well as numerical functions tells us that lexeme could be perceived as an element of the set of natural numbers from *one* to *ten*. Nevertheless, how about ѥдинъ expressing a set of something, the way the one circumference expresses a set of points? Even though it does not have the formal feature of a set, on the contrary, it is opposed to the *many,* it is not hard to find proof at the word formation level that 1 is a set of homogenous and easily distinguishable elements.

1. Element of set;
   единъ ∈ {ѥдинъ; дъва; трие; четꙑре; пѧть; шесть; седмь; осмь; девѧть; десѧть}
2. As a set.
   {единъ}

The fact that our predecessors had the notion of a set that contains one element is evidenced by the fact that the lexemes calling “unification, an association of items, persons, etc.” result namely from the name of the number *one* – ѥдинениѥ ‘unity’ ѥдиньство ‘unity’. We observe the same phenomenon in the modern Bulgarian language: ***един***-*ство* ‘unity’*,* ***един***-*ен* ‘unitary’*, об-**един**-явам* ‘to unite’. We observe analogous derivation in another language” the Latin *unitas* ‘unit’, *unio* ‘to unit, to combine into one’; the English *unit* in the meaning ‘a group of people who work or live together, especially for a particular purpose’, *to unite* ‘to join together with other people to do something as a group; the French *unite* in the meaning ‘character of what offers a whole, a sequence where everything fits together’, *unir* ‘to join two or more things together’. The same lexeme for *universe* (French *univers*, English *universe*) derives from the Latin *universum* ‘everything that revolves as one’ and is related to the number *unus* (Dauzat 1954). The derivatives from ѥдинъ, from *unus*, which on one hand call multitude and the other hand implicitly bring inside the unit, demonstrate that the person of those times has the adequate notion of the presence of a single set.

Binary relation

After we outlined the Old Bulgarian names for the numbers from 1 to 10 in a set, we will try to see in their meanings, etymology and syntaxis service whether we could find some dependencies of mathematical sets.
Thus, the primary notions of the set theory are *set*, noted with the Latin capital letter, for example, *A*, *object (element)*, noted with the Latin lowercase, for example, *a,* and the binary relation *belongs*, noted with the sign “$\in$“. Thus the thought “The object a belongs to the multitude A.“ mathematically is written as $a \in A$. To form certain object sets, these should also be considered as sets. For example, the elliptic bundle of circumferences is a multitude of circumferences yet circumference is a multitude of points (Petkanchin 1968; Petrov 2012). We accepted that {ѥдинъ, дъва, тριѥ, четыре, пѧть, шесть, седмь, осмь, девѧть, десѧть} is a set.

After we witnessed the way word formation, semantics, and etymology helped us recover ancient people’s notion of a set and its elements, we would try to see how to express the binary relation $a \in A$, see above (Petrov 2012). The character $\in$ means *belongs* or *element of something* (Petkanchin 1968; Petrov 2012). Direct expression of binary relation is present in the uses of genitive case, without preposition and combination of prepositions отъ when designating part of the whole (Grammar 1991: 458), for example: посъла дъва отъ оученикъ своихъ М Лк 19.29 (*He sent two of His disciples, saying to them…* Luke 19.29); ѣко единъ отъ васъ прѣдастъ мѧ М Мт26. 21 (*Truly I tell you, one of you will betray me.* Matthew 26.21) The binary relation is expressed in the same manner, in Ancient Greek and Latin with genitive partitive. In the Ancient Greek genetitivus partitivus serves to designate part of the whole, as well as to designate the part without meaning the whole (Milev 1979). In the Latin language, genetitivus partitivus means the whole from which one part is taken or highlighted. It is translated in Bulgarian language with the preposition *om* ‘from’. It is used after nouns that mean ‘set, aggregate’. In addition to genetitivus partitivus we could use ablatives with the preposition *ex* or *de* (Gandeva 212-213). Let us remind you that *part – whole* is linguistic category that discloses the relations between things expressed via the means of language when something is part of whole and vice versa, when the whole is multitude of parts (Zherebilo 2010). In linguistic science, there are cases in which the lexical meronomy is presented namely via formulae of the set theory namely with the implementation of binary relation. B. Okal and F. A. Miruka presents lexemes that call the parts of the human body, of birds, of the house as elements of sets:
Hand $\ni$ {arm, arm pit, elbow, fingers, forearm, palm, wrist}.
Fingers $\ni$ {fore finger, little finger, middle finger, ring finger, thumb} (Okal & Miruka, 2016).

Empty set (void set)

While considering the Old Bulgarian numbers, we noted that there is a direct referral of the empty set. Nevertheless, our predecessors had the notion of an empty set and expressed it figuratively: Блаженꙑи же призъвавъ слоугѫ глагола ѥмоу. иди даждь ѥмоу дроугѫѭ ꙁ҃ ꙁлатицъ. отъвѣштавъ же глагола. вѣрѫ ими чьстнꙑи отьче ꙗко нѣстъ остала **ни ѥдина** ꙁлатица въ ризьници / *Πίστευσόν μοι τίμιε πάτερ· οὐ κατελείφθη* ***οὔτ' ἓν*** *νόμισμα ἐν τῷ βεστιαρίῳ*". (… *The brother said: "Believe me, honorable father, there is not a single coin in the cupboard."*) (http://suprasliensis.obdurodon.org/pages/supr061v.html). We could see that in citations for example from *Hagiography of Saint Grigorios,* the empty set is presented via negation of the single set, i.e. before the number ѥдина we have the particle ни. The Greek original presents the same idea before the number *' ἓν* we have *οὔτ* 'neither' (Milev 1979: 326). We find identical thoughts in the etymology of modern English *no one* (https://www.etymonline.com/word/nobody). This hints at the binary system in which G. Leibnitz sees an allusion to creation – 1 as the image of God, and 0, its opposition as a symbol of non-existence (Kurant 1985).

Successors and predecessors

Above we saw how one of the proofs for outlining the numbers in separate speech parts is the distinguishment of numerical, arithmetic functions (*counting* in Zholobov), whereas numbers are used individually from the quantitative function when they play the role of definitions. Zholobov considers the lexemes that call number as rhythmically connected text of paired words ѥдинъ - дъва, трие - четꙑре, пѧть - шесть, седмь - осмь, девѧть - десѧть and schematically present them n and (n+1). In the abovementioned text, numbers have strict places and no other lexemes could be included that mean the same quantity, i.e. instead of дъва we could not include оба (Zholobov 2012). Maybe we could try finding behind the text cited by Zholobov in which numbers play only arithmetic functions, elements of the theory of natural numbers whereas every natural number A_1 has only one successor A_2, whereas 1 is not the heir of some natural number meaning that 2 is the successor of 1, 3 of 2, 4 of 3, etc. (Petkanchin, 1968). Let us remind you that while analyzing the numbers, Suprun notes their feature asymmetry 3 contains 2, 4 contains 3, yet the opposite is not true (Suprun, 1969). Told in mathematical language, the same looks like that:

Let us write the number 1 as the only element of the set E, i.e. $E = \{1\}$, and with A final set (final would mean with a fixed number of elements), whereas both sets differ from the empty set. The successor A' of A we would present as the unity of the sets A and E, i.e. $A' = A \cup E$ (Petrov, 2012).

This formula is so complex at first glance is reflected quite clearly in the etymology of names of the numbers *four, five, six… ten* related to the fingers of the hands (Zholobov, 2006). We accept that the thumb is the only element of one set. We express it mathematically this way $E = \{1\}$, and $A = \{1; 2; 3; 4\}$ is a final set with the strength of 4 because it reflects the old quarter system of the human hand without thumb. In the case of *five*, being the successor of *four*, the thumb is already included i.e. $A' = A \cup E = \{1; 2; 3; 4; 5\}$. The set A' has the strength 5 and unites the set of the four-finger hand with set that contains just the thumb. Thus, we continue for every following number.

Conclusions

Our reasoning demonstrated how mathematical dependencies discovered in newer times are present in semantics, etymology, and the word-forming features of the names of numbers. Let us not forget that the kinship name *число* < *čislo, *čismę is relative of the Old-Indian kȅtas 'thought, deliberation, wish', showing this way it reflects something as abstract (Zholobov 2006; Fasmer, 1986).

Behind outlining the arithmetic function in numbers, we have the idea these could be considered namely as a set of natural numbers. Based on the presence of lexeme ѥдинъ, *unus* in the set of natural numbers and the semantics of its derivatives (ѥдьнодоушьнъ, ѥдиньство; *unit, unity*) we understand that our predecessors had the intuitive notion of set that contains just one element.

From the impossibility of exchanging the places of the separate elements in the text of numbers that have arithmetic functions, we have the dependency – every natural number has one successor and one predecessor, except for 1 which has only one successor.

In the syntaxis constructions where Old Bulgarian numbers take part, we see a direct reflection of the mathematical relation *belonging of one element to a set*. In Old Bulgarian the empty set is expressed descriptively namely via antonym of a lexeme that calls a single set ѥдинъ: ни ѥдинъ. The same opposition is present in Ancient Greek *ἓν : οὔτ ἓν.* All this leads us to the binary numerical system that is fundamental in the development of informatics and computer equipment.

Data Availability Statement
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