ARITHMETIC SYSTEMS IN *SPONTANEOUS* GREEK SIGN LANGUAGE.

Dr Papadopetrakis, Eftichis
University of Patras, Greece, Dept. of Mathematics
Papaprokopiou, Lamprini, BSc
University of Patras, Greece, Dept. of Mathematics

ABSTRACT

The ability of the human being to count objects starts through spoken language and imitation, and it is completed during the first years of school life via organized instruction. This ability presupposes the assimilation of both a spoken and a symbolic (arithmetic system) language. This symbolic language is nearly common throughout the whole planet while the spoken one, obviously is not. In the case of Deaf people, the assimilation inability of the spoken language constitutes an obstacle for the assimilation of the symbolic one too. Greek Sign language covers to a satisfying extent this inability.

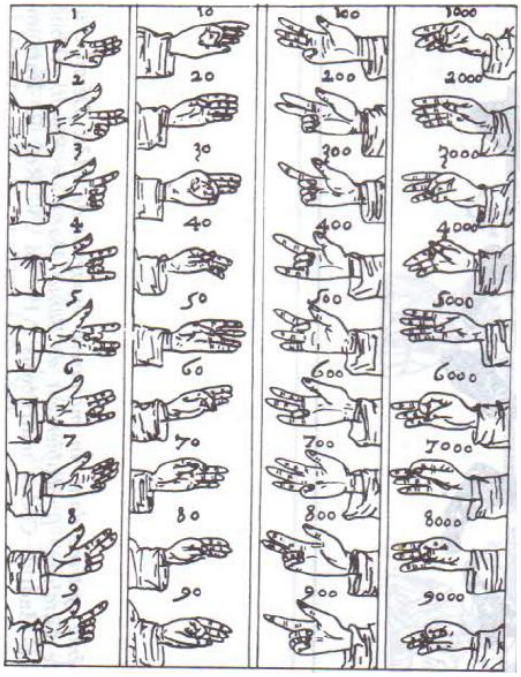
The aim of the current study was to collect and study the different manifestations of the Greek Sign language on the numbers, which have been developed spontaneously, under the pressure of daily needs, by Deaf elderly individualswho have had no appropriate educational opportunities. We aim to study the alphabet and the syntax of this language in order to find out where it can be classified based on the hierarchy of Noam Chomsky. We take into consideration that the Greek spoken language on numbers is governed by a normal grammar, such as the symbolic one, which means that is situated on the bottom of Chomsky's hierarchy.

In this study, the researcher and another deaf mediator took videotaped interviews of elderly deaf. The interviews took place in various Greek cities.

The contribution of our study will be the coverage of a relative gap both in the native and the international literature.

Every human society that, in a relative independence, takes its first cultural steps, develops, a special language, together with its natural one, able to capture, express, or even communicate the notion of numerical multiplicity. This special language is either *symbolic*, *oral*, or very often a *sign* language as well.

Exchanges with the use of sign language in a primitive society



Sign symbols from the book «Suma de Aithmetica, Geometrica» of Luca Patioli Venice, 1494

Accounting in sign language, Egypt 16th century B.C.

Examples of sings

This special symbolic language for the natural numbers has been connected to the term “numeral system” (or “system of numeration”). Every such system, no matter the time era it has firstly appeared and been used to came into use, always featured the three fundamental concepts of a language, which are the alphabet, syntax and semantics:

i) **Alphabet:** The set of symbols in use, which could be graphs, phonemes, or nods.
ii) **Syntax rules**: The general syntax rule is the ***concatenation*** of symbols, probably with some restrictions.
iii) **Semantic rules**: Rules that correspond the symbol sequences, that are in accordance with the syntax rules (grammatically correct), with cardinalities. These rules are described by the semantic function.

Three kinds of such languages have been developed in the history of civilization, the main criterion being the nature of the semantic function:

Given a sequence $a_n a_{n-1} \cdots a_2 a_1 a_0$
In additional systems:

$$f(a_n a_{n-1} \cdots a_2 a_1 a_0) = f(a_n) + f(a_{n-1}) + \ldots + f(a_2) + f(a_1) + f(a_0)$$

Meaning that the value of the sequence is the value of the sum of the values of the included symbols.

While in the positional:

$$f(a_n a_{n-1} \cdots a_2 a_1 a_0) = a_n b^n + a_{n-1} b^{n-1} + \ldots + a_2 b^2 + a_1 b^1 + a_0 b^0$$

Where b is the base of the system where, in positional systems, is always the cardinal of the Alphabet.

The ability of a social human being to admeasure or count objects, was, for thousands of years, bequeathed from one generation to another, through the oral language and the use of examples, in order for it to be mastered through the organized teaching, after the beginning of the school life. This ability demands the appropriation of an oral language as well as a symbolic one (numeral system). The symbolic language, by contrast with the oral one is the same in almost every corner of the planet.

In the case of deaf people, the inability of appropriation of the oral language, from their social environment, becomes a burden for the appropriation of the symbolic one as well. Hellenic Sign Language, as it is taught in special schools, covers this inability to a quite satisfactory degree. However, there are cases of people at an older age, who, for some reasons, have not been recipients of this special education. This need for communication, as well as the need for management of numerical data, has led lots of them to the creation of their own special language for numbers, either individually or collectively.

After conducting a thorough research, we reached the conclusion that there is no unified Hellenic Sign Language of Numbers(HSLN), but there are multiple ones that differ according to the geographical area. The basic differentiations that can be detected in the alphabet.

For 9 *For 10* *For 11* *For 15*

For 20 *For 10^6* *For 10^9*

The syntax and semantics is the same in all cases: it is that of ancient decimal additional systems, containing alphabetical symbols. The only restriction is that higher order symbols precede lower order symbols. Such a numeral system was the Ionian which was developed in the cities of Ionia, at the ancient region *of* Asia Minor and was used throughout the whole Byzantine era.

Our research on the sign languages of numbers lasted about a year and the collected material includes interviews of teachers, translators and deaf HSL speakers. The variations in the HSLN stem from the fact that it was recorded from those two different groups of people. The third category includes elderly deaf HSL speakers from all over Greece, whom we recorded during arbitrary personal conversations. “Arbitrary” here meaning every little notion, sign but also language as a whole, that deaf people come up with in an attempt to exchange information concerning cardinalities with other deaf and non-deaf people.

In the following pages we present three indicative cases of deaf people signing; one living in Nafpaktos, another in Patras and one in Thessaloniki.

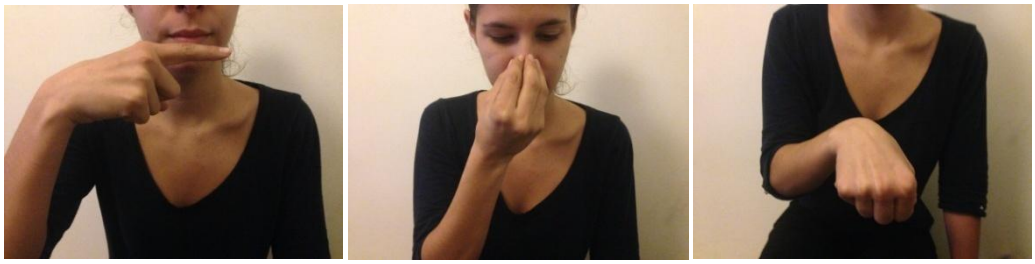
THE CASE OF MR NIKOS OF NAFPAKTOS

Mr. Nikos from Nafpaktos is a 68 year old man. He narrates that he tried to attend the local primary school as a kid only to expelled by the teacher two months later! Since then he became a worker in agriculture. There were no other deaf people in his family. He has had four children, two of which are also deaf. He uses his personal form of sign language, which he developed in two stages; before and after his marriage to a hearing woman. He was never

taught HSLN but through his everyday communication with hearing people he has developed his initial personal sign code into what is now HSLN for the numbers 1 to 10.

During the first stage he had developed a sort of personal code to be able to count to 10. This was an unfinished arbitrary code that bears no resemblance to HSLN. Although for the numbers 1 to 5 the amount of fingers held up is the same:

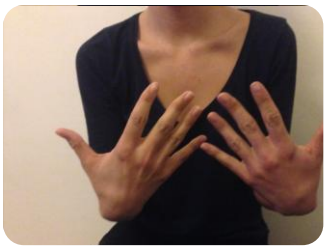
The numbers 6 to 10 show no cardinality whatsoever with the signs used being totally arbitrary:



For 6 *For 7* *For 8*

For 9 *For 10*

During the second stage he started using HSLN signs for counting to ten without ever having been taught. The code he uses for numbers from 10 on is a standard additional system, like the Minoan of Crete (1500 b.C.), which strictly follows the rule of presenting higher order symbols first, followed by the lower order symbols in a row.



For 10 in the second stage

If we were to depict one finger held up with a vertical line and 10 fingers held up with a horizontal line, then here is what Mr. Nikos would sign to count to to 99:

𝍠,𝍡, 𝍢, … 𝍣 ,𝍣𝍠, 𝍣𝍡, 𝍣𝍢,… 𝍤, 𝍤𝍠, 𝍤𝍡, 𝍤𝍢 and so on to 99

The two symbols we just used are the two first symbols of the total of five symbols of the Minoan numeral system. This is a decimal, additional system with five symbols which used the concatenation to compose numbers.

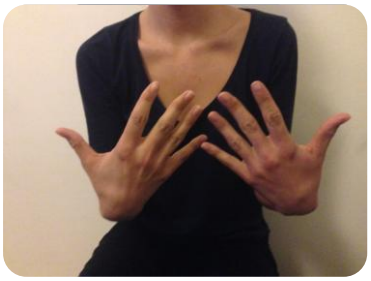
Clearly the signings that Mr. Nikos uses do not signify abstract integers but specific quantities. They are adjectives and not nouns. Mr. Nikos does not grasp the meaning of 𝍣𝍡 as the integer 12 but rather as a quantity of 12 items. In our case coins, euros.

It became clear during our conversation that he could only understand physical quantities. All the mathematical operations we used concerned transactions. Mr. Nikos was indeed very capable of performing mathematical operations with integers and small decimals. However for him to really understand the meaning of addition we had to ask him “HOW MANY ITEMS ARE THESE ALL TOGETHER” or “HOW MUCH DOES IT COST IN TOTAL”.

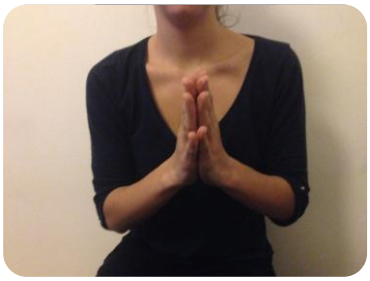
THE CASE OF PATRAS

This case is about an 80-year-old man from Patras. His has no other deaf family member, except his wife. He never went to school and his occupation is related to horses.

For numbers 1 to 10 he uses HSLN, while for numbers 10 to 50 he composes as in the case of Nafpaktos, with the difference that the former is touching his palms, whereas the latter is pointing at them. However, from a syntactic point of view, they implement the same sequence.



The case of Nafpactos



The case of Patras

For numbers over 50, he declares their digits in their indo-arabic writing. The declaration of every such digit corresponds to the one of HSLN's. For instance, number 548 is expressed as 5-4-8, and, accordingly, number 1543 as 1-5-4-3. We got impressed with his remarkable enthusiasm on how large the number 1543 is. We then realized that to him meant 1543 euros!

He connected the signs of numbers to either money or playing cards. He was so keen on arithmetical operations, that he reacted contemptuously to the "easy" tasks that he was asked to perform. However, he got quite frustrated in the view of the symbol of addition, as it was something that he was totally unfamiliar with. He was used to conducting the addition of two numbers by writing the second number just below the first one.

By the way he corrected his own mistake , it got apparent to us that during an addition, he implements the algorithm of positional systems. It seems that his familiarization with card playing has been catalytic in declaring numbers after 50, according to their indo-arabic writing.

THE CASE OF THESSALONIKI

This case is about a 66-year-old man from Thessaloniki. He never went to school. His parents were hearing, whereas all his siblings were also deaf. He was communicating with them through a sign language of his own contrivance.

His way of expression is a combination of the two previous cases, without, though, having met any of them. More specifically, for numbers 1 to 100 he follows the rules of HSLN, he expresses decades as in the case of Patras and hundreds same as Mr Nikos from Nafpaktos.

CONCLUSIONS

The Greek State has not yet established an official Hellenic Sign Language of Numbers. The educational gaps remain vast, while the need of deaf people for communication is still imperative. The creation of spontaneous signs basically covered this need. These signs have a lot in common with some of the hundreds of sign languages that have been recorded in ancient civilizations or even contemporary ones that are geographically isolated. People tend to provide similar solutions to the same problem. It is no coincidence, then, that the official HSLN follows the structure of the Ionic numeral system, as it is adjusted to the Neo-greek oral language, which has been based on the Ionic numeral system. It is impressive how a tangible signified is an imperative demand for everybody. This principle exists, according to Vygotsky, in children as well, but with the tension to get weaker through education.