A VERSION OF GT GRAMMAR FOR MODERN GREEK LANGUAGE PROCESSING
PROPOSED AS A MODERN GREEK LANGUAGE CALL METHOD DEVELOPER

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Abstract

In this paper, we put forward a version of a Generative Transformational Grammar (GTG), for the Modern Greek Language (MGL) Processing, which is used for the development of a Computer-Assisted Modern Greek Language Learning (CAMGLL) Method. This suggested Grammar, composes of the Template Grammars (TG's-generative dimension), the Basic Modern Greek Computational Multilexicon (BMGMLx) with its algorithms (transformational dimension). The model of this suggested Grammar is based on the structure and function of the MGL System, that is, MGL components, relations and functions of which it comprises. Thus, the teaching of the Grammar Code of the MGL is approached by the modern linguistic and communicative perception (Holistic Approach) with which morphology and syntax, forms and functions are inseparable. Furthermore, the suggested Grammar is able to parse and generate Modern Greek Sentences[1], in the framework of an Open Educational Environment where learning is experimental, creative and cooperative. The contents of the computational lexicons of the BMGMLx and the production rules of the TG's are suitably selected and enriched in order to use, firstly, words of themes and meanings from communicative areas, secondly, their dominant semantic combinations and thirdly, the commonly used morphological and syntactical rules. All these contents are functional for the basic forms of the communicative written MGL (Communicative Language Teaching Method). The Computer-Assisted Modern Greek Language Learning method based on the suggested Grammar can be used either in a classroom at school or by Internet correspondence, for teaching MGL as a native or foreign language.

1. Introduction

The reason for analyzing a Modern Greek Sentence, as it occurs in a sentence in every natural language, is understanding its contents, which means, identifying various actions, as well as the attributes that characterize the agents, the actions, and the recipients of these actions, for further use, for example in language teaching. Thus Modern Greek text processing presupposes: (a) the formalization of the MGL data, which are the vocabulary of the language, the syntax rules, the morphology rules and the semantic rules, i.e., the components, the relations and the functions that compose the structure and function of the MGL System, (b) Modern Greek text syntactic analysis or parsing, whereby each Modern Greek Sentence of

[1] When referring in this paper to the Modern Greek Sentences, we mean the whole (ακέραιες=akerees) and main (κύριες=kyries) sentences,

the text is "delinearized", i.e., a tree structure is extracted from the words which make up the sentence. This tree structure describes the role of each word in the Modern Greek Sentence. In parsing, the central role is played by the Grammar which is a device for giving the specifications of Modern Greek Sentences. However, the mechanisms of the structure and function of the MGL System lead to form this procedure for the MGL. In fact, the referred mechanisms form the required Grammar since it is a system which describes the ways of forming acceptable Modern Greek Sentences [1,4].

The MGL mechanisms are generative, that is, its application leads to the generation and the parsing of the syntactic structure of Modern Greek Sentences, which are classified[2] as simple, compound, amplified and compound-amplified [1,2,3,4,5]. These mechanisms are transformational whereby from every syntactic structure arises an infinite number of Modern Greek Sentences, using the appropriate sets of words and transformational rules each time. Applying the transformations to each word of the constructing sentence, the words form[3] the appropriate morphological type according to their syntactic role and comply with the rules of their semantic agreement. There are many and composite transformations as the MGL is an inflectional language. Similarly, in parsing a Modern Greek Sentence, the syntactic role of its words is found, i.e., Modern Greek Sentence syntactic structure.

In inflectional languages, the grammatical relations are expressed by declension, i.e., word suffixes, rather than the syntagmatic order of words or by the prepositions, as it occurs in the non-inflectional or in the semi-inflectional languages, like the English Language (EL) [1,4,21]. For example , in the EL a sentence which consists of a subject, a verb and an object can be expressed correctly, without having its meaning changed, only according to the pattern SVO; however in MGL, this sentence can be expressed correctly, having its meaning unchanged, according to the following six patterns: SVO, VSO, OVS, SOV, VOS and OSV. Thus the basic feature of MGL is that the syntactic relations are indicated by the case (see footnote 3). However, the semantic agreements which are held between the lexical items correspond to the semantic relations held between Subject-Verb, Verb-Object, and so on, in a sentence [1,4,5]. Hence, the semantic relations in MGL indicate the interdependence of syntax, semantics and morphology. Moreover, we note that specific word class or word classes are provided for each syntactic role.

Many schemes have been proposed for the natural language processing, which displayed certain inadequacies. It should be noted that such inadequacies were observed and

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[2] As provided by the Modern Greek Syntax as it is taught at the Secondary Education Level .

[3] This in the Modern Greek Syntax, is expressed as follows: "the words irrespective of order found in a sentence and according to their syntactic role form their appropriate morphological type"; evidently complying with the rules of their semantic agreement.

recorded primarily in the case of the EL, which differs considerably from MGL, as mentioned above [14,15,16,17,20,21].

In recent years, a certain amount of research has appeared in the MGL processing. This research is usually orientated towards certain ranges of MGL processing [13,18,19,22, 23,24,26].

A method which addresses the full range of MGL processing, from the lexical level to the semantic one is a version of GTG's, whose model is composed of the Template Grammars (TG's-generative dimension), the Basic Modern Greek Computational Multilexicon (BMGMLx) with its algorithms (transformational dimension) [1,2,3,4,5,6,7].

Template Grammar is a modified version of the Grammar of Chomsky's hierarchy. This modification requires that by definition the production rules, which are finally syntactic structure rules, be grouped to templates of rules, producing the syntactic structure of the Modern Greek Sentences. The production rules are internationally established as phrase structure rules, mainly used for the English language processing. The syntactic categories of the inflectional MGL designate grammatical functions, which are inherent relation notions, rather than grammatical categories and express the interdependence of syntax, morphology and semantics [4,5]. In addition, results in the production and parsing an intermediate, abstract language of syntactical categories of MGL. This language is free of morphological rules and meanings having the same structure as Modern Greek Sentences and defines a Pattern Language, that is the Language of Syntactic Categories of MGL. Pattern Language is a formal language simply processed. The Template Grammars take on a special importance as an efficient tool for parsing and generating Pattern Language Sentences with the introduction of characteristic exponents. The characteristic exponents characterize the structure of the Pattern Language Sentences and map them to the corresponding templates of grammar rules which generate them. The characteristic exponents are strings of integers which are easily extracted and recognized. The characteristic exponents allow to find directly the template of generation of the Pattern Language Sentence which is proposed and hence the category of sentences where the individual sentence belongs avoiding the time consuming searching methods [1,2,3,4].

The Basic Modern Greek Computational Multilexicon (BMGMLx) is a system of computational and interconnecting lexicons which consists of recorded data concerning the vocabulary, the syntax, the morphology and the semantics of MGL. The BMGMLx for every word it contains and by means of its algorithms, can recognize or give any information about the word morphology and the word semantic agreement with other words in accordance with its syntactic role each time. This information is utilized by the algorithms of BMGMLx which describe "what has to be done" so that: (a) given the syntactic structure and chosen words to be transformed into an acceptable Modern Greek Sentence and (b) given a Modern Greek Sentence, the syntactic roles of its words and structure are pinpointed. In other words, the generative and transformational MGL mechanisms are finite rules which are expressed by algorithms. These algorithms recognize Modern Greek words, generate and parse their forms and their semantic combinations as well as Modern Greek Sentences [1,4].

According to the suggested Grammar, a Modern Greek Sentence is converted to the corresponding Pattern Language Sentence by means of the BMGMLx, its algorithms and Template Grammars (TG's). The resulting Pattern Language Sentence is expressed in the normal order of its syntactic categories as the Modern Greek Syntax defines; irrespective of its corresponding position of words in a given Modern Greek Sentence [1,4].

The proposed GTG as it is based on the structure and function of the MGL System continues the uniform perception of the GTG's of Noam Chomsky, where his model composes the morphological structure and the syntactic function of the language due to the semantic agreements of the words of the sentence [8]. Furthermore, the possibilities which derive from the realization and application of the suggested GTG in the teaching of the MGL guide the teaching of the Grammar Code of the MGL according to the modern linguistic and communicative perception. Based on these perceptions, morphology and syntax, form and function are inseparable; these principles are expressed by the Holistic Approach [12,28].

Moreover, the teaching of the morphology and syntax assisted by computer technology and the proposed Grammar is done without the pressure of rules and complex phrasing. Hence, the morphological and syntactic rules are presented in a simplified way through the emphasis on the production and parsing of commonly used Modern Greek Sentences of themes and meanings from communicative areas, in an Open Educational Environment. Thus the Communicative Language Teaching Method is followed. The BMGMLx with information it provides and is available at any time, makes the learning result more effective and efficient since it minimizes the metalanguage of morphological, syntactic and semantic rules of the MGL. In addition, the BMGMLx provides the necessary self-sufficiency for the user not to resort to other means of electronic or printed matter when finding language phenomena.

We note that, the proposed GTG is principled, computationally efficient, descriptively adequate for our purposes and introducing a MGL learning/teaching method development. Thus, the proposed GTG constitutes a Grammar Framework which allows for an accurate computational implementation and may form the syntactic component (Expert Module) of an Intelligent Computer-Assisted Modern Greek Language Learning (ICAMGLL) Method [9].

2. A Modified Version of GT Grammars for MGL Processing

2.1 Template Grammars and Characteristic Exponents – Generative Dimension

The application of Template Grammars in MGL processing led to the TG_1, TG_2, TG_3 και TG_4[4] with which the syntactic structures of the simple, the compound, the amplified and the compound-amplified sentences correspondingly are produced and parsed [1,2,3,4].

For example the TG_1 is defined as: $TG_1=(V_{M1},V_{T1},P_1,S)$, where: $V_{M1}=\{S,A,B,C\}$, $V_{T1}=\{a,b,c,g\}$, $P_1=\{p_{1,1}, p_{1,2}\}$, with $p_{1,1}=\{S\rightarrow AB, A\rightarrow a, B\rightarrow b\}$and $p_{1,2}=\{S\rightarrow AB, A\rightarrow a, B\rightarrow gC, C\rightarrow c\}$ [1,2,3,4].

We note that:

- S≡<<simple_sentence>>,A≡<<simple_subject>>,B≡<<simple_predicative>>,C≡<<simple _predicate>>, a≡<subject>, b≡<predicative_verb>, c≡<predicate>, g≡<conjunctive_verb>,
- $p_{1,1}$ and $p_{1,2}$ are the templates of production rules which produce the syntactic structures of the simple sentences,
- The production rules of $p_{1,1}$ and $p_{1,2}$ are the formalized syntactic rules, by means of the metalanguage BNF [1,2,3,]. Thus:

  <<sentence>>::=<<simple_sentence>>,
  <<simple_sentence>>::=<<simple_subject>><<simple_predicative>>,
  <<simple_subject>>::=<subject>,
  <<simple_predicative>>::=<predicative_verb> |
  <conjunctive_verb><<simple_ predicate>>,
  <<simple_predicate>>::=<predicate>.

The TG_1 produces the language $L(G_1\}=\{ab, agc\}$. The Pattern Language Sentences ab and agc are the patterns for an infinite number of Modern Greek Sentences.

Similarly TG_2, TG_3 and TG_4 are defined. We note that the templates of P_2 are twenty. However the templates of P_3 and P_4 are many because of the great variety of the MGL modifiers and their combinations. In our research, the commonly used types of amplified and compound-amplified sentences are included. These have a high rate of frequency in the Modern Greek texts. P_3 and P_4 are extended in the course of the research and the application of the proposed method [1,4].

The formalization of the syntactic structure rules of Modern Greek Sentences for processing led to [1,2,3,4]:

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[4] Although one TG could be defined describing all the Modern Greek Sentences syntactic structures, we introduce four distinct TG's each for every Modern Greek Sentences category so it achieves a small number of variables for each TG and greater transparency of the Pattern Language Sentences produced by the same template.

1. the substitution of the categories NP (Noun Phrase), VP (Verb Phrase), Art (Article), N (Noun), etc., of the phrase structure rules with the MGL syntactic categories <subject>, <predicate >, <predicative_verb>, <conjunctive_verb>, etc. of the MGL syntactic rules. The syntactic categories of the inflectional MGL simplify MGL processing since they are grammatical functions and express the interdependence of syntax, morphology and semantics. Thus, these functions in every syntactic category correspond to semantic[5] acceptable word in its acceptable morphological type and vice versa. On the contrary, the grammatical categories are insufficient for MGL processing since the syntactic roles of words which are provided depending on their order in a sentence do not consist in any case of sufficient condition detected in the syntactic roles in Modern Greek Sentences.

2. the generation and parsing of an intermediate and abstract Pattern Language, called Language of the Syntactic Categories. Pattern Language Sentences having the same structure as Modern Greek Sentences define Modern Greek Sentences deep structure, i.e. deep structure of Modern Greek Sentences is identical to the syntactic structure of Modern Greek Sentences and free of meanings.

3. two different Modern Greek Sentences that is two different surface structures as we define can have either the same deep structure, if having the same syntactic structure, or different deep structure, if having different syntactic structure. Pattern Language has formal language features and behavior which is easily programmed. These affect the acceleration of Modern Greek Sentences processing since they simplify the formalization, the generation and parsing of the Pattern Language Sentences, detecting directly the template of its production rules by means of the characteristic exponents. The characteristic exponents are strings of integers which are easily extracted and recognized. The characteristic exponents characterize the structure of the Pattern Language Sentences and map them to the corresponding templates of which generate them avoiding the time consuming searching methods.

For example (see Table 1) :

a) The characteristic exponents of the Pattern Language Sentence ab is the string κ,ρ_1,ρ_2 = 0,1,0, and the characteristic exponents of Pattern Language Sentence agc is the string $\kappa,\rho_1,\rho_2,\lambda$ = 0,0,1,0.

b) The template $p_{1,2}$ generates the unique Pattern Language Sentence agc.

c) The template $p_{2,18}$={S→AB, A→a|Ava|Aua, B→gc, C→Cuc}, is one of the templates which generates the syntactic structures of the compound sentences. $p_{2,18}$ generates the class

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[5] The interdependence of syntax and semantics is indicated by the semantic relations between Subject-Verb, Verb-Object, and so on. We note that, similar to the semantic relations between the syntactic categories in Pattern Language Sentences (deep structure), the semantic agreement is defined between the lexical items in the corresponding Modern Greek Sentences (surface structure) [1,2,3,4,5,6,7].

of Pattern Language Sentences $a(v^ia)^{\kappa}u^1a^1gc(v^ic)^{\lambda}u^1c^1$, where $i = 0,1$ and $\kappa, \lambda > o$, that is, $p_{2,18}$ generates more than one Pattern Language Sentence, e.g.,

for $\kappa,i,-,j,\kappa,\rho_1,\rho_2,\lambda,i,-,j,\lambda = 1,1,-,1,1,0,1,1,1,-,1,1$ the corresponding Pattern Language Sentence is avauagcvcuc[6],

for $\kappa,i,-,j,\kappa,\rho_1,\rho_2,\lambda,i,-,j,\lambda = 2,1,-,1,1,0,1,2,1,-,1,1$ the corresponding Pattern Language Sentence is avavauagcvcvcuc, and so on..

Templates of Syntactic Rules	Structures of Syntactic Categories and Classes of Structures of Syntactic Categories	Characteristic Exponents																					
		κ	i	j	j	κ	...	κ_2	i	j	j	κ_2	ρ_1	ρ_2	λ	i	j	j	λ	...	μ	...	
$p_{1,1}$	ab	0											1	0									
$p_{1,2}$	agc	0											0	1	0								
$p_{2,18}$*	$a(v^ia)^{\kappa}u^ia^igc(v^ic)^{\lambda}u^ic^i$	>0	0|1	-	1	1							0	1	>0	0|1	-	1	1				
$p_{3,20}$*	abe_1	0											1	0							1		
$p_{4,23}$*	$ad_1(v^iad_1)^{\kappa}u^i(ad_1)^ib$							>0	0|1	-	1	1	1	0									

Table 1: 1. $\rho_1 = 0|1$, 0 indicates that the verb is not a predicative verb b, while 1 indicates that the verb is a predicative verb b.

2. $\rho_2 = 0|1$, το 0 indicates that the verb is not a conjunctive verb g, while 1 indicates that the verb is a conjunctive verb g.
3. $\kappa = 0, 1, 2, 3, \ldots$ indicates that there is 1, 2, 3, . . . times the subject a.
4. $\kappa_2 = 0, 1, 2, 3, \ldots$ indicates that there is 1, 2, 3, . . . times the pair ad_1.
5. $\lambda = 0, 1, 2, 3, \ldots$ indicates that there is 1, 2, 3, . . . times the predicate c.
6. $\mu = 0, 1, 2, 3, \ldots$ indicates that there is 1, 2, 3, . . . times the object e_1.
7. $i = 0|1$, similarly if the punctuation "," i.e. v is omitted or not.
8. $j = 0|1$, similarly if the conjunctive, e.g. "and", i.e. u is omitted or not.
9. in case that one of i or j doesn't belong to the syntactic structure the dash "-" is corresponded to the CE i or j.

* The corresponding templates in details are:

$p_{2,18} = \{ S \to AB, A \to a|Ava|Aua, B \to gc, C\ Cuc\}$,

$p_{3,20} = \{ S \to AB, A \to a, B \to bE_1, E_1 \to e_1 \}$,

$p_{4,23} = \{ S \to AB, A \to aD_1|AD_1vaD_1|AD_1uaD_1, B \to b, D_1 \to d_1 \}$.

It is proven that in each template corresponds to a unique combination of characteristic exponents. Also Pattern Language Sentences which belong to the same class of syntactic structures correspond to unique values of the unique combination of characteristic exponents [1,2,3,4].

2.2 Basic Modern Greek Multilexicon and its Algorithms -Transformational Dimension

In the proposed model in order to transform the abstract Modern Greek Sentences deep structure to surface structures, i.e., Modern Greek Sentences, we insert meanings into the deep structures, following prescribed rules [1,2,3,4,5]. That is, based on semantic specifications, we attach words to the syntactic categories of a Pattern Language Sentence, converting it in the beginning into a sentence form with meanings (transformation level of semantic synthesis).

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[6] Η Ειρήνη, η Σοφία και ο Δημήτρης είναι φρόνιμοι, επιμελείς και ευγενικοί
I Irini, i Sofia ke o Dimitris ine fronimi epimelis ke evgeniki
Irini, Sofia and Dimitris are sensible, diligent and polite
is one of the infinite Modern Greek Sentences (surface structure) which corresponds to the Pattern Language Senetence or deep structure avauagcvcuc.

Then according to the Modern Greek morphological rules, the appropriate types of words in the sentence form with meanings are formed (transformation level of morphological formation). Thus, the surface structure or the acceptable Modern Greek Sentence results. Similarly Modern Greek Sentences are transformed to their corresponding deep structures.

The information which is used in the two transformation levels (obligatory transformations) is the information which every word is given in Modern Greek Sentences; it is morphological, syntactical information of the semantically accepted matching, depending each time on the syntactic roles of the words in a sentence. This information which is formalized, codified and filed define the Basic Modern Greek Computational Multilexicon (BMGMLx) which is used by its algorithms, as they describe "what should be done" in order to transform a deep structure sentence into a surface structure and vice versa detecting the syntactic roles of the words in Modern Greek Sentence.

The BMGMLx is a system of computational and interconnecting lexicons made up of four - unit - lexicons of MGL. Every unit-lexicon of this system corresponds to one of the four different dimensions of the information content, thus [1,4,5]:

1. The Modern Greek Computational Lexicon (MGCLx) contains, in alphabetical order, all the words that the proposed system recognizes and processes. The contents of MGCLx is enriched in the course of the research and the application of the proposed method.

2. The Logical Computational Lexicon of Basic Meanings (LCLxBM) and the Computational Lexicon of Context of MGL (CLxCMGL): The items of these lexicons are entries of the Modern Greek Computational Lexicon, whereby in the former they are ordered in a strict succession of meanings of its contents and in the latter are formed in semantic rules. LCLxBM gives the synonyms and antonyms of words, phrases and idioms of the words of Modern Greek Computational Lexicon. CLxCMGL produces and recognizes the dominant semantic combinations of its items according to their semantic relations and agreement.

3. The Modern Greek Morphology Computational Lexicon (MGMCLx) contains all kinds of morphological information which every word of Modern Greek Computational Lexicon may hold in order to formulate an accepted morphological type of word or to detect its type.

4. The Modern Greek Syntax Computational Lexicon (MGSCLx), are the prescriptions of Modern Greek Syntax which provide the agreement of the morphological types of the sentence terms according to their syntactic role in the sentence.

The morphological formation is the most mechanical phase of the obligatory transformations, requiring knowledge of Modern Greek Morphology, appropriate recording of data as well as appropriate codification of its mechanisms and mechanisms of its interdependencies of Modern Greek Syntax and the items of the Modern Greek Computational Lexicon [1,4].

On the contrary, the semantic synthesis is the most difficult phase of the transformation procedure, mainly concerning the definition, the designing and the formalization of the semantic rules [5]. The required semantic information is not recorded in a similar way as the syntactic information, with which the Modern Greek Sentence deep structures are described. Thus a procedure similar to that of syntax is proposed to be formulated, whereby from a finite number of dominant semantic rules or semantic criteria of matching words, a direct semantic manipulation of an infinite set of words occurs, that is, the generation or parsing an infinite number of Modern Greek Sentences. Simultaneously, it provides the ability from the same procedure to minimize the possibility of non-manipulation of ambiguous meanings, conversely maximizing the possibility of recording and controlling the possible meanings of words or idioms or common phrases, their synonyms and antonyms. Generally speaking, the possibility of usage of lexicon provides "the entire lexicon" and its direct further enrichments.

1. GENERAL		2. SPECIFIC	
1.ABSTRACT	2.CONCRETE	3.MATERIAL	4.IMMATERIAL
1.ΥΠΑΡΞΗ (HYPARXI) EXISTENCE	8.ΧΩΡΟΣ (CHOROS) SPACE	13.ΑΝΟΡΓΑΝΗ ΥΛΗ (ANORGANI HYLI) INORGANIC MATERIAL	15.ΝΟΥΣ (NOUS) MIND
2. ΣΧΕΣΗ (SCHESI) RELATION	9.ΔΙΑΣΤΑΣΗ (DIASTASI) DIMENSION	14.ΟΡΓΑΝΙΚΗ ΥΛΗ (ORGANIKI HYLI) ORGANIC MATERIAL	16.ΒΟΥΛΗΣΗ (VOULISI) MIND
3. ΕΝΟΤΗΤΑ (ENOTHTA) UNIT	10. ΣΧΗΜΑ (SCHIMA) FORM		17.ΔΡΑΣΗ (DRASI) ACTION
4.ΤΑΞΗ (TAXI) ORDER	11.ΕΝΕΡΓΕΙΑ (ENERGIA) ENERGY		18.ΑΞΙΕΣ (AXIES) VALUES
5.ΠΟΣΟΤΗΤΑ (POSOTITA) QUANTITA	12.ΚΙΝΗΣΗ (KINISI) MOTION		19.ΣΥΝΑΙΣΘΗΜΑ (SYNESTHIMA) FEELING
6.ΑΡΙΘΜΟΣ (ARITHMOS) NUMBER			20.ΗΘΟΣ (ITHOS) ETHOS
7.ΧΡΟΝΟΣ (CHRONOS) TIME			21.ΘΕΟΣ (THEOS) GOD

Table 2: The 21 Broader Basic Units of Meanings-Chapters (BBUM-Ch's) which are classified into 4 sub-categories of BBUM-Ch are also divided into 2 categories of BBUM-Ch.

Thus, to formalize the dominant semantic rules, we adopt the model of the Logical Lexicon [5]. The material of the Logical Computational Lexicon of Basic Meanings (LCLxBM) are the items of the Modern Greek Computational Lexicon (MGCLx) which are codified with a strict succession of the general meanings and grouped to their partial meanings including the synonyms, related words and language expressions. Every word belongs to one of the 21 Broader Basic Units of Meanings-Chapters (BBUM-Ch's) of Table 2.

Every Broader Basic Units of Meanings-Chapter (BBUM-Ch) includes its general meanings by which are named Meanings-Chapters (M-Ch's). For example, the BBUM-Ch "Υπαρξη" (Hyparxi=Existence) contains 7 M-Ch's of Table 3.

1.Υπαρξη (Hyparxi) Existence	2.Ανυπαρξία (Anhyparxia) Non-Existence
3.Κατάσταση (Katastasi) Situation	
4.Περίσταση (Peristasi) Occasion	
5.Εσωτερικός Κόσμος (Esoterikos Kosmos) Inner World	6. Εξωτερικός Κόσμος (Exoterikos Kosmos) Outer World
7.Εγώ (Ego) Ego	

Table 3: The BBUM-Ch "1_ΥΠΑΡΞΗ" (HYPARXI=EXISTENCE) contains 7 M-Ch's.

For every one of its 1500 Meanings-Chapters (M-Ch's), the words, idioms or common phrases, which by meaning belong to the same general meaning, are included, and are classified in corresponding paragraphs. That is, every M-Ch consists of as many paragraphs as there is of inflected and uninflected words, idioms or common phrases which appear in the same general meaning. For example the M-Ch "Υπαρξη" (Hyparxi=Existence) contains only the 5 paragraphs of Table 4.

p.o	Paragraphs	Words belongs to BMGLx
1	κ1_noun	ύπαρξη (hyparxi=existence), υπόσταση (hypostasi=subsistence), το είναι (to ine=being), etc.
2	κ3_intransitive_verb	υπάρχω (hyparcho=exist), είμαι (ime=be), υφίσταμαι (hyfistame=exist), etc.
3	κ4_transitive_verb	δίδω υπόσταση (dido hypostasi=lead to existence), διατηρώ (diatiro=maintain), etc.
4	κ5_impersonal_verb	υπάρχει (hyparchi=there is), είναι (ine=it is), βρίσκεται (vriskete=it is found), etc.
5	κ6_adjective	υπαρκτός (hyparktos=existent), υπάρχων (hyparchon=existent), υφιστάμενος (hyfistamenos=being), etc.

Table 4: The M-Ch "1_Υπαρξη" (Hyparxi=Existence) contains only 5 paragraphs, where p.o means paragraph order.

In every paragraph, words are grouped according to the partial meanings where-by they are recorded and cited directly after the corresponding synonyms and related words. For example, we give some of these groupings according to the partial meanings of the words where the paragraph "noun" of the M-Ch "Ύπαρξη" (Hyparxi=Existence) contains the 11 groups of Table 5

pmw.o	Words / nouns belongs to BMGLx
1.	ύπαρξη (hyparxi=existence), υπόσταση (hypostasi=subsistence), (το) είναι (to ine=being), οντότητα (ondotita=entity),
2.	αυθυπαρξία (afthyparxia=self-existence), αυτοτέλεια (aftotelia=self-sufficient), αυτοζωή (aftozoi=self-being) , αυτοζωία (aftozoia=self-existence),
3.	προΰπαρξη (prohyparxi=pre-existence), προϋπόσταση (prohypostasi=pre-subsistence),
4.	συνύπαρξη (synhyparxi=coexistence),
5.	ενύπαρξη (enhyparxi=in-existence),
6.	διατήρηση (diatirisi=preservation), παραμονή (paramoni=stay),
7.	διάσωση (diasosi=salvage), περίσωση (perisosi=save), επιβίωση (epiviosi=survival),
8.	όν (on=being), οντότητα (ondotita=entity), πλάσμα (plasma=creature),
9.	άτομο (atomo=individual), πρόσωπο (prosopo=person), ψυχή (psyhi=soul), κανείς (kanis=anyone), κανένα (kanena=anybody), τις (tis=somebody), ένας (enas=someone), κάποιος (kapios=some),
10.	αντικείμενο (andikimeno=object), πράγμα (pragma=thing), κάτι (kati=something), τίποτε (tipote=anything),
11.	οντολογία (ondologia=ontology).

Table 5: The 11 groups according to the partial meanings of the words (pmw) which the paragraph "1.noun" of the M-Ch "1_Ύπαρξη" (Hyparxi=Existence) contains, where pmw.o means partial meaning word order.

For instance the verb "μελετώ"[7] (meleto=study) is the first verb of paragraph "κ2.1", i,e, "2.verb(transitive-intransitive)" of the 828_M-Ch "Μάθηση" (Mathisi=Learning) of 15_BBUM-Ch "Νούς" (Nous=Mind). This verb and all its synonyms and its relations, which belong to the same paragraph, are accepted semantically as subject of any word of paragraph "κ.1" i,e, "1.noun" belongs to one or more M-Ch's having further the semantic feature "ανθρώπινο_όν" (anthropino_on=human_being). We define as semantic category of the MGL all the words that belong to the same paragraph of one or more M-Ch's and, in turn, each time can substitute a specific syntactic category with a specific combination of words in a sentence form with meanings [1,4,5].

We note that the semantic categories may be defined, apart from the grouping of words of the same paragraph, also by groupings of semantic categories always being based on

[7] this verb has multiple meanings, this example refers to one of these meanings, similarly this applies to the other meanings as well.

a common semantic feature which acts as a semantic prescription of substitution of the specific syntactic category from the pool of words of the paragraph which they belong to. These groupings concern all types of paragraphs of the M-Ch [1,4,5].

The semantic category is represented by the unaccentuated Greek word, which specifies the common feature that groups words, in the pair <...>. There are no specific rules but only principles that lead to the definition of semantic categories. A sample of noun paragraph grouping belonging to a multiple M-Ch, as shown in the grouping of Table 6, shows the way this procedure is defined [1,4,5].

<table>
<tr><th>s.c.o</th><th colspan="3">Semantic Categories</th></tr>
<tr><td>1.</td><td><εμψυχ_ον>
<empsychon>
<animate></td><td>::=</td><td><ανθρωπιν_ον> |<ζω_ον> |<πετειν_ον> |<ψαρι_ον> |<εντομ_ον> |<ερπετ_ον>,
<anthropin_on> <zo_on> <petin_on> <psari_on> <entom_on> <erpet_on>
<human> |<animal> |<bird> |<fish> |<insect> |<reptile>,</td></tr>
<tr><td>2.</td><td><ανθρωπιν_ον>
<anthropin_on>
<human></td><td>::=</td><td><ανθρωπος> | ... | <διδασκαλος> | ... | <πολεμιστης> | ... | <συγγραφεας> | ... ,
<anthropos> <didaskalos> <polemistis> <sygrafeas>
<man> | ... | <teacher> | ... | <warrior> | ... | <writer> | ... ,</td></tr>
<tr><td>3.</td><td><ανθρωπος>
<anthropos>
<man></td><td>::=</td><td>άνθρωπος | απόγονος του Αδάμ | λογικό όν | ανθρωπάκι | ... ,
anthropos apogonos tou Adam logiko on anthropaki
man | descendant of Adam | logical being | little man | ... ,</td></tr>
<tr><td>4.</td><td><διδασκαλος>
<didaskalos>
<teacher></td><td>::=</td><td>διδάσκαλος | δάσκαλος | νηπιαγωγός | ... | καθηγητές | ... ,
didaskalos daskalos nipiagogos kathigitis
teacher | school master | kindergarten teacher | ... | professor | ... ,</td></tr>
<tr><td>5.</td><td><συγγραφεας>
<syngrafeas>
<writer></td><td>::=</td><td>συγγραφέας | διηγηματογράφος | ... | δημοσιογράφος | ... ,
syngrafeas diigimatografos dimosiografos
writer | writer of short stories | ... | journalist | ... ,</td></tr>
<tr><td>6.</td><td><πολεμιστης>
<polemistis>
<warrior></td><td>::=</td><td>πολεμιστής | αγωνιστής | στρατιωτης | πεζοναυτης | ... .
polemistis agonistis stratiotis pejonaftis
warrior | fighter | soldier | marine | ... .</td></tr>
</table>

Table 6: A sample of semantic category definition, where s.c.o means semantic category order.

Semantic rules are the acceptable and the dominant semantic combinations between the words of a paragraph or the words of the same type of paragraphs of different M-Ch's with words of other similar types of paragraphs of different M-Ch. This is achieved by the dominant semantic combinations which are based on the meanings of the words as well as the semantic relations between the words as required by the corresponding syntactic roles. The semantic rules are procedures which are described by means of the syntactic categories [1,4,5]. For example, the expression:

υποκειμενο[8](μελετώ)::=<ανθρωπιν_ον> or

[8] i.e., subject.

υποκειμενο(15.0828.κ2.1)::=14.0543.κ1.1|15.0831.κ1.2|17.1111.κ1.3|15.0956.κ1.1|...,
(see Tables 2-7, screen 1) comprises a semantic rule which defines the subjects of the verb"μελετώ" (meleto=study).

MGLx	LCLxBM	MGMLx	CLxCMGL
	BBUM-Ch . M-Ch . Paragraph . w.o		
w.o. άνθρωπος	ORGANIC MATERIAL. Man . noun . w.o 14 . 0543 . κ1.1 . w.o	MN.003	<ανθρωπος> <man>
w.o. δάσκαλος	MIND . Teacher. noun . w.o 15 . 0831. κ1.2. w.o	MN.003	<διδασκαλος> <teacher>
w.o. μελετάω-ώ	MIND. Learning . verb . w.o 15 . 0828 . κ2 . w.o MIND . Examination . verb . w.o 15 . 0845 . κ3 . w.o MIND . Memory . verb . w.o 15 . 0918 . κ3 . w.o WILL . Purpose . verb . w.o 16. 1010 . κ3 . w.o	RM.105	<ανθρωπομαθηση> <human_learning> <παρατηρηση_εξεταση> <examination_observation> <ανθρωπομνεια> <human_memory> <σκοπος> <purpose>
w.o. στρατιώτης	ACTION . Warrior . noun . w.o 17 . 1111 . κ1.3. w.o	MN.017	<πολεμιστης> <warrior>
w.o. συγγραφέας	MIND . Writer. noun . w.o 15. 0956 .κ1.1. w.o	MN.056	<συγγραφεας> <writer>

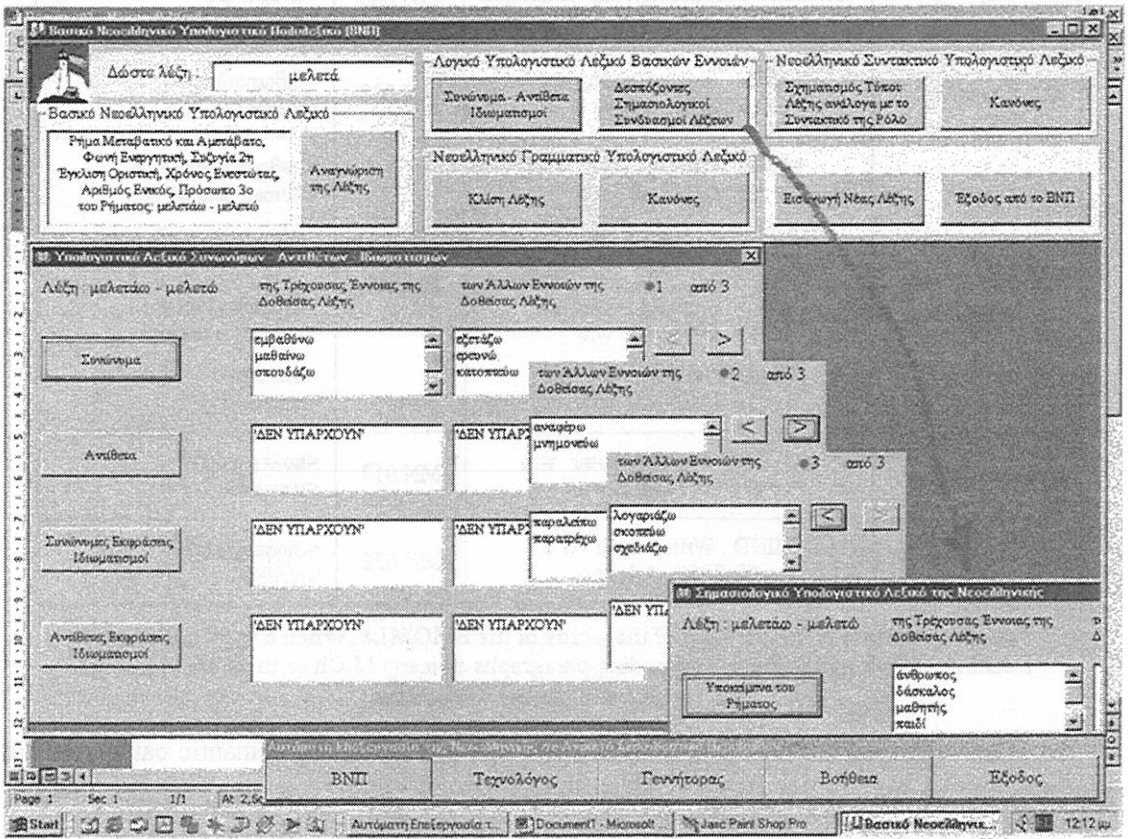
Table 7: A sample of codification of the words of the BMGMLx. When a word has multiple meanings, it belongs to the corresponding paragraphs as many M-Ch as there are meanings, where w.o. means word order.

The variety of the semantic rules or the combinations of the semantic categories are just as many as there are the variety of the syntactic categories and the semantic relations between them, as seen in the Modern Greek Syntax. Moreover, with a finite number of semantic rules, an infinite number of lexicon entries may be combined defining the semantic structures. The set of the MGL semantic rules, the set of the MGL semantic categories and the MGL semantic structures constitute the semantic basis of MGL [1,4,5].

3. The Proposed Modern Greek Sentences Generators and Parsers the Key-stones of a CAMGLL Method Development

It can be taken for granted that a Natural Language does not simply comprise a set of words expressing simple meanings, but a set of words put into use communicatively and interrelated with morphological rules and syntactic structures in speech. Therefore, composite meanings and concepts can be expressed. For the user, the aim of a Computer-Assisted Modern Greek Language Learning (CAMGLL) method without using the overload of rules and extensive phrasing can be made aware of the mechanisms of the language (profound knowledge) and the acquisition of the ability to produce, comprehend and process written and spoken texts (ability of use). The degree by which a CAMGLL method can provide efficiency with the response to the pursuit of a CAMGLL aim mainly depends on the efficiency of its design [6,7,9,25,27], (see Screens 1,2).

Thus, the efficiency of the proposed Grammar for the development of the CAMGLL method can be shown by the steps of parsing the Modern Greek Sentences concerning the processing of components, relations and functions of the MGL System.



Screen 1: The computational lexicons of the BMGMLx interconnected with Microsoft Programs or not, have the efficiency to recognize and give information of morphological, syntactic and the semantic combination in general or specific for every word they contain, if the word belongs to a particular sentence

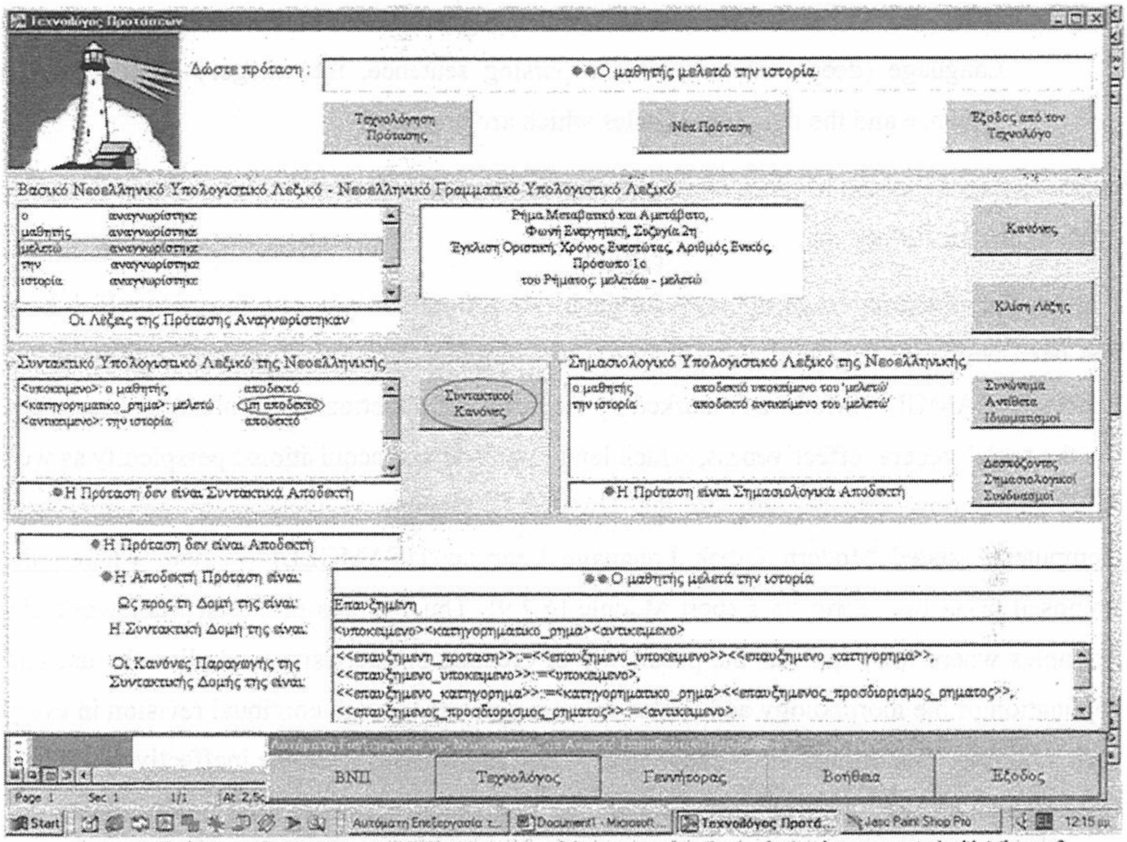
Step 1 The keying of the parsing sentence (surface structure)

Step 2 Lexical and Morphological recognition of the words of the sentence by means of:

1. the Modern Greek Computational Lexicon (MGCLx) and
2. the Modern Greek Morphology Computational Lexicon (MGMCLx)which are Unit-Lexicons of the Basic Modern Greek Computational Multilexicon (BMGMLx)

- Checks if the words of the parsing sentence belong to the MGCLx.
- Returns information for the part of speech for each word of the parsing sentence and information for its morphological type if flectional.
- Possibility of analytically showing the morphological types of any word in the parsing sentence.

- Possibility showing any Related Morphological Rule.
- Possibility of pinpointing a non-morphological type of any word of the parsing sentence and its error correction (corrector).
- Possibility of interconnections with commonly-used Microsoft Programs.



Screen 2: The Parser of MGMS's, as with the Generator, of the proposed method, whether interconnected with Microsoft programs or not, gives the pupil the opportunity of writing in MS Word for example the ability to parse any MGMS or its words. In the case of written mistakes of morphology, syntax or semantics, the system detects, gives the opportunity of explanation to the ignored rules and corrects those mistakes, as in the example of the screen above.

Step 3 Recognition of syntactical role of words of sentences by means of the Modern Greek Syntax Computational (MGSCLx).

- Possibility of pinpointing of non-morphological type relating to the syntactic role of any word of the parsing sentence (corrector)
- Possibility of showing any related syntactic rule.
- Possibility of interconnections with commonly-used Microsoft Programs.

Step 4 Recognition of semantic combination of words of the sentence by means of the The Logical Computational Lexicon of Basic Meanings (LCLxBM) and the Computational Lexicon of Context of MGL (CLxCMGL):

- Possibility of pinpointing unacceptable semantic combination relating to the syntactic role of any word of the parsing sentence.
- Substitution of any word in the parsing sentence with their synonyms and antonyms.

- Possibility of showing for any word of the parsing sentence, its possible semantic combination of words of the MGCLx in accordance with its syntactic role each time.
- Possibility of interconnections with commonly-used Microsoft Programs.

Step 5 Following Steps of 1,2,3 and 4 there is the appearance of the corresponding Pattern Language (deep structure) of the parsing sentence, the category of the parsing sentence and the template of rules which are produced.

It can be noted that the Modern Greek Sentences generators follow similar steps with similar efficiencies for further use.

The effectiveness of the tools for the Modern Greek Sentences processing which have just been described for the development of the Computer-Assisted Modern Greek Language Learning (CAMGLL) Method is marked by the structure, function and content of these tools, i.e. the tools' general effectiveness, which lend linguistic and acquisitional perspicuity as well as computational effectiveness to the CAMGLL Method as well as to an Intelligent Computer-Assisted Modern Greek Language Learning (ICAMGLL) Method, where the proposed GTG may form its Expert Module [6,7,9]. Thus, in this proposed framework, the examples where the pupil has the possibility of creating or exercising underline the use and application of the morphology and syntax rules in practice through continual revision in every unit; avoiding long, monotonous theoretical and in many cases tiresome ineffective phrasing. Cooperative learning is promoted through the realization of the Modern Greek Sentences processing in an open experimental and creative environment from the pupil for written Modern Greek Sentences by means of pedagogical methods [10,11,25]. Given simultaneous emphasis on the language practice which is an element of the modern language teaching [12,28]

Another example promoted by the proposed grammar is the independent use of the computational lexicons of the Basic Modern Greek Computational Multilexicon (BMGMLx) through which each word they contain are able to recognize and give information for its morphology, syntax and semantic combination in general or specific if the word belongs to a particular sentence. The BMGMLx with information it provides and is available at any time, makes the learning result more effective and efficient since it minimizes the metalanguage of morphological, syntactic and semantic rules of the MGL. In addition, the BMGMLx provides the necessary self-sufficiency for the user not to resort to other means of electronic or printed matter when finding language phenomena.

The realization of the CAMGLL Method works in the commonly used Windows'95, '98, 2000 and XP.

4. Conclusions

The goal of this study was to apply a version of a GTG for the MGL Processing, in order to use it in the development of a Computer-Assisted Modern Greek Language Learning (CAMGLL) Method. The suggested GTG is composed of the Template Grammars - generative dimension and the Basic Modern Greek Computational Multilexicon (BMGMLx) with its algorithms - transformational dimension.

Template Grammars are a version of GTG of the Chomsky hierarchy, with the additional property to group the production rules, which generate the strings of the corresponding language. Template Grammars generate the Pattern Language of MGL. Pattern Language Sentences are free of morphological forms and meanings, but with the same syntactic structure as the corresponding Modern Greek Sentences. Characteristic exponents, which are also introduced, characterize Pattern Language Sentences structure and automatically map them to the corresponding templates of rules, from which they were generated and vice versa, avoiding time consuming search methods.

Basic Modern Greek Computational Multilexicon (BMGMLx) is a system of computational and interconnecting lexicons which consists of recorded data concerning the vocabulary, the syntax, the morphology and the semantics of MGL. BMGMLx algorithms describe the finite rules, which express the generative and transformational MGL mechanisms and recognize Modern Greek words, generate and parse their forms and their semantic combinations as well as Modern Greek Sentences. For this, the Semantic Basis of MGL is also introduced.

This GTG model is based on the structure and function of the MGL System. Thus, the teaching of the Grammar Code of the MGL is based on the Holistic Approach. Furthermore, the suggested GTG is able to parse and generate Modern Greek Sentences, in the framework of an Open Educational Environment where learning is experimental, creative and cooperative.

The contents of the computational lexicons of the BMGMLx and the production rules of the Template Grammars are suitably selected and enriched in order to use, firstly, words of themes and meanings from communicative areas, secondly, their dominant semantic combinations and thirdly, the commonly used morphological and syntactical rules. All these contents, interconnected with Microsoft Programs or not, are functional for a Communicative MGL Teaching Method, based on the written Modern Greek Sentences, avoiding long, monotonous theoretical and in many cases tiresome ineffective phrasing. Also, BMGMLx provides the necessary self-sufficiency for the user not to resort to other means of electronic or printed matter when finding language phenomena.

The CAMGLL method based on the suggested GTG can be used either in a classroom at school or by Internet correspondence, for teaching MGL as a native or foreign language.

Moreover, the suggested GTG, on the one hand constitutes a Grammar Framework which may form the Expert module of an ICAMGLL Method, on the other hand describing the structure and function of other Natural Language Systems may introduce a CALL Method as well as the Expert modules of an ICALL Method, for the corresponding Languages.

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