

Section 5. Philology and linguistic

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LINGUISTICS AND LOGIC: PROS AND CONS

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Abstract

The article is devoted to the study of the interconnection between linguistics and logic. To analyze linguistic material we propose the use of taxonomic methods within a holistic systemic logical approach, structural and combinatorial analysis, object recognition, comparative analysis, modeling in the form of graph-schematic representations of linguistic constructions and more. Principles of a new interpretation of the problem of parallel semantic and structural study of linguistic expressions are proposed. Based on the logical-functional conjunctive, disjunctive and implicative properties of linguistic objects, we present a new, to some extent, universal functional-linguistic model of natural language.

Keywords: *linguistics, logic, function, relation, clustering, recognition, modeling*

Introduction

Natural language is a multifaceted multifunctional system in which the formal and semantic-content connections of its elements are intertwined within a hierarchical structure. The meaning of a word is closely tied to the constantly changing reality and is characterized by particular flexibility. At the same time, language conveys the totality of knowledge, thought, will and emotions. Within the system of language there are certain logical relationships between signs, where each sign is determined by all the others, and such relationships are the object of study for structuralists. Modern linguistics has increasingly focused on the internal systemic relationships and connections within

language itself. A necessary intermediate step for identifying these relationships is the description, analysis, and synthesis of formal-content interconnections and the properties of linguistic constructions and units of varying complexity. At this stage, the relationship between linguistics and various related fields in the humanities and natural sciences begins to play a crucial role as linguistic rules and categories are closely interconnected with logical thinking. Semantic completeness – the potential ability to express arbitrary information in any natural language – is achieved through the indispensable presence of certain signifying tools that express conjunctive, disjunctive, conditional relationships and negation.

Traditional and current questions in linguistics are deepened, expanded and enriched by ideas, opportunities and methods applied in other scientific disciplines, which become new tools for linguistics itself. As a result of such interactions linguistics primarily “retains” and “integrates” only those concepts and research methods whose application proves rational and appropriate. The autonomy of linguistics as an integral science provides the foundation for extracting necessary elements and pragmatic simple and complex models from a wide range of related sciences. Within linguistics new definitions and concepts borrowed from other sciences acquire specific characteristics. The study of the application of definitions and principles from the exact sciences to linguistics has revealed certain limitations of this apparatus in representing and describing many linguistic phenomena. Consequently, the need arises to reconsider the relationship between linguistic and applied methods and to incorporate additional logical tools. Linguistics and logic are distinctly defined in terms of their objects and capabilities; however, they converge and become adjacent, as the analysis of natural language utterances is a consequence of the cognitive process. In linguistic research the use of logical concepts requires their clear definition and unambiguous interpretation. However, it has been found that this apparatus is insufficient for representing and describing all the subtleties of linguistic phenomena. An in-depth, holistic and fundamental analytical study of certain linguistic constructions with complex structures is a linguistic task. This task involves identifying and extracting the general properties and internal needs of language as a system of relationships without the formal-mechanical use of the logical-mathematical apparatus. So, Saussure noted: “Linguistics is closely connected with several other sciences, which at times borrow its data, while at other times provide their own to it. The boundaries separating it from these sciences are not always entirely clear” (Saussure, 1997).

Research methods

The application of methods from natural sciences cannot transform linguistics into a purely deductive or inductive science, as empirical linguistic material is widely used in lin-

guistic research. In some cases it may become necessary to adapt the existing logical apparatus to linguistic tasks, create new models, develop new analytical expressions for specific linguistic patterns. Modifying this apparatus and methods for linguistics is a challenging task, as it requires describing elements of live language using rather abstract terms and tools. Appropriate adaptation is only possible, if these elements are semantically equivalently characterized by the proposed formal-content language. Otherwise, logical-formal methods cannot fully reflect the depth and diversity of language. In structural-semantic research of linguistic objects the use of a special language – a metalanguage – is often necessary. This metalanguage does not complicate the understanding and explanation of the object language, but serves as a system of concepts for its description and study. Not all terms in traditional grammar meet the requirements of new approaches to studying certain linguistic phenomena, and therefore they must be replaced with a new system of terms. It is known, that the metalanguage of linguistics is a special semiological system used, when speaking about language itself as the object language. The elements of the metalanguage rely on the words of the object language to explain the meanings of the corresponding concepts being studied in relation to the surrounding reality. A distinguishing feature of the metalanguage is its ability to describe the properties and relationships of elements within a specific sublanguage domain. The meanings and senses of sublanguage words used in scientific research often require expansion and additional processing. In logical-linguistic research metalanguage concepts such as *statement*, *true*, *false*, *relation*, *function*, *class*, *cluster*, *recognition*, *image* and among others are used (Anderson, 2001; Clustering and Classification, 1999; Xu, Wunsch, 2009).

One of the significant factors of referential semantics is the correlation of a statement with reality, conveyed through the metalanguage terms *true* and *false*. In natural language statements the meanings of true and false are contextually determined and can be concrete, absolute, relative or hypothetical. The words *truth* or *fact*, which convey reliable information, are interconnected with their antonyms *falsehood* or *lie*. It should be

noted, that in artistic literature these words often carry specific contextual meanings.

The word *relation*, used in natural language, is also a metalanguage term and aligns with the logical concept of *relation*. Logical relations include *binary relations*, among others. In many linguistic statements relationships between subjects and objects can be represented using the logical-mathematical concept of a binary or bilateral relation. Applying this concept to natural language clarifies many issues related to examining the multifaceted and multidirectional interconnections of related sides, objects, phenomena, processes in nature, society and thought from the perspective of logical-semantic syntax. It is worth noting that these relations in linguistic statements can be explicit or implicit and are determined by context. In addition to binary relations, *multidimensional relations* can also be applied in linguistic research. In most cases, the order of elements in relations plays a significant role.

In many cases the semantics of simple and complex sentences can be represented by equivalent logical functions of *negation*, *conjunction*, *disjunction*, *exclusive disjunction*, *implication*, reverse implication and others, which are also elements of the metalanguage. These functions involve variables and the functions themselves, both of which can take on true or false values. Logical functions, as statements, can serve as formal and substantive tools for representing and analyzing linguistic expressions (Hakobyan, 2017). Logic demonstrates that all logical statements can be constructed using the functions of conjunction, disjunction and negation, as they form a complete system. Through substitution or superposition, all possible logical connections can be expressed.

In linguistic constructions, alongside logical functions and relations, logical methods developed in pattern recognition theory are widely used. These methods are applied in various fundamental theoretical and applied studies. In particular, cluster analysis is one of the key research methods and represents one of the oldest and most complex scientific endeavors. The theoretical results obtained in this area have broad practical applications for systematic material organization in various fields of science and technology. Tasks

and methods of clustering and recognition are also relevant in studying natural language, where a detailed, comprehensive analysis of a large volume of initial linguistic data is required. In linguistics objects or patterns may include constructions and units of different linguistic levels, such as words, phrases, simple or complex sentences, that meet specific formal or substantive properties. The initial linguistic data are processed and presented in the necessary formal-content format. The classification of linguistic units involves two research approaches: from form to meaning and from meaning to form. For example, in hierarchical clustering of complex sentences grammatical units with their formal structure and substantive meaning are the foundation, reflecting the application of these two traditional research approaches.

The task of clustering involves creating clusters in which elements within the same cluster are more similar and closer to each other in certain parameters, than to elements in other clusters. The initial stage of any clustering process involves grouping elements based on formal-content features. Clusters may consist of groups or classes. Groups are characterized by common quantitative-formal features, while classes are defined by qualitative-substantive characteristics of the included patterns.

Numerous clustering algorithms have been developed, and one is chosen for each specific case. It is important to note, that the final result provides an accurate and adequate picture only if the initial properties of the object were reliably, logically and linguistically correctly selected by the researcher. The number of clusters may be known in advance, simplifying the process. However, when the number of clusters is unknown, the process becomes more complex and requires the development of additional specific methods.

The task of recognition is based on functional-logical and structural-geometric research approaches and involves determining the affiliation of a certain pattern to one of the predefined clusters to which the given linguistic object belongs. The recognition system algorithm may rely on the principle of feature commonality, when formed clusters are characterized by shared properties inherent to all their members.

The functional-logical approach assumes representing the semantics of a linguistic object through a specific functional connection, which allows sentences characterized by the same logical function to be grouped within each cluster. Recognizing a specific linguistic pattern requires thorough, deep formal-content analysis to identify properties and characteristics that help associate it with one or more predefined clusters containing patterns with similar features.

The structural-geometric or graphical approach represents the structure of the studied objects geometrically, in the form of directed or undirected graphs, as well as hypergraphs, which are widely used to describe structural connections in various fields of natural and human sciences (Berge, 1973). Components of these models are specific linguistic patterns with inherent interconnections. It is worth noting that in such an algorithmic process of defining components and their interconnections, the professional judgment of the linguist-researcher plays a critical role, as only they can provide exhaustive information describing and characterizing the linguistic units under consideration.

Research results

A comprehensive study of an individual natural language involves examining both its formal and semantic characteristics and can be conducted based on two diametrically opposed principles: from structural-formal to content-semantic and vice versa – from content-semantic to structural-formal. In a multi-aspect study from formal to semantic linguistic objects are initially systematized according to their internal structure, after which the semantics of the already created classes or groups are examined. This approach is practically applied in language engineering, which helps solve tasks such as creating electronic dictionaries, translation systems, review programs, automatic proofreading, search engines, plagiarism detection software and more. The downside of such constructed models is their very rapid “obsolescence.” Empirical data from recent decades show, that this approach requires constant modernization and ongoing refinements due to the emergence of new interests and demands, as well as the semantics of for-

malization. Language research following the principle of moving from semantic to formal is based on the systematization of semantics with subsequent formal modeling. This type of research is more complex and requires specialized development. A significant stage in both principles is the systematic generalization of obtained results for studying and comparatively analyzing the general linguistic properties of languages.

A comprehensive and holistic representation of the general linguistic properties of natural languages assumes the creation of a unified general linguistic model. Many linguists have conducted such studies. However, it is becoming clear, that the task is extremely difficult: developing a unified general linguistic model is extraordinarily challenging and perhaps even impossible. In constructing the framework of a potential universal theory of language, G. Dzhaugyan proposed a four-level classification of linguistic structures: lexical, taxematic, predicative and textual levels, with their intra-level and inter-level relationships. Within each of these levels, he identified two sublevels: in the lexical level – root or lexematic; in the taxematic level – tagmatic and syntagmatic; in the predicative level – protasematic and symprotasematic; and in the textual level – textematic and syntextematic (Dzhaugyan, 1999).

We have presented a new, in some sense, universal functional-linguistic model of natural language, which is based on the logical-functional conjunctive, disjunctive and implicative properties of linguistic objects corresponding, as previously noted, to conjunctive, disjunctive compound and conditional complex sentences (Hakobyan, 2025).

For a more detailed structural analysis and synthesis of the studied linguistic objects with regard to the logical functions under consideration it became necessary to conduct a level-based hierarchical clustering. Key structural taxons of linguistic functional units were identified, and a graph-schematic model was developed to represent and study their structural connections. We analyzed words, phrases, simple and complex sentences, parts of text in which the logical-functional relationships characteristic of the linguistic units under study were identified. In analyzing these objects, the issue of iden-

tifying the tools and methods for revealing the corresponding functional relationships was addressed. As a result, the following five linguistic levels were organized and distinguished: *tagmatic*, *syntagmatic*, *protasematic*, *symprotasematic* and *textematic*. Each of these five levels can, in fact, be conjunctive, disjunctive or implicative, resulting in 15 functional clusters. For each of these clusters the linguistic level units comprising them are defined, a certain portion of which are functional units. These units must explicitly or implicitly be associated with the corresponding logical function of conjunction, disjunction or implication. Intra-level and inter-level structural connections of the units carrying the primary functional-semantic load were studied.

Conclusions

Thus, the taxonomic studies of linguistic constructions with regard to logical functions

conducted by us represent only a small part of the theoretical and practical questions and tasks within the inexhaustible field of exploring the interconnection between linguistics and logic. The taxonomy of linguistic constructions of varying complexity based on specific selected parameters will enable the development of additional precise and universal research methods, opening new opportunities for solving linguistic tasks.

However, it should be remembered, that logical-formal methods for studying structural interconnections in complex sentences can have both positive and negative aspects. Excessive enthusiasm for structural schematization may lead to contradictory conclusions from the perspective of linguistic theory. Therefore, it is important in each specific case to determine the appropriate depth of formalization. Structural formalization must be justified from a linguistic standpoint.

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