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TERMINOLOGICAL FOUNDATIONS OF REASONING: TOWARDS THE GENERAL THEORY OF EVOLUTION OF HUMAN KNOWLEDGE

Beginning with the end of the 1980s a new approach to the study of relations between language and knowledge appeared in Russia, which quite soon became one of the leading directions in the study of language and was called cognitive linguistics. This reflects the general growth of the interest in the problem of discovering the main principles of thinking and knowledge organisation which results in revealing new aspects of this problem and an increase in the number of corresponding sciences, beginning with the traditional philosophical disciplines – gnoseology and epistemology, traditional logic, followed by later disciplines, such as semiotics, anthropology and history of science and technology, science of science, artificial intelligence, heuristics, creative logic (a new trend formed with the aim of overcoming the limitations of the classical formal logic), age psychology, pedagogical psychology (because learning can be viewed as the specific process of knowledge growth) and ending with the latest comers – cognitive psychology, national psychology and culture studies (though there are reasons to suspect that this list is incomplete).

At the same time it should be mentioned that none of the above-mentioned sciences tried to consider the process of evolution of cognition, the development of human thinking from the point of view of reflection of this process in language, especially in vocabulary. This aspect of cognitive studies becomes especially important in connection with the latest findings in general anthropology and the subsequent need for the revision of the evolution theory.

The widely known theory of evolution which is presented even at the secondary school level which deals with the history of humankind beginning with the simplest one-cell organisms through the intermediate stages of fishes, lizards, birds and mammals and finally coming to anthropoid apes. According to this theory ontogenesis repeats the phylogenesis, i.e. every human being in his prenatal development repeats the similar stages. Theory of evolution also presents evidence of the close relation of apes with humans, but here it stops, as if there was no further development of human beings. Therefore in our opinion the existing theory of evolution which is in fact reduced to embryogenesis leading only to anthropoids may be viewed rather as a theory of evolution of apes, and not humans. To be applied to human beings it should be made complete and deal with the further development of man, resulting in increasing differences with the apes.

Now, it was always considered that the main difference between human beings and even the most highly organised apes lies in the human ability of reasoning, which is based on the usage of language. Experiments with apes, especially teaching American Sign Language to a chimpanzee named Washoe, showed that the apes can acquire more than one hundred signs,

may produce sensible combinations of two and even three signs and may teach other apes to use sign language. That seems to point to the fact that anthropoids are capable of combining ideas and producing utterances, i.e. they are capable of some sort of reasoning. Therefore it becomes essential to establish a more detailed picture of human reasoning; the history of its development, with the aim of establishing precisely whether there still remain any differences between animals and human beings and whether there was any evolution of the human species proper. It would also be advantageous to determine the present state and perspectives of human evolution. In our opinion all this could be accomplished on the basis of the already existing linguistic data.

In traditional linguistics there are many publications dealing with the problem of relations between language and thinking. There are also the latest works in cognitive linguistics of N.D. Arut'unova and Je.S. Kubrjakova. Beginning with the end of the 1980s cognitive linguistics, which studies relations between language, cognition and knowledge growth, became one of the leading directions in linguistics. But in the general linguistics the denomination of this problem – “language and thinking” - somehow excludes the possibility of the diachronic approach, because thinking is traditionally regarded as belonging to the present time.

At the same time, due to the fact that in the process of cognition as well as in scientific and technical thinking, mainly special vocabulary is most actively used (first of all terms), the cognitive approach in terminology science became one of the most promising and leading directions of Russian linguistics (the term "kognitivnoje terminovedenije" (cognitive terminology science) was introduced in the 1989 by Prof. Olga Akhmanova; also “gnoseologicheskoe terminovedenije” (gnoseological terminology science) by Sergei Grinev [Grinev, 1990a]).

A number of gnoseological functions of terms and terminologies was discovered beginning with the heuristic function of the term [I. Dolgopolova, 1980; V. Leichik 1986], and also including diagnostic and prognostic functions of terminology [Grinev, 1991 and 1993], simulating function of term [Grinev, Leichik & Nalepin, 1987]; the function of fixation of knowledge [V. Leichik, 1980; 1986; Grinev, Leichik & Nalepin, 1987] and instrumental function [N. Sljusareva, 1982].

There are a number of successfully defended Dr. Sc. dissertations (M.V. Volodina, L.A. Aleksejeva, G.A. Dyanova); at one of the last annual international conferences, organised by the Russian terminological society in June, 2001, quite a number of presentations dealt with various problems of this direction of terminology science.

One of the first problems formulated as early as 1984 by H. Felber in his “Terminology Manual” was determining whether a term is the name of a concept viewed as a unit of cognition or a unit of knowledge. In the first case we should study the general process of development of the systems of scientific knowledge; in the second case rather the isolated act of reasoning. Lately the complex character of the problem of relation between language and knowledge induced the necessity to recognise the triple nature of the concept in terminology: as a unit of knowledge, cognition, and thought [Picht, 2002]. Difference in approaches

may determine methods of investigation – in the case of cognition there are reasons to view the diachronic approach as the most effective, while in other cases synchronous approaches may be preferable.

In Russian tradition the problems of knowledge, cognition and thinking are closely connected with the general theory of consciousness and perception of the surrounding world (the reflection theory). It deals with the multi-level scale of consciousness known since Aristotle and based on the ways of our perception of the surrounding world.

It starts with a sensation – an impression received with the help of one of our senses. This type of consciousness serves as a basis for our reflexes and is characteristic for the lower type of organisms. The next step is perception – an impression of a complex type that comes as a result of the sum total of sensations and gives a fuller impression of some object or a phenomenon of the environment. It is associated with the organic life of a higher order. Still the next step is associated with the ability to form mental images received in perception so that they could be retained in their absence, so it is connected with the memory and notions. Notion is a sensory-direct (vivid, obvious), generalised image of objects and phenomena of reality, which is preserved and reproduced in memory and without the direct influence of those objects and phenomena on the sensory organs. The last step, which presumably separates human beings from the rest of the living entities, is thinking proper that operates with concepts. The concept is an idea which mentally separates objects of a certain class according to their specific features. Concepts are denoted by terms – special lexical units. In our everyday life we use notions, not concepts, so ordinary words denote notions.

Now some of those features we share with other organisms. Despite all the nice words being said about homo sapiens, we are still animals and share with other creatures some essential features in perceiving the surrounding world. We share sensations with all of the other living organisms, beginning with the simplest, like unicellular, bacteria and fungi, also plants, insects, arachnids, reptiles, amphibians, etc. We share perceptions with fishes, amphibians, reptiles, birds and other mammals; and we share memories with mammals. But somehow we are not worried about our differences with bacteria while we feel it essential to separate ourselves from the apes (they say that the most harsh feelings exist between the closest relations).

It is difficult to scrutinize the historical development of the whole picture of the world in the human mind, but quite possible to get insights by studying small separate parts of it. During the last fifteen years in Russia there has been a number of investigations of the evolution of various fields of knowledge as reflected in the historical development of respective terminologies.

It was based on the assumption that practically all historical changes in human mentality, progress of culture and knowledge growth are reflected in changes in the lexical system. From the point of view of terminology science, knowledge growth is accomplished by the development and consecutive replacement of conceptual systems – paradigms. In our opinion the most universal means of manifestation of the conceptual paradigm is the corresponding terminological structure, i.e. the particular terminology. Every change of conceptual

paradigm is inevitably reflected (though it may take some time) in respective formal or semantic alteration of terminological structure which provides evidence of the high degree of isomorphism between them and also of the manifestation of terminological function of establishing the level of knowledge [Grinev, 1994]. Consequently an opportunity arises to implement the analysis of transformations of terminological apparatus of a definite field of knowledge in obtaining a relatively accurate notion of the specific features and tendencies of evolution of theoretical thought.

Diachronic investigation of terminologies, which serves as a means of manifesting conceptual paradigms in national languages, also makes it possible to simulate the evolution of virtual historical conceptual paradigms, because all their transformations would find formal expression in the quantitative and structural changes of respective lexical systems (terminologies). The use of the attribute “virtual” is motivated by the fact that the result of such reconstruction is a speculative system, supposedly but not necessarily coinciding with the real historical state of the respective field of knowledge. Sufficiently well-known to historical terminologists facts of incomplete correspondence of terminologies and respective systems of concepts to a considerable degree could be explained by the fact that quite rarely the sole aim of the scientist happens to be a formulation of the system of concepts. In the majority of cases, classification schemes of the concepts where the concept systems are represented in a perfect way are elaborated only as part of terminology ordering. In many cases the system of concepts is not present explicitly in the consciousness of the scientist and the incompleteness of terminology that he uses reflects the state of the respective system of concepts.

This approach has been elaborated during the last fifteen years of studies and creates the opportunity to reconstruct the historical states and tendencies of development in material culture as well as in scientific outlook; to determine the most possible time of formation of various specialised fields of knowledge and also to discover specific features of formation and evolution of particular scientific disciplines. By means of comparison of synchronic sections of terminologies viewed as a means of formalising respective systems of concepts attributed to various chronological epochs, we obtain the possibility of estimating the tempo of development of a chosen conceptual fragment of the picture of the world, its quantitative and qualitative historical variations, stages of specialisation and filiation (branching) of particular scientific sub-disciplines. In general it might be used as a relatively reliable basis for research aimed at discovering the causes and conditions of accelerating knowledge growth.

Some of the oldest fields of knowledge, in many cases - parts of everyday life requiring little professional knowledge, such as buildings, rooms, dress, furniture, pictures, weather, drinks, windows, ornaments, stairs, etc. were chosen as objects of the study. A number of thematic dictionaries and dictionaries of synonyms (such as Longman Synonymy Dictionary (1986), Roget's Thesaurus of English Words and Phrases (1987), Webster's New Dictionary of Synonyms (1988), Chambers Thesaurus (1991), The Cambridge Thesaurus of American English (1994), The Oxford Thesaurus (1997)) were used to collect the necessary materials. The Oxford English Dictionary was used in tracing semantic changes in the history of words. The information collected as the result of research in this direction (resulting in suc-

cessfully defended 14 Cand.Sc. and some 35-40 MA dissertations²) points to the following considerations:

It was found that the character of human reasoning was not the same during various stages of development of human mental abilities. In the history of development of any field of scientific knowledge we can observe a number of stages and, first of all, we can distinguish the scientific stage which is based on the predominant use of concepts and terms and the pre-scientific stage which is based on the use of special notions and proto-terms. In a number of cases, especially when analysing terminologies of the oldest fields of knowledge, we can single out three stages in their development.

Thus, investigation of English and Russian terminologies of meteorology revealed three chronological layers. The oldest layer consists of names of precipitation (or hydrometeors) and was formed by borrowing from the common everyday vocabulary words (like rain, snow, hail, dew, mist, drizzle, etc. and their Russian counterparts) that mainly already existed in respectively Old Teutonic and Proto-Slavonic languages. The next chronological layer attributed to the period, beginning in the 15th Century and up to the 18th Century, consists of names of local winds (such as tramontana, phoen, surazu, hamsin, ventania, barguzin, coche, hava janubi, etc.). Those words already denote special notions; they are mainly borrowed from various languages and already belong to the specialised vocabulary. The third layer, formed in the 19th and the 20th Centuries, consists of constructed scientific latinised terms (like cumulus, cirrus, humilis, capillatus, stratocumulus, etc.) denoting concepts (M.A.Lazareva). A similar arrangement was found in a number of other terminologies.

It follows that in the process of development of scientific knowledge we can single out several historic types of reasoning used in various stages of evolution of man and in our opinion determining the character of cognition.

The oldest, initial type of reasoning that we called the naive type, uses common everyday words and word-combinations, which testifies that it was based on worldly wisdom and common-sense and operates with everyday general notions. Those notions, judging by the meanings of these words, had a fuzzy character: for example the Old English snow also meant snowflake, blanket of snow, snowfall, snowstorm; the word dew also meant dewfall, moisture, humidity. Another example is the word mood which had the meanings mind, intellect, reason, common-sense, heart, thought, feeling, soul, spirit, inclination, view, anger, courage, stoutness, pride, passionate grief, disposition, humour, temper, state of mind.

Besides fuzziness, another typical feature of early words was their general character. The word apple at first was used to denote also any kind of fruit, or even vegetables, which is still reflected in words like pineapple, Apfelsine, Pomeranze, pomme de terre, pomo d'oro, pomaranca (Polish). This may be explained by the fact that apple was the first fruit discovered by early man and subsequently any kind of fruit or vegetable was apprehended as an apple; discrimination came much later and required a search for new names. Such facts could also be used to reveal the order in which various objects and activities were discovered and mastered by man when there is no other evidence.

A number of other typical characteristics of early words was discovered, such as their random character, wide variation of form, predominantly simple formal structure, absence of motivation, comprehensibility to everybody, looseness (lack of systemic relations), presence of synonyms, etc.

This is a pre-scientific period, which according to M.W. Wartofsky is associated with the three main sources of knowledge – mythology, everyday experience and technology of materials processing (M.W. Wartofsky, 1968). This period may be attributed to the epoch from the appearance of the homo sapiens species till the Middle Ages. It is characterised by domination of manual labour in production and usage of primitive tools. In language we notice first of all syncretism of meaning when a word may correspond to up to a hundred contemporary words. The words used in reasoning belong to everyday language and denote general notions.

The next, the proto-scientific period is characterised by the appearance of specialised words – proto-terms, which signifies the appearance of the special notions and special (professional) activities – first of all crafts. The meanings of such special words are known only to the persons belonging to a certain profession. This is obtained either by borrowing from other languages, as it was, e.g. with English and Russian names of winds, Latin medical proto-terms borrowed from Greek (in Greek they had a general universally understandable meaning which was quite inconvenient) and Russian names of wood-cutting tools (planes), that were borrowed from German, or by the so-called internal borrowing, that is from regional dialects (as with Russian names of insects used by gardeners) or from other subject fields. Other features of lexical units of this period are random character, regional variation of forms, structural diversity, absence of systemic relations, narrowness and concreteness of meaning often achieved by specialisation of meaning in borrowing from other languages or different layers of the same language, abundance of synonyms, etc.

The corresponding trade type of reasoning uses special notions and is based on common-sense. This period may be attributed to the epoch beginning in the late Middle Ages and New Time – till the 18th Century, though in some fields of special knowledge where there are no theoretical foundations, this type of reasoning still dominates. In production culture there is a gradual transfer from individual manual labour to manufacture and the beginnings of industry.

The third, contemporary stage of cognition is characterised by scientific thinking, which is based on the use of scientific theories and systems of concepts. At this period terminologies proper are formed or constructed, concepts are defined, methodology of research is elaborated and scientific equipment is introduced. Only at this stage do we deal with terms proper which have precise meanings, and are consciously chosen or constructed (sometimes as a result of long and heated debates). They also form a system, are usually motivated, uniform, esoteric, are predominantly devoid of synonyms, and standardised. There is also a tendency towards lengthening of their form, reflecting constant specifying of the content of ideas (be they notions or concepts) by the adding of attributes to their nominations, which results in the growth of word combinations (in both their amount and length).

The general tendency in knowledge growth is specialisation when new sciences and scientific disciplines appear in geometrical progression. According to the data presented in the Encyclopaedia Britannica more than two thousand new scientific disciplines appeared in the 20th Century. Specialisation of knowledge is reflected in constant specialisation of the meaning of words by introducing new lexical units. Generally speaking, the process of civilisation (or human evolution proper, or knowledge growth) could be viewed as a constant overcoming of syncretism. Like galaxies that comprise our universe and move apart at unbelievable velocities, thus widening the space of the void, our awareness of the surrounding world is constantly growing, broadening the space of the known. With the deepening of knowledge, every semantic field is dividing into sub-fields which gradually become independent fields of knowledge. It is assumed that every 25 years the number of scientific disciplines doubles and that leads to a geometrical progression in growth of number of new concepts and terms.

There are reasons to believe that the general rule that ontogenesis repeats philogenesis could be applied to both the evolution of human reasoning and mentality, and its reflection in language. It can work two ways: on the basis of philogenesis we can (more or less roughly) predict the development of a child; at the same time we can project some of the characteristics of child development on the possible features of man at various stages of his evolution. High emotionality coupled with a simple mode of thinking, rapid transitions from one emotional state to another - all of this we can witness in the behaviour of quite grown-up people in the Middle Ages and during the Renaissance, judging by contemporary literature and chronicles.

In ontogenesis, starting with one small semantic field of extremely fuzzy notions that we exploit in early childhood, we eventually come to the awareness of the highly sophisticated system of the vast amount of scientific knowledge in our grown-up years. Of course, the question remains whether that is knowledge of the surrounding world or knowledge of our imagination of the surrounding world. In some aspects that would be the same or perhaps we can ignore the difference.

There is a number of implications of the results of this investigation.

We can try to estimate the average general age of intellectual development, or the level of mental maturity (in comparison to the present age of maturity) of human beings at various historical periods. Then we may establish more precisely their motivation, and the reason for their actions and behaviour. We can discover the true meaning and message of historical texts, for there are reasons to believe that in many cases we understand the words the ancient authors use in their modern sense, within the framework of our contemporary knowledge and mentality, and we subconsciously substitute the contemporary ideas for their real ones, which leads to overestimating their achievements and misinterpretation of their thoughts.

In research concerned with the simulation of human reasoning in artificial intelligence systems we may either concentrate on the third, really scientific period of human thinking and ways of establishing the contemporary overall system of declarative knowledge and then

transfer to procedural knowledge, or try to imitate the mental development of humankind starting with the naive mental activities of the first period.

We can work out some principles of reasoning, including a general strategy of reasoning, methodology, methods and techniques of reasoning. We may presume then that, as in computers, thinking consists of two general elements – declarative and procedural knowledge, and power of reasoning depends on the amount of what is known (which we would call profoundness of thinking) and the ability to associate (in the case of simple reflections) and to bring together parts of the future systems – in the case of more complicated reflections (which we would name elasticity of reasoning).

We can also predict some features of the next stage of human mental evolution. Some features – such as rapid growth of vocabulary and specificity of meaning of new words - we may take for granted. For example at the beginning of the 19th century according according to our calculations there were about 10,000 building terms, at the beginning of the 20th century their number grew to 30-35,000, while at the present time it may amount to 250,000. Along with this, we can observe the growth of personal vocabularies. According to our estimates, at the end of this century an average educated person would know some 150-160,000 lexemes.

Eventually we can try, on the basis of comparing some features of national mentality, to establish language peculiarities responsible for the differences in human attitudes and behaviour.

Generally speaking, a whole new direction of terminology science is emerging nowadays that may greatly improve the contemporary theory of evolution and would let us get a better understanding of human reasoning.

¹ It is quite demonstrative that according to Ahmad Khurshid [TKE, 1998?] in the latest works of Th. Kuhn the term “conceptual paradigms” is substituted by the term “lexical systems”

² see for example the following theses (all in Russian):

ALESENKO T.A. (2000) Comparative research of English and Russian terminology of water environment ecology. M., MPU.

ALEXEJEVA O.B. (1994) Cognitive aspects of diachronic research of terminology of building materials. M., MSU

BULANOVSKAYA T.A. (1999) Producing terms from place-names (on material of the English and the Russian languages). M., MPU.

DONSKOVA I.I. (2001) Problems of systemic comparison heterolingual lexics (on material of the English and the Russian lexical content of semantic field “Living houses and spaces”). M., MPU.

- FILIPPOVA JE.V. (1996) Evolution of the English oncological terminology. M., MSU.
- ILCHENKO JE.V. (2000) Comparative analysis of English and Russian lexics of the semantic field “swords”. M., MPU.
- KLEPALCHENKO I.A. (1999) Specific features of evolution of the architectural terminology (based on names of stairs in English and Russian). M., MPU.
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- MIRONOVA JE. JE. (2002) Comparative systemic analysis of the English and the Russian building terminology (on material of names of architectural elements). M., MPU.
- TENENEVA I.V. (2001) Problems and principles of ordering terminology (based on material of comparative analysis of English and Russian photographic terms). M., MPU.
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