

Tatiana V. Drozdova

A SCIENTIFIC TEXT AS IMPLYING INFORMATION

ABOUT METACOGNITIVE CAPACITIES OF ITS AUTHOR

Astrakhan State Technical University, 16 Tatischev St., Astrakhan, 414056, Russia, [drozdova\\_astu@mail.ru](mailto:drozdova_astu@mail.ru)

**Abstract.** The paper considers the issue of language and consciousness interconnection in view of verbal units and structures of a scientific text as providing access to mental activity of its author. Proceeding from the generally accepted assumption that all types of human activity are guided by and depend on their metacognitive capacities, which in turn activate their cognition, it is suggested that the author of a scientific text should be regarded as demonstrating these capacities in two interconnected planes: primarily, being a subject of scientific activity and, secondly, being a subject of literary activity while engaged in disseminating the results of the primary one via a written text. The scientific text content is considered in the paper as objectification of the results of cognitive processes and mechanisms guided by metacognition, the “traces” of metacognitive skills can be found in the meaning of certain lexical units and/or inferred by analysing certain syntactic structures in the text. It is argued that a scientific text composition itself can also be considered as created due to metacognitive capacities and language cognition.

**Key words:** scientific text; cognition; metacognitive capacities; metacognitive strategies; verbal objectification; lexical units; grammatical patterns.

**Introduction**

The tenets of cognitive linguistics describe the natural language both from psychological and linguistic perspectives: as a mental phenomenon, a cognitive capacity, the main tool of processing and objectifying information, but also as a form of knowledge “which has to be analyzed accordingly, with a focus on meaning” [6, p.3]. In view of this, the scientific text has been investigated by cognitive linguists mainly from the perspective of its comprehension i.e. analyzing the types of information or knowledge represented in the text through lexical units and grammar constructions. By means of this analysis they could gain access to cognitive structures storing special information and to the conceptual fields of different branches of science as well as to the conceptual system of the text author. Unlike the issue of scientific text comprehension, the issue of creating scientific text looked upon as verbal objectification of its author’s mental models of storing special and background knowledge has not yet been examined in detail in linguistic literature. Though comprehension and creation of a scientific text are not mirror images, both involve the activity of consciousness, or, to be precise, metacognitive and cognitive processes and mechanisms. The purpose of the paper is to highlight the role of metacognition and cognition in scientific text creating and to provide evidence that, reconstructing this process by analyzing the meaning of text linguistic units, syntactic structures and text

architecture one can infer information about metacognitive capacities of the writer.

**Materials and Methods**

The Russian and English scientific articles, scientific monographs and academic texts for university students provided samples of material for investigating the issue, some of them also contributed to the theoretical basis of the paper. The elements of conceptual analysis, semantic analysis, clause relation analysis and traditional written text analysis were applied to the material to get evidence of explicit or implicit ways of text providing access to metacognitive capacities and strategies of its author. General scientific methods of inference and conclusion were used to draw the line of argumentation.

**Findings and Discussion**

Undertaking the investigation into the issue of science, text creating viewed as guided and controlled by writer’s consciousness or his/her metacognitive and cognitive capacities, the information about which can be traced to various levels of text organization, it is necessary to briefly outline the notion of metacognition, its relations to consciousness and cognition.

The notion “metacognition” introduced by J. H. Flavell [5] and understood as “knowing about knowing”, “thought about thought”, the capacity of an individual to monitor own knowledge, has been further explained and developed by many

psychologist of cognitive schools. According to D. M. Rosenthal, “metacognition consists in the mental access we have to our cognitive states” [11: P. 203 ] i.e. to our mental states which are conscious. It means that consciousness and metacognition are closely connected, or, as A. Koriat assumes, “metacognitive processes represent an integral part of conscious-controlled functioning” [7: P. 149]. Psychologists made it evident that metacognitive processes such as metacognitive monitoring and control of cognitive processes and mechanisms accompany a great deal of human activities.

It has been illustrated by psychologists that in many cases such monitoring and control are deliberate, intentional, and can be successfully exercised on condition that metacognitive capacities of an individual are well-developed. As to metacognitive capacities or skills, it should be mentioned that there does not exist a generally accepted list of them. Nevertheless, in the majority of psychological works devoted to the subject of metacognition the following metacognitive capacities and strategies are mentioned: to be aware of knowing and to assess the volume and value of possessed knowledge (or working skills); to set the goal of learning something new (or producing a kind of work), to predict the results of knowing (or production), to plan the tasks, to determine stages and means of accomplishing the task, obtaining results, and to control the progress of the task, to compare obtained results with the existing ones and evaluate them, to make inferences, etc. (cf. [5], [10], [12]).

Metacognitive capacities or skills are distinguished from metacognitive knowledge; they concern the procedural knowledge, are highly interdependent, and form and develop in everyday experience and/or while obtaining education, i.e. thanks to repeated situations, deliberate “rehearsal” and self-reflection ([12: P. 90], [ ]). It is quite natural, that scientific activity requires especially high level of their development and individuals involved in this field of activity should be “scientifically literate in order to make informed decisions” [7: P. 1058]. It can be assumed that continuous scientific activity results in metacognitive capacities internalization. However, to explain the essence of any investigation or research, write up the obtained results, to present the content of scientific concepts and describe their relations within the realm of a certain science a scientist makes them explicit by means of introspection – a conscious review of mental activity with obtained knowledge the constituents of which were already given initial nominations.

Re-thinking mental activity in inner speech as well as expressing results of this activity in written words involves linguistic competence of an individual, or, to be more precise, linguistic cognition, i.e., according to V. Z. Demiyankov, everything an individual knows about the language and operations with it [1: P. 30], the fact that language is knowledge, including. It means that an individual, being a language-user, can be conscious of the steps of abstract reasoning, of “whatever contents can be linguistically expressed” [4: P. 6].

Analysing a scientific written text, cognitive linguists can find explicit reference to or implications of cognitive and metacognitive capacities of its author. These are reflections of comprehended mental activity involved both in research conducting and in text creating. Explicit representations of the activity of human mind and its content are viewed in the paper as “linguistic metarepresentations” which are defined by T.A. Klepikova as linguistic units which fulfill the onomasiologic function of nominating a cognitive situation in which the content of cognition, perception or speech is being conveyed. In other words, they represent already existing verbal representations which refer to comprehended mental states. T.A. Klepikova distinguishes phonetic, lexical (including words of cognitive semantics) and syntactic explicit markers of linguistic metarepresentation [2: P. 5-6].

As to the scientific text, we assume that only the last two can be found in the text space and they are mainly used in combination. Moreover, it seems justified to consider these means of metarepresentation as an integral part of metadiscourse which, as N.K. Riyabtseva states, is an obligatory element of scientific discourse which provides for conscious knowing objectification through communication, and at the same time serves a source of scientific metalanguage. The latter reflects the subjectivity of knowing or perception and forms a unified system of means of explication, systematization, categorization and formalization of scientific knowledge [3: P. 456].

Lexical metarepresentations as constituents of the scientific metalanguage include, primarily, the words of cognitive semantics which nominate the objects of mental activity (*idea, hypothesis, теория, значение, знание, etc.*), including the names of units of consciousness (*concept, category, понятие, гештальт, etc.*) and cognitive structures (*frame, world image, нейронная сеть, пропозиция, etc.*). All such words imply the cognitive content which they can introduce and which is formed as the result of cognitive processes, e.g.:

*My own view is that language is, in this same sense, an artifact ...* [4: P. 12].

To this group belong the names of mental processes, like *understanding, awareness, допущение, предположение*, etc.), e.g.:

*The development of a ... model ... requires an understanding of how stress accelerates the bound rupture reaction* [8: P. 137].

The list of lexical metarepresentations can be extended by another type of words which explicate information about metacognitive strategies, their conscious monitoring and/or control. These are verbs which N. K. Riyabtseva [3: P. 458-466] called “mental performatives”, or simply “performatives”, since they nominate an intellectual event, can explicit the author’s self-reference to his/her mental sphere, or reasoning. They mainly perform the function of predicate in the main clause (*вычислить что? доказывать что?*, etc.); some of these verbs are used metaphorically (*делать вывод; принять доказательство*, etc.). The argument to a mental performative explicates the content of consciousness, e.g.:

*I do not know how long it took Darwin to compose these two paragraphs* [8: P. 154].

The above-mentioned scientist also offered a semantic-based classification of these verbs and pointed out that they constitute an element of mental performative utterances (statements), like the following: *Допустим, что (сопротивление воздуха равно нулю); Отвлечемся от (параметра P); Вернемся к (пропозициональной семантике)* [3: P. 459].

As long as syntactic structures have already been touched upon, we consider it necessary to mention that M. Halliday found out that highly typical of what he called “a scientific register” is the grammar pattern which “exploits **metafunctional** principle of clause structure: that the clause, in every language, is a mapping of three distinct kinds of meaning – interpersonal, ideational and textual (clause as action, clause as reflection, clause as information)” [8: P. 140]. In the last two types of the pattern, as can be assumed, the information explicates the content of consciousness, with the main clause predicate being a mental performative. This assumption is supported by investigation of T.A. Klepikova into syntactic type of linguistic metarepresentations in which it was established that the most typical syntactic type of such metarepresentation in the English language is a complex sentence with a sentential complement:

*The theory maintains that presuppositions and anaphors can be resolved in the same way* [2: P. 5].

This syntactic pattern is also frequent in the Russian-language scientific texts, e.g.:

*Кроме того, в психологии давно замечено, что косвенные, имплицитные способы передачи*

*смысла действуют сильнее, чем прямые* [3: P. 489].

Speaking about syntactic (or grammatic) patterns we consider it necessary to mention some which reflect the conscious comprehension of cause-effect or other types of relations, namely *if ... then, although ... (but), хотя, ... но* and the like patterns, (cf. [a + cause + x] in [Hal: 137]) and refer to certain implied metacognitive strategies. Syntactic structures of this kind can be found both in English and Russian scientific texts and, in our opinion, may be considered a type of syntactic metarepresentation with the ellipsis of explicit marking (like *consider, know, believe, принимать во внимание, учитывать*, etc.) which can be easily restored e.g.:

*If public language evolved so as to aid interpersonal communication and cooperation, then these uses are, to coin a phrase, teleologically constitutive: they are the essence of language...* [4: P. 9].

*Чтобы установить, какие именно мыслительные операции субъект выполняет, он должен предпринять особые умственные усилия, осознанную интеллектуальную рефлексю* [3: P. 473].

In fact, different types of logic relations while reasoning are mainly conveyed in the scientific text by means of a chain of several sentences. And, in general, various types of linguistic metarepresentations combine in the scientific text to mark different metacognitive capacities and strategies.

Having described the types of explicit metarepresentational marking of metacognitive activity in the scientific text, we proceed by discussing the kinds of information the text conveys about metacognition, or, to be exact, when, where, and how metacognition manifests itself. As to “when”, we suggest distinguishing between two time planes: the first one, or primary, is when the author of the text acts as a subject of scientific/research activity, and the second one, or secondary, is when the author of the text acts as a subject of literary or (writing) activity. “Where” concerns two fields of knowledge and two conceptual spheres: those of a certain science branch and of the natural language. Speaking about “how”, we mean individual’s deliberate implementing different metacognitive strategies, on the one hand, and our distinguishing between orders or levels of metacognition, on the other. The suggested division is artificial and done purposefully, as we are, of course, quite aware of the fact, that all mental processes are interconnected and operating with knowledge means operating with language.

Knowing in scientific activity involves special procedures of learning properties of physical world objects or constructing mental objects with certain

features. Metacognitive strategies and skills are responsible for activating main cognitive processes of conceptualization and categorization, and cognitive mechanisms, like comparing. Their activity results in scientific concepts and categories formation, the content and composition of which, when verbalized, can be presented in the scientific text through their names and definitions which refer to mental structures storing this knowledge and imply corresponding metacognitive strategies and skills. Definition of a scientific concept/notion can be presented as a single sentence, according to a classical formula “A is B”, or it can be extended via a chain of sentences, involving other notions of the same branch of science, which can be organized in a text passage, like the following one representing a definition of a psychological notion:

*Metacognition is, roughly, the access we have to whether, or how likely it is that, we know something. When we make judgements about whether we know something or how easily we will learn some item or even whether we have successfully learned it, these are metacognitive judgements.* [11: P. 203].

We shall define the metacognition at this level as “primary scientific activity level metacognition”. In contrast to this type, we shall define its introspected representation in the text as “linguistically metarepresented primary scientific activity level metacognition”. Its explication by linguistic metarepresentation marking is illustrated by the following sentence which implies such a metacognitive capacity as “to be aware of one’s knowledge”:

*Recall that metacognition is referred to as “thinking about thinking” and involves overseeing whether a cognitive goal has been met* [10: P. 3].

The metacognition which is connected with the level of language, or, upon the whole, of verbal objectifying mental activity results, can also be purposefully viewed as acting at several levels:

(a) the level of science word (or term) building – “primary language metacognition”;

(b) the level of representing comprehended mental activity in the field of scientific investigations, metacognitive strategies included, – “secondary language metacognition related to scientific activity”;

(c) the level of literary activity, i.e. writing or creating a scientific text viewed as a problem-solving task which involves selecting information, organizing it in logic sequence according to the author’s reasoning and requirements to the scientific text type structure (architecture) – “secondary language metacognition related to text-writing activity”.

The information about metacognition of level (a) concerns 1. the awareness of knowledge of common and special lexis (terms) and, 2. in case the appropriate name is missing – metacognitive monitoring and control over linguistic mechanisms of word-building. This information is mainly explicated by lexical metarepresentations or implied by the content of a sentence, e.g.:

*...поэтому такие перформативные высказывания было бы более точно назвать социологизированными перформативными речевыми актами или социальными перформативами* [3: P. 459].

The information about metacognition of level (b) can be inferred due to procedures of written text analysis and semantic analysis of words and verbal expressions in the text space. The metacognitive skills and strategies are taught and developed at educational institutions [7]. They are related to the level of intellect development [12]. Verbal means of reasoning and logic text content structuring in the Russian and English languages as well as metacognitive strategies providing problem solving in scientific text writing are described in detail in many practical guides and academic writings (cf. [3], [7]). The explicit marks of the metacognitive capacities to consciously monitor text-writing activity of an individual can be found among various clichés characteristic of scientific style: *to begin with..., to summarize..., the purpose of the text is..., не перейдем к вопросу ... следует указать, что..., etc.*

The information at level (c) is implied by the whole text structure (or meta-structure, text architecture). In some types (or genres) of the scientific text the headlines of its structural parts, like *Introduction, Discussion*, etc. can be viewed as explicit metarepresentations of metacognitive strategies.

As it has been already mentioned above, we assume that since verbal units and expressions in scientific text can be used in combination, it is typical for them to simultaneously objectify the results of mental activity, serve as explicit metarepresentations of some metacognitive strategies and provide implication to metacognitive capacities of monitoring and control cognitive activity and text creation viewed as problem-solving task. To support the assumption the following text passage is analyzed:

*... A supra-communicative view of language, as I define the term, holds that the availability of linguistic encodings enhances our problem-solving capacities by somehow transforming the kind of computational space in which we operate. This vague*

and wide definition can be filled out in a number of different ways ... [4: P. 2].

The information this abstract conveys to the reader about metacognition of its author concerns:

- “primary scientific activity level metacognition”: the metacognitive capacity to be aware of the bulk of special knowledge and state that the introduced notion is new (or missing); to comprehend the task of construing the content of scientific notion *a supra-communicative view of language* and the metacognitive strategy to complete this task by activating the cognitive process of conceptualization;

- “primary language metacognition” explicated by the corresponding coined term *a supra-communicative view of language*;

- “secondary language metacognition related to scientific activity”: the result of metacognitive strategy to construe the content of the notion is represented by the lexical metarepresentation *holds*, while the cognitive content is presented by the sentential complement *the availability of linguistic encodings enhances our problem-solving capacities*...;

- “secondary language metacognition related to text-writing activity”: the metacognitive capacity of comprehending the necessity to continue the passage with the description of *different ways* as well as metacognitive strategy to observe the logic of reasoning (and narration) is implied by the meaning of the syntagma *vague and wide definition can be filled out*.

### Conclusion

Drawing the line of conclusion to the above discussion, we consider it necessary to underline the complexity of the issue. Though it is evident that the scientific text convey information about metacognitive (as well as cognitive) capacities of its author, the ways and means of conveying the information, the types of information and the types of corresponding metacognitive capacities and strategies should be investigated and described in more detail.

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**Tatiana V. Drozdova**, Head of the Department of Foreign Languages, Senior Doctor (Philology), Associate Professor