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Professional discourse: the verbal and visual semiosis interplay

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Abstract. Professional discourse has become one of the most researched types of discourse in modern cross-disciplinary studies. Being widely represented in linguistic studies, it still has received unfairly tenuous attention in semiotic studies. Some areas of professional discourse such as popular science discourse have been out of focus of linguo-semiotic studies so far. The goal of this paper is to identify the dominating semiotic system in the formation of meaning and knowledge transfer in popular science discourse. The authors have carried out the semiotic analysis of verbal-visual relations in journal articles headlines belonging to the sphere of popular science, their correlation in the process of semiosis, representation of scientific knowledge in popular science discourse. Data obtained in the result of the conducted research support a new trend in semiotic research that visual system is no longer viewed as subordinate as it is capable of shifting the emphasis in the process of semiosis. Based on the previous body of research relating to word-image interdependencies, the authors develop their own approach to determine the dominance of one semiotic system over the other in certain contextual environments. While departing from a traditional approach of defining the nature of relations between two major components – the verbal and the visual, the authors propose to include an "intermediary" element to form a triad consisting of

heading, sub-heading and photograph. The analysis of the relations among the three elements gives the results which sometimes reflect contradictory tendencies in verbal-visual relations present in single (heading-sub-heading) or multimodal (heading-photograph) systems. The authors determine three models of interaction of verbal and visual components – complementarity, neutrality, controversy, though under the influence of the "intermediary" component the models may significantly change. The results contribute to deeper understanding of professional language picture among specialists, as well as familiarizing non-specialists with professional language picture. The results also may be employed as guidelines in the academic courses of texts composition, writing popular science articles, and as a teaching tool in disciplines focused on text analysis.

Keywords: Popular science discourse; Professional discourse; Semiosis; Semiotic analysis; Verbal signs; Visual signs

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Профессиональный дискурс: взаимодействие вербального и визуального в семиозисе

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Статья поступила 14 февраля 2022 г.; принята 04 марта 2022 г.; опубликована 30 марта 2022 г.

Аннотация. Профессиональный дискурс является одним из наиболее изучаемых видов дискурса в современных междисциплинарных исследованиях. Будучи широко представленным в лингвистике, он, тем не менее, достаточно слабо представлен в семиотических исследованиях. Некоторые области профессионального дискурса, такие как научно-популярный дискурс, до сих пор оставались вне поля зрения лингвосемиотики. Цель настоящей статьи – выявить доминирующую семиотическую систему в формировании смысла и передаче знаний в научно-популярном дискурсе. Авторы провели семиотический анализ вербально-визуальных отношений на материале заголовков журнальных статей, относящихся к сфере научно-популярной литературы, их соотношения с позиций семиозиса, репрезентации научных знаний в научно-популярном дискурсе. Данные, полученные в результате проведенного исследования, подтверждают новую тенденцию в семиотических исследованиях, согласно которой визуальная система больше не рассматривается как второстепенная, поскольку она оказывается способной смещать акценты в процессе семиозиса. Основываясь на исследованиях предыдущих лет, касающихся взаимозависимости и взаимодействия слова и изображения, авторы разрабатывают свой собственный подход к выявлению доминирования одной семиотической системы над другой в условиях определенных контекстов. Отходя от традиционного подхода к определению характера отношений между двумя основными компонентами – вербальным и визуальным, авторы предлагают включить «промежуточный» элемент для формирования триады, состоящей из заголовка, подзаголовка и фотографии. Анализ отношений между тремя элементами дает результаты, которые иногда отражают противоречивые тенденции в вербально-визуальных отношениях, представленные в одной (заголовок-подзаголовок) или разных (заголовок-изображение) знаковых системах. Авторы выявляют три модели взаимодействия вербального и визуального компонентов – взаимодополнение, нейтральность, противоречивость, хотя под влиянием «промежуточного» компонента модели подвержены существенным изменениям. Полученные результаты способствуют более глубокому пониманию профессиональной языковой картины специалистами, а также ознакомлению неспециалистов с профессиональной языковой картиной. Результаты также могут быть использованы в качестве методического руководства в разработке учебных курсов по написанию текстов, научно-популярных статей и в качестве учебного пособия по дисциплинам, ориентированным на анализ текста.

Ключевые слова: Научно-популярный дискурс; Семиозис; Семиотический анализ; Вербальные знаки; Визуальные знаки

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1. Introduction

The issue of professional communication is actively studied in modern research from various standpoints. Professional discourse is understood as a specific feature of the participant of professional communication based on his belonging to a certain profession or a field of professional activity (Peluso, 2021; Ylänne, 2021). It is also viewed as the type of

communication which is pursued while conducting professional activity and aimed at solving profession-related problems (Irimiea, 2017; Gunnarsson, Linell, Nordberg, 2014; Bargiela-Chiappini, Nickerson, Planken, 2013; Koester, 2010). It is a specific type of discourse due to several distinguishing features such as status character of relations between the participants, thematic focus, lexical peculiarities, pragmatic functions of professional communication, genre specifics, and situational contexts.

Due to the latest developments in economic, political, social and cultural spheres which lead to the formation of an integrated world community, communication has acquired new features. It has become more advanced and complicated, more abundant in terms of information exchange as well as more diversified in the ways of coding the information. The relevance of visual components has inevitably increased. The combination of natural language as an element of culture and the visual range as an international language of communication resulted in the convergence of the signs of verbal and other semiotic systems, which foregrounds the semiotic approach to the analysis of both verbal and visual components.

There exist fragmentary semiotic studies of certain types of professional discourse (Blasch, 2021; Peluso, 2021), but they mostly include the analysis of media and political discourse, while popular science discourse lies beyond the scope of modern semiotic research. The rationale behind this research is to analyze the interplay of interpreting verbal and visual signs in journal articles headlines belonging to the sphere of popular science. Drawing on the studies that explore the semiosis through verbal and visual signs in media and advertising discourse (Arnold-Murray, 2021; Kohrs, 2021; O'Hagan, 2021; Reilly, Zhang, Feng, Wei and Xia, 2021; Flurie, Peelle, 2020), we aim to a) study the verbal representation of meanings in popular science discourse; b) identify the correlation between verbal and visual signs in the type of discourse under study; c) classify linguistic means of representation into three main categories which any sign system is comprised of. The objectives of the article include generalizing the theoretical knowledge on semiotic studies of professional discourse and popular science discourse in particular, selection of texts for analysis, description of language means of meaning representation in popular science discourse, development of models of verbal and visual signs interplay while representing the scientific knowledge in popular science articles' headlines.

As a result of the conducted research, it has been possible to prove the hypothesis that in journal headlines semiosis can be viewed as a three-element process which includes not only the traditionally studied interrelation of verbal (heading) and visual (photograph) representation of meaning but also a third element – sub-heading which is also relevant to the general process of sign interpretation. At the same time meaning is inferred both from the combination of all the three components of sign systems – syntax, semantics, pragmatics, and it is complemented with a visual element, which establishes multi-semiotic systems and stipulates the multimodality of communication within popular science discourse.

2. Literature Review: Professional Discourse, Semiotics, Verbal-Visual Interplay

In our professional activity we constantly immerse ourselves into occupation-related discourse associated with the notions of "professional discourse" – "communication among organizations and individuals in business and government", "communication – in speech and writing – not only within the professional group, but also between different specialist groups and between experts and laymen" (Gunnarsson et al., 2014: 2), "business discourse" – "how people communicate using talk or writing in commercial organizations in order to get their work done" (Bargiela-Chiappini at al., 2013: 3). According to the opinion of F. Bargiela-

Chiappini and C. R. Nickerson (1999), professional discourse is "a hyper-category that encompasses several others", "rather it is a collective category where discourse is intended in the singular and towards which other institutional genres converge by virtue of sharing some of its characteristics" (Bargiela-Chiappini, Nickerson, 1999: 1, quoted in Irimiea, 2017: 109). It represents "institutional discourse" – "interaction between an expert and a lay person" (Agar, 1985: 147, quoted in Irimiea, 2017: 109), "workplace discourse" – "interactions occurring across all kinds of occupational settings" aimed at "getting things done" (Koester, 2010: 5), "specialized discourse" – "the specialist use of language in contexts which are typical of a specialized community stretching across the academic, the professional, the technical and the occupational areas of knowledge and practice" (Gotti, 2008: 24), "institutional talk" – "task-related" interaction which involves at least one participant who represents a formal organization" (Drew, Heritage, 1992: 3).

Multitude of approaches within which professional discourse is studied proves its significance in modern cross-disciplinary research. It is quite evident that every analysis conducted in the framework of a certain research paradigm reveals a specific feature of professional discourse which contributes to its better understanding and allows expanding our perception of its nature. A definition proposed by K. Kong embraces the features of professional discourse individually mentioned in the definitions presented above: "professional discourse is the language produced by a professional with specialized training to get something done in the workplace" (Kong, 2014: 2). A broader vision of professional discourse and its defining attributes is presented in the classification of "communicative genres" developed by P. Linell (1998) which shows various levels of interaction within the general scope of professional communication. P. Linell differentiates (1) intraprofessional discourse – a discourse within a specific profession; (2) interprofessional discourse – discourse between individuals representing different profession; (3) professional-lay discourse (Linell, 1998: 235-260).

Key distinguishing features of professional discourse are specified by P. Drew and J. Heritage (1992), and include: (1) "goal orientation" – "an orientation by at least one of the participants to some core goal, task or identity … conventionally associated with the institution" (Drew, Heritage, 1992: 22); (2) "constraints on allowable contributions" (Drew, Heritage, 1992: 21-25), i.e. correspondence to the norms of communicative behavior – what exactly can be said or written; (3) asymmetrical nature of communication (Drew, Heritage, 1992: 21-25) – the distribution of institutional power and expert knowledge among the communicants.

Although it is being extensively studied within an array of methodological approaches nowadays, professional discourse "has become a research area in the last two-to-three decades" and it mostly "has been studied as an interdisciplinary area, drawing on sociology, psychology, anthropology, linguistics, and any discipline that could investigate or explain human behavior in particular settings" (Irimiea, 2017: 117).

Semiotics is a relatively new research paradigm as far as professional discourse is concerned. Its relevance to the study of professional discourse is determined by the fact that any phenomenon is potentially semiotic as it may be represented by some kind of semiotic systems – verbal and non-verbal.

Semiotic study is currently one of the leading research paradigms in modern linguistics. A large number of international indexed academic journals[1], scientific areas

[1] Social Semiotics, Applied Semiotics, Interdisciplinary Journal for Germanic Linguistics and Semiotic Analysis, Carte Semiotiche, Discurso – Revista Internacional de Semiótica y Teoría Literaria, Cybernetics and Human Knowing, Variaciones Borges – Journal of philosophy, semiotics and literature, Cognitive Semiotics,

and schools[2], professional associations[3] studying general and private semiotics issues as well as the works of individual scientists provides convincing evidence of the fact that semiotics, as the science of sign systems' organization and functioning, is a demanded research paradigm not only in philosophical and cultural directions, but also in a number of other fields, including linguistics.

Over the past decades, a fairly large number of linguosemiotic research on communication in general (Cobley, Kull, 2017; Kisak, 2016; Leeds-Hurwitz, 1993; Nöth, 2014; Queiroz, 2013), and on the semiotics of professional discourse and various types of professional communication in particular (Berger, 2016, Drăgan, 2019; Menchik, Xiaoli, 2008; Olteanu et al., 2019; Zantides, 2019; Zlatev, 2015) have been published.

Semiotics as a research methodology is used in almost every sphere of human activity, including a number of interdisciplinary areas, such as "semiotics and literature", "semiotics of the literary text", "semiotics and psycholinguistics", and "political semiotics".

Semiotic approach is used most actively in the research of marketing and online communication (Kettemann, 2013; Ferguson, Greere, 2018; Sykioti, 2016).

Despite the broad thematic range of publications on semiotics, professional communication as a form of institutional communication has been studied fragmentarily, i.e. only certain narrowly specialized types of professional discourse have been analyzed.

Semiotic method has successfully been applied to the analysis of various kinds of genres as well as types of discourse. A number of scholars addressed the issues of correlation between representing, generating, comprehending and attributing meaning. (Eco, 1986; Johansen, Larsen, 2002; Kress, Leeds-Hurwitz, 1993). From the earliest studies and continuing today, semiotics-related studies have encompassed the study of verbal and visual signs, verbal and visual communication, verbal and visual interplay.

In modern communication the boundaries of semiotic systems are mutually-penetrating, thus one system may influence the other and visa-versa. The correlation of verbal and visual modalities methodologically traces back to semiological tradition of R. Barthes (1972) who "was the first to apply ideas of semiotics, as it developed from linguistics, to visual images" (Curtin, 2007: 54), the anchorage-relay dichotomy which was further developed by T. Vestergaard and K. Schrøder (1985) to analyze multimodal texts where the primary type of relations between verbal and visual components is one of anchorage with relay elements, or, on the contrary, relay with elements of anchorage (Vestergaard, Schrøder, 1985).

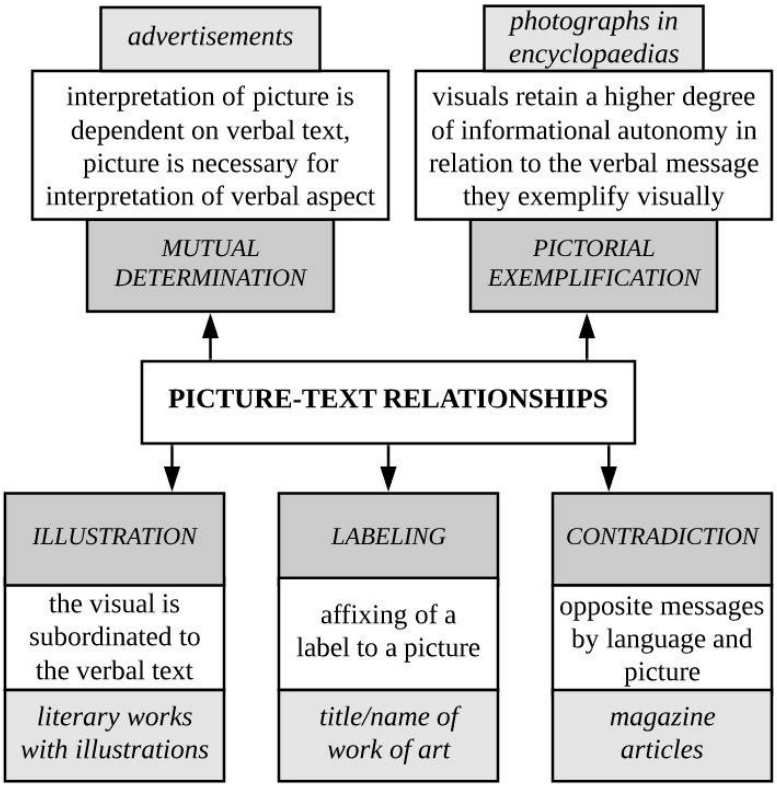
In W. Nöth's understanding, verbal-visual relations include anchorage-relay as sub-types being incorporated in other higher-order relations (Nöth, 1990):

Biosemiotics, International Journal for the Semiotics of Law, International Journal of Marketing Semiotics, Signs and Media, The American Journal of Semiotics, Critique and Semiotics, Acta semiotica Estica, de-Signis, Chinese Semiotic Studies, Semiotopos, Zeitschrift für Semiotik, Versus: Quaderni di studio semiotici, International Journal for the Semiotics of Law - Revue internatio-nale de Sémiotique juridique.

[2] Tartu Moscow School of Semiotics – Yu. Lotman; school of the Ruhr-University Bochum - M. Fleischer, V. Koch, U. Figge; French school of Semiotics and Structuralism – J. Derrida, R. Barthes, C. Levi-Strauss; Moscow Semiotic School - I.I. Revzin, A.A. Zaliznyak, V.N. Toporov; Polish Semiotic school – E. Farino, E. Pelts, A. Boguslavsky; semiotic studies of U. Eco.

[3] International Association for Semiotic Studies, International Association for the Semiotics of Law, International Society for Biosemiotic Studies, the Semiotic Society of America.

Figure 1. W. Nöth's understanding of picture-text relations



Some, though scarce, research has been conducted on media texts as far as verbal-visual juxtaposition is concerned. For climate change news there is "a profound disjuncture between images and text" (Dahl, Fløttum, 2017). While analyzing the interplay of verbal and visual components in German news of refugees and asylum seekers, V. Dan, M. Grabe and B. Hale (2020) differentiate the following degrees of interaction: redundancy (full support), congruence (partial support) and mismatch (incompatible meanings are conveyed by verbal and visual modalities) (Dan et al., 2020).

Still, popular science discourse lies beyond the scope of modern research literature on language-image relations though it possesses substantial research material offering great perspectives of semiotic studies.

3. Materials and Methods

3.1. Materials

In multimedia environment where visual codes dominate while suppressing verbal codes, the analysis of cross-semiotic processes in various semiotic systems is of particular interest.

This research paper presents the results of semiotic analysis of the correlation between the three elements of a journal article – a heading, a sub-heading and a photograph which form a heading-sub-heading-photograph triad representing several sign systems. On the one hand, the triad includes verbal and visual elements which may enter into relations of harmony or dissonance (Dahl, Fløttum, 2017) and within certain contexts may be structured in such a way as to channelize the attention of the reader in accordance with the communicative tasks of the author. On the other hand, verbal elements belong to various semiotic systems – language system and mass media system as well as are characterized by certain genre specificity –mass media and scientific genres, which combined together, communicate a kind of consolidated meaning, at the same time the meaning is defined by every semiotic system within which it exists.

The articles for research are taken from the latest issues of online popular science journals Popular Science and Science News. The articles are united by a common theme – they are all thematically focused on such topics as Space, Technology and Science as the most rapidly developing areas in the world science in general and Russia in particular. Since scientific and technological progress plays an important role in today's world technological development, we find it important to study the ways of transferring the scientific knowledge to the general public, communicating it from professional to laymen community. Total number of articles is 30 with 10 per each subtopic – Space, Technology, Science. The articles have been published within the last 18 months and are devoted to the latest technological advances witnessed by the world science in the three thematic subtopics.

3.2. Methods

To solve the goals set it is necessary to draw a wide range of research methods which are implemented in the study synchronously and interdependently. We find such complex usage of methods both productive and efficient.

3.2.1. Semiotic method

Sign systems are an indispensable part of every possible sphere of communication. Semiotics serves as the most functional way of their study proposing the semiotic method of research. The approach appeared within structural studies and was aimed at structuring and categorizing the reality. Semiotic analysis gives an opportunity to characterize the structure of the text, perceive its meaning as well as highlight the elements which the author uses to achieve mutual understanding with the reader. It becomes possible only if the author views the text in its semantic, syntactic and pragmatic integrity.

At the same time, semiotic method is characterized by its original approach to the analysis of the research object – it allows defining and explaining the symbolic sign specifics of the research object, decoding the notional structures of the texts under study.

Thus, viewing the research object as an example of multi-semiotic texts, we find it appropriate to use semiotic approach to the study of the triad from the point of view of various semiotic systems. Semiotic analysis will allow us to resolve into components the meaning that represents the scientific knowledge, as well as the means of representing it. It will also enable us to differentiate the results by certain criteria: to define major sign paradigms, to identify the pragmatic intentions of the author, to highlight the dominating semiotic system within a certain triad, to define the correlation of verbal and visual sign systems, the character of their interrelation (complementarity, neutrality, controversy) in the process of generating the meaning.

3.3. Procedure

The procedure for this research includes a number of steps listed below in the order of their performance:

1. Selecting sources of the corpus materials and conducting content analysis (based on such criteria as the topic of the article, the availability of all the three elements included in the triad)
2. Identifying linguistic features of the corpus texts
3. Analyzing the texts to identify the pragmatic intentions of the author, to define the dominating semiotic system while comparing and contrasting headings and photographs
4. Conducting semiotic analysis of the texts within the triads to define the correlation of verbal and visual semiotic systems, the character of their interrelation.

Semiotic analysis includes a three-stage procedure; every stage is devoted to the analysis of correlation between certain components of the triad. First, we contrast the two elements belonging to the same semiotic system – the heading and the sub-heading. Then we confront the heading and the photograph. Finally, we contrast all the three elements, and compare the results with the results of the previous stages.

4. Results and discussion

4.1. Linguistic analysis of headings and sub-headings

Before turning to the discussion of the linguistic features of heading and subheading in micro-contexts, it is essential first to look at a wider context of scientific communication from the point of view of semiotic studies.

Scientific communication is characterized by a number of specific features (Degaetano-Ortlieb, Teich, 2019; Doran, 2017; Schäfer, Fähnrich, 2019):

- Intentionality – every scientific idea is grounded and prudent. In contrast to other genres, scientific communication thus strives for rationality of utterances rather than emotionality, and semiotic processes are structured in accordance with this purpose.

- Close connection between a sign and its meaning. This principle has changed over time, though still remains the ideal of scientificity – there exists a certain set of conventional practices and norms which determine the scientific procedure, linguistic representation of scientific facts, description and explanation of the reality.

- Accuracy of utterances – dominance of scientific terminological vocabulary. Exactness and unambiguity are imperative for scientific communication; they are achieved on rational-verbal level.

- Multi-semiotic nature and multimodality of scientific communication – the sign system of science is represented by all types of signs – icons, indices, symbols. Iconic signs include documented records such as photographs as well as fact designations in the form of graphs, diagrams, etc. Indexical signs are represented by a number of indicators typical of science such as barometric pressure – such signs do not show something, they point at a certain fact which is generally understood within a certain area of science. The examples of symbolic signs include national flags, Morse code, traffic lights.

- The most accurate relation between a sign and its denotation. It means that semiotic system of science is the least metaphoric and indirect – semantic accuracy, clarity, unambiguity are definitely typical of it as one of the goals of science is the formation of exact meanings of key scientific notions and ideas.

- Structuring and consistency of scientific description – syntactically complex structures and sentences, passive, impersonal sentences, cause-and-effect links are typical of science communication to achieve objectiveness and generality.

- Rational cognition as a pragmatic feature of communication. Scientific communication is aimed at discussing theories and empirical suppositions, exchange of ideas among representatives of professional scientific community, popularizing scientific knowledge through decoding the scientific knowledge by means of ordinary language.

While thematically belonging to a type of scientific communication, journal articles' headings are of multimodal character as they also possess features of media discourse. They serve as the signs which direct and channelize the attention of the reader to the most relevant pieces of information, influencing his choice of the information, communicating both scientific ideas and the position of the authors of the articles. Headings realize two main functions – nominative and attractive, and arouse the reader's interest to the article itself thus making him familiarized with the scientific knowledge.

From the point of view of semiotics, the heading is a complex speech sign which is formed with the signs of primary denotation – words and word combinations which realize their meanings in an utterance syntactically shaped according to a certain model while each of them is aimed at realizing both an informative and manipulating function which is typical of media headings. At the same time, headings reflect the tendency of achieving the standard of the language, its expressivity and compression.

The semantics of headings is revealed by lexical units which realize their denotative and connotative meanings, and are often used to introduce citations to reflect the authors' attitudes.

Both lexical and syntactic features help achieve the pragmatic potential of headings, for they serve as the means of communicating the intentions of the authors – to popularize the scientific knowledge by encouraging the reader to interpret the meaning in a certain way.

Sub-heading in this regard adds up to the meaning introducing some detailed information on the topic, verifying the meaning expressed in the heading.

The examples presented below demonstrate the first stage of semiotic analysis aimed at defining the type of relation among the triad components – neutrality, complementarity, contradiction. First, we contrast the two elements belonging to the same semiotic system.

The following examples clearly demonstrate ***complementarity*** of the two elements:

(1) Heading: *Coronavirus and technical issues delay a Mars mission's launch*

Sub-heading: *The joint European-Russian mission to launch the ExpMars rover was postponed to 2022* (Science News, March 12, 2020)

(2) Heading: *SpaceX and Boeing are one big step closer to launching astronauts*

Sub-heading: *Both companies are neck and neck as NASA's last ride to the space station races closer* (Popular Science, November 5, 2019).

(3) Heading: *Fundamental constants place a new speed limit on sound*

Sub-heading: *Under normal conditions, sound waves can't go faster than 36 kilometers per second* (Science News, October 9, 2020).

In all three examples the main information is presented in the headings and informs the readers about the subject of the articles, though only in the most general way. For instance, from the heading in example (1) it can be inferred that some circumstances hinder the launch of exploration mission though it is still unclear who is supposed to fulfill the mission, and what a new date of launch can be. It is made clear only with the help of the sub-heading.

The heading in example (2) again gives only general information of the subject of the article, with no signs of the connotative meanings expressed in the sub-heading. While reading the heading we may understand that two companies cooperatively work on the prospects of launching astronauts. Only seeing the sub-heading we realize that the two companies are in competitive but not cooperative efforts *(neck and neck, races closer)*.

Example 3 follows the same model of adding up the meaning though expresses the certainty of improbability of the situation described in the heading. On the one hand, there exists an urgent necessity to increase the speed limit of sound waves, but on the other hand, it is physically impossible.

The following examples show ***neutral*** relations between the headings and sub-headings:

(4) Heading: *What will astronauts need to survive the dangerous journey to Mars?*

Sub-heading: *When space is tight, what should go into the medical bag?* (Science News, July 15, 2020).

(5) Heading: *Bubble-blowing drones may one day aid artificial pollination*

Sub-heading: *Flying machines could step in when bees and other insects are scarce, researchers say* (Science News, June 22, 2020).

In both examples the meaning is clear from the headings, and the information presented in the sub-headings expands on the meaning of the headings, though no connotative meanings are added to the meanings contained in the headings. In example (4) lexical units *survive*, *dangerous* are supported by the adjective *tight*, and the fact that it says about medical condition of the astronauts is both expressed by the lexical units survive and medical bag.

In example (5) *bubble-blowing drones* are correlated to *flying machines*, while the

verb *aid* clearly expresses the idea of *scarcity of bees and other insects*.

There are cases when the heading and sub-heading may express controversial meanings, which is the manifestation of ***controversy*** of two elements within the same semiotic system:

(6) Heading: *A new artificial eye mimics and may outperform human eyes*

Sub-heading: *The high-tech device boasts a field of view and reaction time similar to that of real eyes* (Science News, May 20, 2020).

(7) Heading: *Hyundai's walking concept car promises to go where other vehicles can't*

Sub-heading: *The Tiger vehicle is only a concept, but Hyundai has faith in the concept of cars with legs* (Popular Science, February 15, 2021).

In these two examples the meanings presented in the headings are quite clear and unambiguous – (6) an artificial eye shows stronger characteristics than a natural eye (*outperform*), but the idea expressed in the sub-heading does not coincide with the expectations of the readers (the artificial eye is *similar* to the human eye); (7) the heading conveys the meaning that Hyundai company is confident about the unique abilities of the future car (*promises, other vehicles can't*) while the sub-heading does not communicate this exact meaning – it is not a *promise* but a *concept*, and the idea of a vehicle with *legs* sounds quite unusual – is it really a car?

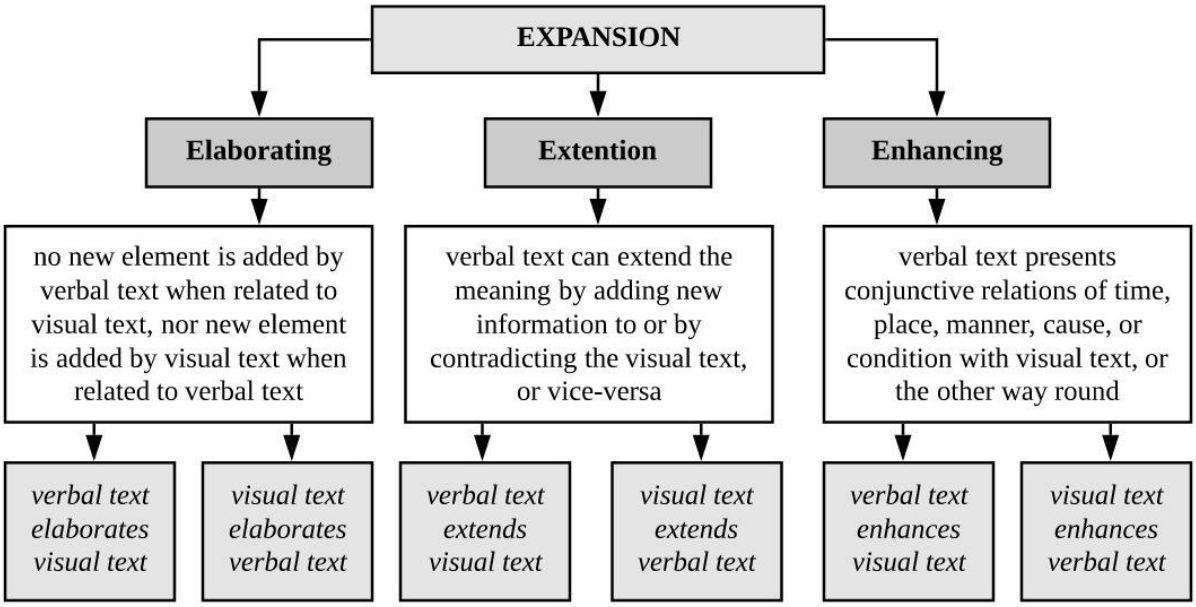
4.2. Defining the dominating semiotic system in the triad "heading–sub-heading–photograph"

The development and increased complication of communication resulted in the appearance of new ways of information coding. The new ways are primarily characterized by the significance of non-verbal elements, namely a visual component. As U. Eco noted, visual phenomena are "messages that include culturally manifested meanings, which we try to express by words" (Solík, 2014: 208). They are contextual and the meaning they convey may be inferred depending on certain circumstances. In our view, these circumstances include the type of relations between verbal and visual signs within a certain context – which semiotic system dominates and which is more relevant in establishing the meaning that is further interpreted by the reader.

As it was mentioned before, the first study of correlation of verbal and non-verbal signs is presented in the essays of R. Barthes: non-verbal signs introduce additional information, specify the content, help restore the previous experience of the reader and establish the grounding for the message while verbal signs give the reader guidance in finding certain signs among the whole multiplicity of iconic signs (Barthes, 1972). This idea has changed with the convergence of visual and other semiotics systems. Non-verbal component in modern research is no longer subordinate in relation to verbal signs, it is viewed as an independent component as it can convey connotations of verbal components; it has its own abstract and specific meaning, content and image, and possesses high associative potential.

Due to this fact, several models of verbal-visual relations (see Figure 2) have been proposed by A.S. Pagano, F.F.de Paula and K. Ferreguetti (Pagano et al., 2018) differentiated by the idea that "an image expands the ideational meaning of a clause, or a clause expands the ideational meaning of an image":

Figure 2. Model of verbal-visual relations



For the purposes of this research, and due to the specific architectonics of a popular science journal article, we disregard the position of the verbal component in relation to the visual component though they are culturally and intellectually marked as well. As Q. Qui (2019) in relation to the position of visual elements in Chinese children's picture books notes, that "the placement of elements within a visual composition evidently represents some kinds of specific information value. In this sense, different zones within a visual composition are endowed with various information values. The variables such as top / down, centre / margin and left / right placements may reflect some differences in meaning potential" (Qui, 2019: 44).

Depending on whether the verbal or visual text elaborates / extends / enhances the text of other semiotic system, we may assume the domination of one semiotic system over the other.

Based on the types of verbal-visual relations presented above, we propose another approach to determine the domination of one semiotic system over the other:

1) verbal text + visual text: verbal text is supported by visual text – verbal system dominates;

2) visual text + verbal text: visual text is enhanced by verbal text – visual system dominates;

3) verbal text = visual text: both texts match each other in conveying the meaning – the two systems are equally important in the process of semiosis.

Different models have been identified while conducting the second step of semiotic analysis – confronting the elements of different semiotic systems:

Model 1: verbal system dominance

Heading: *Bubble-blowing drones may one day aid artificial pollination*

Photograph:

In this example the main idea is clearly expressed by a verbal text which is written according to the linguistic specifics of media headlines – a compressed sentence using no articles or prepositions, rich in terminological units. A visual text in this case only supports the idea represented verbally helping to create the necessary context – stipulating the necessity of using man-made devices to aid plants in their natural processes, which represents the ***neutrality*** of relations between the heading and the picture.

Model 2: visual system dominance

Heading: *Coronavirus and technical issues delay a Mars mission's launch*

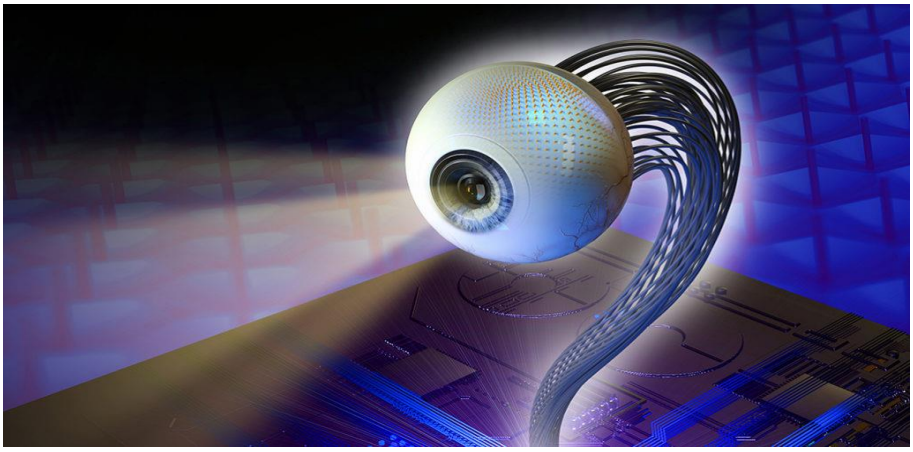
Photograph:

This example demonstrates a different tendency – dominance of visual system. It is our understanding that the main meaning is included in the image – though the mission's launch is delayed due to some circumstances, we understand it as an already fulfilled action mission – a special vehicle is depicted exploring the surface of the red planet. This idea draws the attention of the reader and persuades him of the plausibility of this mission, though having not even been exactly scheduled yet. The example demonstrates ***controversy*** between verbal and visual signs.

Model 3: semiosis is equally dependent on both semiotic systems

Heading: *A new artificial eye mimics and may outperform human eyes*

Photograph:



The third model is a combination of mutually complimentary parts which combined together shape the meaning intended by the author. With the help of a vivid picture it becomes possible for the reader to imagine the power that stands behind the artificial eye – a set of wires symbolizes the might of this device which at the same time is verbally supported by the verb *outperform*. This example demonstrates *complementarity* of verbal and visual signs.

4.3. Semiotic analysis of the triad "heading–sub-heading–photograph"

Having compared and contrasted the pairs of heading–sub-heading and heading–photograph, it became evident that verbal and visual components are relevant to the process of semiosis in a different way. It seems quite reasonable to add sub-heading as an additional element to the semiotic analysis of verbal-visual relations. We propose to conduct the final step of semiotic analysis using the same examples as it will enable us to spot the differences occurring in the process of generating and conveying the scientific meaning.

Triad 1

Heading: *Bubble-blowing drones may one day aid artificial pollination*

Sub-heading *Flying machines could step in when bees and other insects are scarce, researchers say*

Photograph:

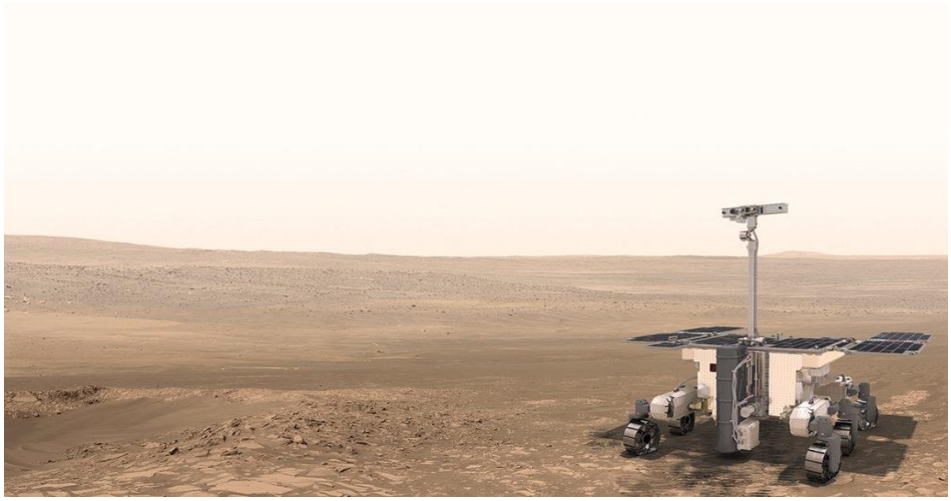
In our opinion, adding an "intermediary" element in the first example does not distort the meaning originally expressed by the verbal text. At the same time, supporting the verbal text with the photograph helps the reader visualize his understanding of the *flying machine*, though the readers' images may vary. The verbal and visual texts are in the relation of ***neutrality*** as the visual text does not change the meaning created by the verbal text.

Triad 2

Heading: *Coronavirus and technical issues delay a Mars mission's launch*

Sub-heading *The joint European-Russian mission to launch the ExpMars rover was postponed to 2022*

Photograph:



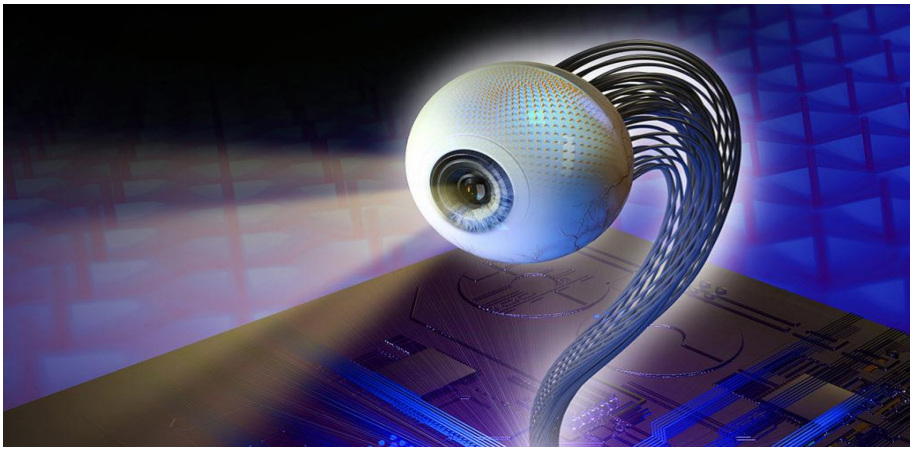
In this example the addition of subheading strengthens the effect of the heading specifying both the date of the proposed launch and the type of the vehicle to fulfill the mission. We believe that these details add to the plausibility of the mission and balance the significance of both verbal and visual texts in shaping the meaning. Thus the given example complies with the third model which recognizes equal importance of verbal and visual texts in the process of semiosis. We consider this example as the manifestation of ***complementarity*** of verbal and visual texts as only with the help of each other they can create the meaning originally intended by the author.

Triad 3

Heading: *A new artificial eye mimics and may outperform human eyes*

Sub-heading *The high-tech device boasts a field of view and reaction time similar to that of real eyes*

Photograph:



The example proves a different tendency compared to the two previous examples. The impression created by the combination of the verbal and visual texts is distorted by the inclusion of the third element – the sub-heading. Originally perceived as a powerful prosthetic device – an artificial eye that was supposed to *outperform* the human eye, it is now understood as less powerful as it is *similar* to the human eye, not *outperforming* it. Verbal text becomes more important than visual text, and it defines the expectations of the reader. This example shows us the relations of ***controversy*** as the two types of texts – the verbal and the visual contradict each other in the process of semiosis.

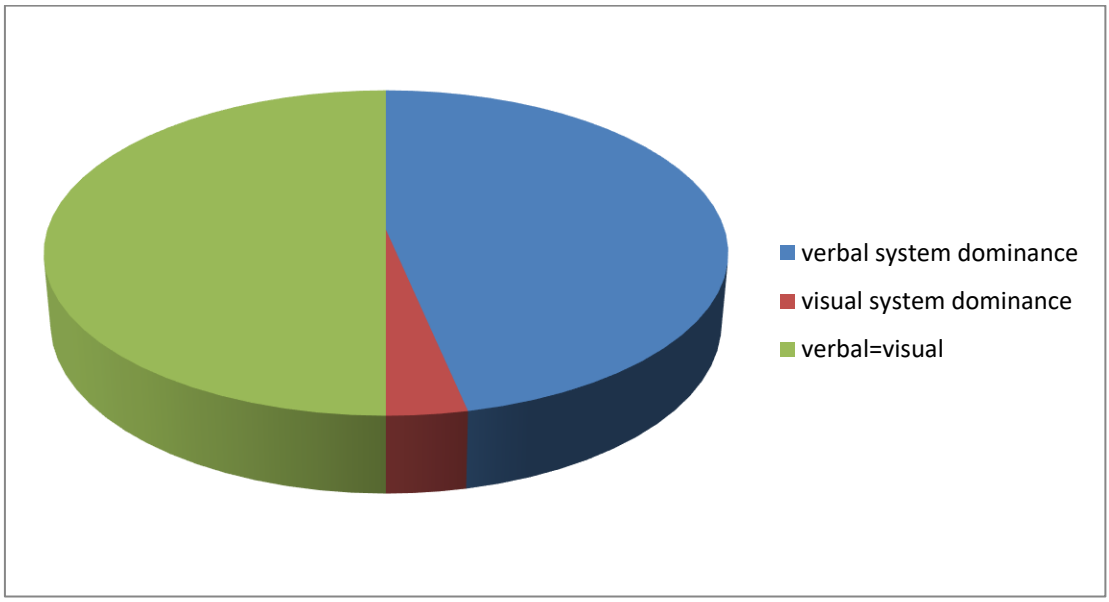
The semiotic analysis of all 30 examples conducted in three stages gave the results which are presented (see Figure 3) and commented below. First, while contrasting the two elements belonging to different semiotic systems, we noted that:

1) verbal system dominance is revealed in 14 examples out of 30;

2) visual system dominance is present in only one example;

3) 15 examples out of 30 show the relation of complementarity between verbal and visual signs, which proves the fact that they are equally important in the process of semiosis.

Figure 3. Results of the semiotic analysis

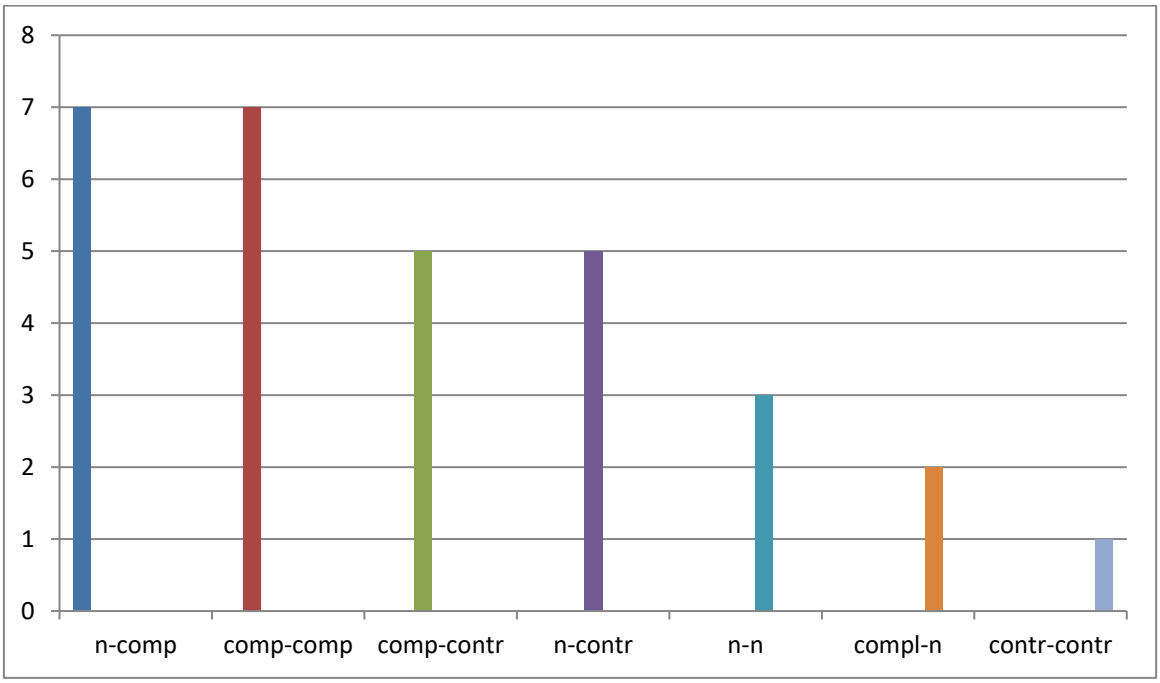


While conducting the third stage of the semiotic analysis, i.e. contrasting the three elements of the triad, we found out that patterns of relations among the elements of the triad may shift compared to the patterns or relations that exist between the two elements of different semiotic systems. The shift changes the results that we obtained in the previous stage of the analysis. These results show a more diverse picture of the relations among the three elements (see Table 1)

Table 1. The shift in the patterns of relations among the elements of the triad

No.	Range of frequency	Shift model	Total number
1.	Most common	(a) neutrality → complementarity	**7**
		(b) complementarity → complementarity	**7**
2.	Relatively common	(c) complementarity → controversy	**5**
		(d) neutrality → controversy	**5**
3.	Less common	(e) neutrality →neutrality	**3**
		(f) complementarity → neutrality	**2**
		(g) controversy → controversy	**1**
4.	Not typical	(h) controversy → neutrality	**0**
		(i) controversy → complementarity	**0**

Figure 4. Types of relations among the elements of the triad



Despite the shift of relations between the two elements of different semiotic systems which occurs when the third element is added, we still observe that there are two major models of relations between the verbal and the visual elements that are equally common and may be considered as typical of popular science discourse – the model of verbal system dominance and the model of equal importance of verbal and visual systems. On the one hand, the results demonstrate the prevalence of the verbal system in generating the scientific knowledge (Bobek, Tversky, 2016). On the other hand, the results support the novel tendency as far as the visual system is concerned (Meyer et al., 2018) – the visual element is no longer recognized as the subordinate element, rather it acts as an independent component possessing its own meaning and high associative potential, which is capable of shifting the emphasis in the process of semiosis.

5. Conclusion

The goal of this study was to define the dominating semiotic system in the process of semiosis in popular science discourse. The conducted analysis enabled us to determine major patterns of verbal-visual interplay while shaping the meanings which transfer scientific knowledge in the type of discourse under study. The data show that within a verbal system two-element models – heading + sub-heading are characterized by three types of relations – complementarity, neutrality, controversy. Another two-element combination where elements belong to different semiotic systems, verbal and visual – heading + photograph – the type of relations allows us to define the dominant semiotic system. According to the obtained results, it becomes evident that when all the three elements of the triad are combined – heading + sub-heading + photograph, the type of relations changes, and may shift from complementarity to neutrality, or even from complementarity to contradiction. Thus the inclusion of the third element – the sub-heading – may become significant in the process of semiosis and the subsequent translation of scientific knowledge to the general public.

Our findings are both of theoretical and practical value. They contribute to

constructing a whole professional language picture among specialists, as well as getting non-specialists acquainted with professional language picture. From the practical point of view, the results are applicable as guidelines in the academic courses of texts composition and writing popular science articles, and as a teaching tool in text analysis disciplines.

We believe that further analysis of the relations among the elements of the triad may determine recurrent patterns of possible shifts in the type of relations, which will inevitably be important in tracing the most effective models of knowledge transfer in popular science discourse.

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