ЯЗЫК, КУЛЬТУРА, ОБЩЕСТВО

SEMANTIC FRAMING OF COMPUTER VIRUSES: THE STUDY OF SEMANTIC ROLES' DISTRIBUTION [1]

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The article deals with the problem of semantic roles' distribution in the frame VIRUS designated by the term *virus* in the computer virology discourse. The study is conducted in the framework of the cognitive discursive paradigm of modern linguistics and comprises the following linguistic approaches to the studies of language for special purposes: cognitive terminology, frame-based terminology, and frame semantics. The article gives a brief overview of the development of computer virology with reference to mental framing of the key aspects in the field. A frame is considered as part of context and a situation model representing a real-life event. Ch. Fillmore's frame semantics and the identification of deep cases or semantic roles are used as the main method of data analyses. We have analyzed the most typical plans of semantic roles' distribution in the frame VIRUS. The semantic roles of the frame VIRUS include Agent, Counteragent, Object, Addressee, Patient, Result, and Instrument. It has been found that besides the most distinctive distribution of semantic roles in the frame VIRUS, showing that the malicious program is conceptualized as the aggressor and a computer or its user as a victim, which correspond to the roles of the Agent and the Patient, there might be the frames with a virus in the role of the Counteragent, the Object, the Result, the Instrument, the Patient, and even the Place. We come to the conclusion that analysis of the roles' distribution helps to determine relations among the event participants and the way the situation is conceptualized and represented in the form of mental models in human minds.

In the *Discussion* section we illustrate the occurrence of typical semantic frames in popular culture, namely in films and television programs. With these we prove the relevance of the approaches and methods chosen to reveal the peculiarities of conceptualization in special areas and connection synergies between language, thought, and communication.

Key words: semantic frame; computer virology; frame-based terminology; cognitive terminology; semantic roles; deep cases; cognitive discursive linguistics.

1. Introduction

Informatization of modern society has become global in its scale: information computer technologies have become an important component of the economy, industry, education, etc. and an integral part of the daily life of the modern man. Without a computer and the Internet, it becomes difficult to carry out workflow, financial transactions, and professional communication. Electronic databases contain personal data, and social networks become storehouses of their users' personal information and a preferable environment for business and everyday communication. These achievements of modern information are at risk with the development of malicious software, in particular computer viruses, which can become an effective tool in the hands of malefactors.

The history of computer virology began in the forties of the twentieth century with the development of J. von Neumann's theory of self-reproducing automata, abstract systems in which functions similar to those of biological systems, namely growth, self-reproduction, interaction and death, were simulated by mathematics. Later, in 1985, such "self-replicating" computer programs were called "computer viruses", described by F. Cohen, a programmer at the University of Southern California, in his thesis "Computer Viruses" [Cohen 1985]. With the development of information computer technologies, viruses of various types, such as direct viruses, rewriting viruses, companion viruses, parasitic viruses, resident viruses, boot sector viruses, mutant viruses, etc. have been created, companies and laboratories, such as Kaspersky Lab, Doctor Web, Avast, Avira, Panda Security, ESET and others, developing antiviral protection and combatting tools, have been organized, education programs of higher education related to information and computer security have been introduced. With the proliferation of smartphones, new viruses emerge that pose a threat to users, such as the loss of personal information and money through mobile applications.

In this regard, the problem of computer security is becoming relevant for a wide range of professionals and users. For linguistics computer virology is also of interest as an object of research with the focus is on its terminology [Bogatikova, Isaeva 2014], metaphor in the language for special purposes [Isaeva 2014], [Mishlanova, Mishlanov 2012], the automation of the development of the computer vi-

rology dictionary [Suvorova, Bakhtin, Isaeva 2016] and others.

In this article, we turn to the problem of frame modeling of computer virology terminology. We believe that this approach to the study of terms will allow us to examine the content of terms in a more precise way and may serve as a basis for developing rules to influence the perception of information by intentionally simulating a term frame in a specific communicative situation.

To do this, we will consider the theoretical foundations of cognitive-discursive linguistics, cognitive terminology, and frame modeling, describe the semantic frames of the term virus in the discourse of computer virology, and outline the patterns of constructing the semantic frame VIRUS.

2. Theoretical background

To determine the basic principles of cognitive-discursive linguistics and cognitive terminology, let us consider what unites them with cognitive sciences in general. According to V. F. Novodranova, cognitive sciences are engaged in cognition, which is predetermined by the process of interaction of a person with the environment. Cognition includes the person's mind, behavior, the language used for objectifying all the processes occurring in the person's mind, namely perception, memory, experience, all kinds of information, etc. [Novodranova 2015: 54]. The study of these processes is conducted indirectly, as E. S. Kubryakova states, on the ground of inferences based on external manifestations, such as behavior and language [Kubryakova 2009: 15]. Therefore, the study of human mental processes, the peculiarities of cognition and perception are fruitfully carried out by cognitive linguists on the material of texts, as objectifiable results of human thinking and the static objects arising in time, text processes of creation and understanding unfold [Kibrik 2003].

Taking into account the fact that a significant part of the cognitive activity of an adult occurs in the framework of his or her professional activity, i. e. special training and professional communication, it is relevant to differentiate the areas of professional activity and to study the general and the particular in languages for special purposes as well as the features of their functioning in various discourses, which refer to types of verbally mediated professional activity carried out in specific situations within cultural contexts [Alekseeva, Mishlanova 2002: 3]. Such

interdisciplinarity, the connection of language with the subject area that it serves, human thinking and consciousness are provided by cognitive-discursive linguistics [Novodranova 2015: 54].

In the framework of the cognitive-discursive paradigm, cognitive terminology takes a special place. There the pragmatic side of the term functioning in discourse is given an integral role.

This idea is preserved in the Frame-based approach to terminology. Its disciples deny viability of the attempt to "find a distinction between terms and words" and underline that "the best way to study specialized knowledge units is by studying their behavior in texts" [LexiCon]. In the framework of this theory terms refer to "compound nominal forms that are used within a scientific or technical field and have meanings specific of this field as well as a syntactic valence or combinatory value" [LexiCon]. Taking this into account it is reasonable to claim that "even <…> most abstract concepts are understood in terms of concrete scenarios" [Pinker 2007]. The importance of taking the scenario or the context into consideration in linguistic studies is pointed out by B. Gasparov, who emphasizes that the context contains some part of a continuously moving flow of human experience. Context absorbs and reflects a unique set of circumstances under which and for which it was created. These circumstances include the author's communicative intentions, the relationship of the author and the addressee, all possible circumstances, significant and incidental, ideological features and stylistic climate of the era in general. The context comprises the environment and specific individuals to whom the message is directly or indirectly addressed, genre and style features of both the message itself and the communicative situation in which it is included, as well as multiple associations with previous experience associated with the event [Gasparov 1996: 10].

Thus, a term being part of a certain context is embedded into the frame of a particular communicative event which is stored in the mind of a person in the form of a context or situation model. According to T. Van Dijk a context model is a generalized mental representation of an event with a set of invariant features and dynamic elements [Van Dijk 2008]. Relying on the contextual model, a participant of the event perceives it through the frame of this mental model and adjusts his or her knowledge and actions to the specific conditions. It is necessary to take into account that the speakers, as a rule, use only a part of their mental models. Context models also control semantic representations by controlling the selection of relevant information of event models [Van Dijk 2012].

From this point of view the interpretation of the term does not mean the disclosing of the entire semantic content of the linguistic sign but implies the expounding of those semes that are activated in the minds of the communicants.

So, with the help of the tools of cognitive-discursive linguistics, cognitive and frame-based terminology, such as frame, taxonomic and metaphorical modeling [Isaeva thesis], generalized cognitive models of the term virus have been created, which come to the fore in two types of communication, in particular between experts and between an expert and a naive knowledge carrier.

In this article, we will go into the problem of developing an event script and distributing the semantic roles within the frame of the term virus.

3. Fillmore frame semantics

In cognitive terminology, it is commonly believed that the term is a frame concept. It marks the hierarchical structure of the term field and nominates special cognitive structures that require appropriate behavior imposed by specific knowledge [Ryabko 2016: 97]. To study the framing of the term virus, let us apply the theory of Frame semantics by Ch. Fillmore. This is a method of investigating the interaction between the language semantic space, i. e. linguistic meanings and the structures of knowledge and thinking space [Boldyrev 2000: 37]. The method allows to determine the principles of structuring and reflecting a certain part of human experience and knowledge in the meaning of linguistic units, to study the ways of activating the common knowledge that provides understanding in the process of verbal communication. The feature of this approach is the lack of a clearly delineated boundary between linguistic meaning and human experience [Boldyrev 2000: 37]. Within the framework of this theory, the frame is determined as a cognitive structure whose knowledge is associated with the concept represented by the word [Fillmore, Atkins 1992: 75]. Since the frame depends on the background knowledge, collective and personal experience of an individual, it is reasonable to include the elements of the contextual and situational models [Van Dijk 2008] into the structure of the term frame. The frames are characterized by a certain composition of participants, spatial and temporal coordinates, conditions, and cause-and-effect relationships [Kibardina 1988: 86]. Thus, a term frame is represented in the form of an event scenario in the context of which the term is used. Therefore, each context is unique. To achieve a certain degree of abstraction, we describe the event scenarios with the help of the deep cases, or semantic roles of Ch. Fillmore. These stand for the semantic functions that determine the roles of the event participants, such as the initiator, the object, the result, the place and the direction of the action. Ch. Fillmore differentiates the following roles: Agent,

Instrument, Stimulus, Patient, Theme, Experiencer, Content, Beneficiary, Source, Goal, Path [Fillmore 2003: 464].

4. Data analysis

In our work we use the classification of semantic roles, represented by Yu. D. Apresyan, in particular Agent (an animated action initiator), Object (the thing that is the object of the action), the Counter-agent (the force against which the action is directed), Addressee (the person for whom the action is performed), the Patient (the thing that experiences the effectiveness of the action), Result (the thing that arises as a result of the action), Instrument (the physical cause of the action / stimulus), and Source (the initial state of the object before the action) [Apresyan 1995: 3–69].

The semantic analysis of the frames of the term *virus* has shown that the distribution of semantic roles in a frame varies in different contexts. So, the participant *virus* can act as an Agent, for example:

*(1) File **viruses** still afflict the unwary, though less often than they did a few years ago* [Miastkow-ski 1999: 123].

In example (1), the verb *afflict* determines the roles of two participants, namely *virus* (Agent) and *the unwary* (Patient). A similar situation occurs in example (2) in which *virus* acts as the Agent, and *program* as the Patient, connected with the help of the verb *infect*:

(2) File virus infects program (.exe and .com) files [ibid.];

and in example (3), where virus is the Agent, and macros is the Object, joined in a single frame with the verb latch onto:

(3) Viruses like Melissa latch onto macros, small programs hidden in word processing software [Christensen 1999: 76].

The frame of the term *virus* in the role of the Agent, can include a participant in the role of the Tool, for example when specifying the method of distribution of the viral program:

(4) Many viruses have spread through pirated, illegally copied or broken games [Minasi 1991: 44]

and in the role of the Place, when specifying the propagation medium of the malicious program:

(5) …different viruses floating around the computer world… [ibid.].

Such a distribution of the semantic roles can be connected with the seme of activity, originally inherent in the lexeme virus [Bogatikova, Isaeva, Burdina, Mishlanova 2014: 201] and typical of the computer virology discourse personification of a malicious program that can independently execute certain malicious actions, move around in the virtual

space, manipulate software objects, and have a significant impact on them.

There may be another distribution of roles in the frame, in which the virus will occupy the position of the Object, i. e. the participant involved in the action, but neither producing it nor experiencing any changes as a result of this action, for example:

(6) Some virus experts say we'll see thousands of different viruses floating around the computer world in the next few years [Minasi 1991: 44].

(7) You've heard about computer viruses – those mysterious, malevolent programs that enter your computer in the dead of night and zap all of your data [ibid.].

In examples (6) and (7), the participants *we* and *you* act as the Agent or Experiencer (the one who observes or experiences some action) if we consider a more precise and partitive Roles' definition, while *viruses* play the role of the Object (in both examples). Here *viruses* are represented as the objects of perception expressed by the verbs *will see* and *have heard*. This exposes the seme of materiality, tangibility. Interestingly, that in the second part of both sentences a typical frame is constructed in which the malicious software acts as the Agent.

In situations in which antivirus software is involved, the typical distribution of roles in a frame is as follows: an antivirus program is the Agent, a virus is the Counteragent, for example:

(8) Four-stage program <…> prevents all known and future viruses, quarantines viruses coming from external sources [ibid.: 54].

(9) Stand-alone program <…> inoculates against specific viruses [ibid.].

The fact that computer virus programs are written and subsequently used in someone's interests is reflected in the formation of frames in which the participant *virus* has the roles of the Result (Example 10) and the Tool (Example 11):

(10) If a whole new class of virus is invented, you may need a product upgrade to deal with it [Komando 1998: 72].

(11) The current political climate globally could easily lead to cyber-terrorism where computer viruses are used as offensive weapons [Home security].

In example (10), it is indicated that as a result of the action expressed by the verb *invented*, the *whole new class of virus* appears, and in example (11) it is noted that the physical reason used by the attackers as *offensive weapons* to perform some action, is *computer viruses*.

Let us consider example (12), in which *virus* plays the role of the Patient:

(12) Prerelease version had trouble repairing a particular boot virus [Miastkowski 1999: 123].

The thing indicated by the phrase *particular boot virus* is the Object of some action expressed with the word *repairing*, as a result of which this thing undergoes some change. This is expressed with the semantic role of the Patient.

In the computer virology discourse, you can find sentences in which the participant *virus* corresponds to the role of Place, for example:

(13) *The name GRAMMERSoft reportedly appears in the computer code in the Love Bug virus* [Beveridge 2000].

In this case, the role of the participant *virus* is due to the verb *appears* and the preposition *in*.

5. Results

The analysis of semantic roles of the term *virus* in contexts showed that the term virus has an elaborated and comprehended semantics, which results in the formation the frame made up of a virus in the role of an Agent, whereas computer software and computer users are victims which correspond to the semantic role of Patient. This frame conveys the idea of virus's activeness, which is preserved in the semantics of the word virus from its Latin progenitor. This semantic feature is maintained in the frame made of antiviral software in the role of Agent and a virus as the Counteragent. This means that even being an object of some manipulation, a virus stays active, for the role of Counteragent (the force against which the action is directed) comprises the semes of activeness (the force), negative connotation (against) confrontation (is directed).

Even if a virus takes the part of an Object it is still active for the participant who acts as an Agent or more specifically an Experiencer (as we or you in Examples 6 and 7) are not active but passively percept or experience the malware, which develop regardless of the Agent or Experiencer's wish. This is sustained in the second clauses of these two examples where the virus becomes the Agent of the frame.

Another rout of semantic elaboration of the term *virus* is discernible in the frames, which contain a virus in the roles of Result and Tool. This shows that this malware is an artificial object produced by a man (the developer) for some particular reason, namely for being employed in some fraudulent activities like theft or manipulation.

It is worthwhile mentioning that despite the fact of being merely a digital and abstract notion, a virus is conceptualized as a material objectifiable matter which can be observed (see Examples 6 and 7), physically modified, namely *repaired* (see Example 12), or even penetrated (see Example 13).

6. Conclusion

The study has proved that terms (in this case the term *virus*) comprise extended semantics, which is being developed in the contexts of the term's usage, i. e. in real life events, in people's thought or communication, being continually modified and updated. Yet, the semantics of the term is regulated by the etymological content of the word, like in the *virus* case the original semes of activeness, substantivity, undesirability, and hideousness. Such kind of deductions are possible to be obtained only within the framework of cognitive discursive linguistics and frame-based terminology approach because the most extensive range of meanings unfold if particular events are taken into account. To avoid fragmentation of conclusions the results have been generalized with the help of frame semantics, which is aimed at standardized description of the context.

7. Discussion

Many of the semantic constructions of virus as it deals with computers have been employed in the popular culture in the form of films and television programs. In this paper they provide insightful scenarios for penetrating into the abstract concepts determined by the Semantic roles.

One of the clearest instances of the computer virus acting as an agent is American dramatic series *Revolution*, which aired for two seasons in 2013 and 2014. The series follows survivors of a cataclysmic event that saw all electricity failing. Most of humanity died in the aftermath, and the action of the series followed a group of survivors who eventually tried to restore the power. As the plot progressed, we learned that Rachel Matheson (Elizabeth Mitchell), one of the survivors, was directly responsible for the calamity when she and her husband released "nanites", which were essentially a virus that destroyed anything that used electricity. After being released by the Mathesons, the nanites became self-aware and attacked anyone who tried to restore the power.

Another series of films imagining computer viruses as an agent attempting to wipe out humanity was the *Terminator* series. In the series, Skynet, a computer system that becomes self-aware, and infects defense systems, causing a devastating nuclear war that kills a large percentage of the human race.

In both of these instances, the intelligent machines operated in the manner of a virus described in sections 1–5.

In Douglas Adams' more lighthearted five-volume story that began with *The Hitchhiker's Guide to the Galaxy*, which was originally written for radio in 1978, Adams imagined the earth as being a supercomputer set up by an advanced race to discover the secret to "life, the universe, and everything". The program went off track when a group of useless humanoids, including people who worked as telephone receiver cleaners. Those people had crashed on earth and acted as a virus that derailed the original programming.

This fits into the manner in which viruses are described in sections 6 and 7, when the virus acts as an object.

There are additional films and programs that would fit in with the other semantic uses of the term virus, but the above serve as examples of how computer viruses have entered the public consciousness. The popular culture thus acts as method of providing tangible evidence of the way in which viruses are described.

Authors' note

Acknowledgments

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МОДЕЛИРОВАНИЕ СЕМАНТИЧЕСКОГО ФРЕЙМА COMPUTER VIRUS: РАСПРЕДЕЛЕНИЕ СЕМАНТИЧЕСКИХ РОЛЕЙ

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Рассматривается проблема распределения семантических ролей во фрейме VIRUS, обозначаемом термином *virus*, в дискурсе компьютерной вирусологии. Исследование проводилось в рамках когнитивно-дискурсивной парадигмы современного языкознания и включило следующие лингвистические подходы к изучению языка для специальных целей: когнитивная терминология, фреймовая терминология, фреймовая семантика. В статье дается краткий обзор развития компьютерной вирусологии применительно к ментальному воспроизведению ключевых аспектов в данной области. Фрейм рассматривается как часть контекста и ситуационной модели, представляющих реальное событие. В качестве основного метода анализа данных используется фреймовая семантика Ч. Филлмора и выявление глубинных падежей или семантических ролей. Проанализированы наиболее типичные планы распределения семантических ролей в фрейме VIRUS. Семантические роли фрейма VIRUS включают в себя следующие: Агент, Контрагент, Объект, Адресат, Пациент, Результат и Инструмент. Было установлено, что кроме самого очевидного распределения семантических ролей в фрейме VIRUS, показывающего, что вредоносная программа чаще всего представляется как агрессор, а компьютер или его пользователь – как жертва, что соответствует ролям Агент и Пациент, встречаются фреймы, в которых вирус выступает в роли Контрагента, Объекта, Результата, Инструмента, Пациента и даже Места. Мы приходим к выводу, что анализ распределения семантических ролей помогает определить отношения между участниками мероприятия и то, как ситуация концептуализируется и представляется в виде ментальных моделей в человеческом сознании.

В разделе *Обсуждение* проиллюстрировано возникновение типичных концептуальных фреймов в массовой культуре, а именно в фильмах и телевизионных программах. С их помощью доказывается актуальность выбранных подходов и методов для выявления особенностей концептуализации в различных предметных областях и взаимосвязи языка, мышления и коммуникации.

Ключевые слова: семантический фрейм; компьютерная вирусология; фреймовая терминология; когнитивная терминология; семантические роли; глубинные падежи; когнитивно-дискурсивная лингвистика.