The problem of sentence meaning: the quantum theory approach

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Abstract

Maybe one of the most profound methodological problems in modern linguistics is the lack of instruments for modeling language as a dynamic, variable system. Language looks in classic linguistic paradigms a static structure without the ability to evolution. In this paper author outlines the «quantum» approach to language. The quantum theory paradigm is one of the most important methodological results of 20th century and it gives an opportunity for the dynamic view on language. The author applies this paradigm to the sentence denotation structure analysis. There are two basic findings from the present study. First, the sentence denotation structure isn't homogeneous, some its elements are more important for humans than others. This statement conforms to the E. Rosch's investigations of human categorization, but, unlike Rosch's assertions, the structure changes when event context becomes different. Second, the sentence denotation structure isn't an external in respect of a person characteristic, but this is the result of a person, language and the external world interaction. The most frequent and consequently the most probable interactions cause its base elements. This affirmation fits the quantum theory paradigm.

Introduction

If we look at the methodological development of modern linguistics, we can observe two main methodological paradigm.

In spite of serious differences between them, the fundamental linguistic theories which appeared at the second half of the 20th Century (Chomsky's Transformational-Generative Grammar theory in all its forms, NSM-theory of Wierzbicka and Goggard, the model «Sense-Text» of Mel'čuk, Apresjan and Zholkovsky etc. (Wierzbicka, 1972; Wierzbicka, 1980; Wierzbicka, 1996; Mel'čuk, 1995; Mel'čuk, 1996; Sgal et al., 1986; Jaszczolt, 2002)) consider language as a formal structure beyond man as a socio-cultural entity. These theories use the approaches in logic and analytical philosophy which are based on the investigations of formal languages. A natural language is interpreted as an imperfect formal language by them and a lot of their base concepts and statements look taken from logic (Dummett, 1991, p.22). In whole, these researches are connected with the tradition of Western rationalism of the 17-18th centuries and, finally, with Plato's and Aristotle's ideas (Glebkin, 2007, p.12-22; Glebkin, 2007a). The main weak point of this approach is the view on language as a static structure without the ability to evolution. A formal language exists beyond time, but the meaning of ordinary words and sentences changes in time and this change is their essential feature, not a defect.

The other approach developing at 80-90's of the last century includes a person in the structure of a language theory, but this person isn't a socio-cultural entity, they haven't variable socio-cultural features. The main features of this person are as universal as the features of Kant's transcendental subject. The obvious example of this approach is the theory of cognitive metaphors based on common for human beings body experience (Lacoff 1987, Johnson 1987). Moving in this direction we also haven't any opportunity for the dynamic view on language.

It is Aristotle, who became one of the first philosophers outlining the dynamic system paradigm. This paradigm is founded on the notion of possibility. In this case changes are described as the passage from possibility to actuality. In 20th century science this paradigm turns into the exact theory. I mean quantum mechanics.

The base postulates of quantum theory are as follows:

a) From the viewpoint of classical theory any physical value is the attribute of an external object and it can be measured absolutely exactly (the result doesn't depend on the measuring procedure); from the viewpoint of quantum theory the physical quantity value is the result of the interaction between the object and the measuring instrument and this value is the property of the interaction process, not the object.

b) It is impossible in quantum theory to say anything about the object's state beyond the process of measuring. One can only say about possibility of an object to be found in some state after the interaction with the device. It is the concept of probability which becomes the quantitative characteristic of this possibility.

c) Classical values become in quantum mechanics only the most probable values of quantum variables. The results of quantum theory passes into the results of classical physics, when the dimensions of the object are large and the most probable value becomes the only possible.

The methodological paradigm, which underlies these postulates, was also formulated in social science in Max Weber's model of «ideal types» (Weber, 1904). Later it became the base of different theories in diverse areas of knowledge. The most important application of this paradigm to cognitive science is James Gibson's ecological approach to cognition (Gibson, 1979). However, quantum mechanics is remaining the most profound and experimentally grounded realization of this paradigm.

In this paper I am showing that the quantum paradigm can be used as the third paradigm in

linguistics, which opens a path for creating a dynamic model of language[1].

Further I am applying this paradigm to the problem of sentence meaning. One can mark out two main views on this problem, which take place in modern linguistics. The most of researchers suppose that "to know the meaning of the sentence is to know under what conditions this sentence would be true" (Jaszczolt, 2002, p.53). This view is connected with works of Frege, but writing «Bedeutung» he meant «Wahrheitswert», i.e. «truth» or «false» (Frege, 2002, p.30). Later Tarsky and Davidson change meaning of «meaning», approaching it to Frege's «Sinn» but they keep his view on the sentence meaning[2]. In these limits we can meet analytic interpretations reducing the meaning of whole to meanings of its elements and their relationships (Tarsky) or holistic ones, which interpret it as some kind of theorem. This theorem is proved by using a finite quantity of axioms, which are general for language. In this case meanings of words derive from the sentence meaning (Davidson). The common trait of both attitudes is the interpretation of the sentence meaning as an attribute of language as external for person reality. You can know the meaning or not know, but you can't change it. This is beyond your competence (Hoffman, 1995; Patterson 2005) .

The second view is connected with the interpretation of sentence meaning as a consequence of the speech act. «The meaning sentence is all that the hearer need know *about the language* in order to interpret the utterance» (Alston, 2000, p.149).

I haven't any opportunity to discuss here these views in detail. However I must note that it's impossible to describe the changing of the sentence meaning in their scope.

Moving to description of quantum approach to the problem of sentence meaning, I would like to specify the limits of further discussion. The main purpose of this paper is to raise problem of meaning formation of simple sentences, what contains basis level concepts. Classical theories of sentence meaning assert that all instances that satisfy these conditions represent the denotation equally. However, it was displayed in E. Rosch's classical experiments with natural language concepts, that the structure of the concept wasn't homogeneous and some objects were clearly better exemplars of the concept than others (Rosch, 1975; Rosch, 1978). The hypothesis of my study was that the structure of the sentence denotation also isn't homogeneous and this structure depends on not only respondents, but also on the context of the investigation.

[1] A few attempts has been done in applying quantum theory to creating some models in the field of cognitive linguistics over last three years (e.g., Aerts et al., 2006; Gabora 2008). However, these models are based on consequences of the main postulates of quantum theory and not connected to the postulates themselves directly. Therefore the analogies that the models draw are derivative and they don't reveal the grounds of the similarity of described processes.

[2] We aren't discussing here differences, which occur in the intuinitionistic or in the falsificationstic theory of meaning, because they change nothing in our discussion. About these differences see: Dummett, 1976

Study

In the research was used well-known free associations method.

Method

Participants. A total of 186 native Russian speakers (25 - 7-8-year-old, 133 - 15-17-year-old, 28 - 18-year-old and older; children and teenagers are pupils of Moscow schools; adults are teachers and engineers); a total of 42 native speakers of French (18-29-year-old, students of Université Toulouse II-Le Mirail).

Procedure. The researcher pronounced the phrase *Chelovek idet po doroge (A person is walking along/down the road)* for Russian participants and the phrase *Une personne va le long du chemin* for French participants and asked them to describe in detail (by the words) the picture, which appeared in their consciousness, when they heard this phrase. They had to describe (if they recognized it) a person (gender, age, how he looks), a road (highway, street in a city, country road, path in the forest etc.), a landscape around, a weather, time of day, season etc. In Russia the investigation was conducted in different places and in different seasons (in summer in the country (Ferapontovo, Vologodskaya district) and in autumn and winter in Moscow), in France – in winter in Toulouse.

Results and Discussion

The results of the study confirm the base hypothesis. The structure of the denotation of the analyzable sentence isn't homogeneous. There are the best patterns of a person (a young or middle-aged man for Russian (57% reports[3]); a young or middle-aged man (40%) and a young women (21%) for French participants), of a road and the landscape around (a country road among the fields (39%) for Russian; the same image (36%) and a path in the forest (24%) for French participants), of a season (summer (including the end of spring and the beginning of autumn) (51%) for Russian; spring (31%) and autumn (31%) for French participants) and of time of day (afternoon - 48% for Russian and French participants).

Some of these results are defined by the structure of language and easily explained by the classical semantics. For instance, *chelovek* (a person) is the masculine gender word and the most of respondents described a man, not a women. Although there isn't articles in Russian, *chelovek* in this sentence is the same as *a person*, not *the person*. It correlates with the fact that many participants didn't describe a person's appearance and some of them wrote that they saw the person from behind. In Russian there are the separate words for a highway (*shosse*), for a street in

[3] 25 reports of children aren't taken into account in this count.

the city (*ulica*), for a path in the forest (*tropinka*), but there isn't a separate word for a country road. One can therefore expect that a country road will be more frequent image of *doroga* (road) than others.

However, some results aren't described by the classical paradigm. In order to make this clear we will select three pairs of subgroups of participants and analyze each pair. The members of the first pair will differ in the place and time of the experiment, the members of the second pair – in the age of respondents, in the third pair we will compare the reports of Russian and French participants. For the main idea of this paper will be important only the results for the first pair. The results for the second and the third pair are beyond the general direction and they will be given an account in the appendix.

Results for the first pair. The structure of groups: group 1 - 32 persons (15-17-year-old, gender: m – 10, f – 22, time of the experiment - June 2008, place - Ferapontovo, Vologodskaya district); group 2 - 44 person (15-17-year-old, gender: m – 17, f – 27, December 2008, Moscow). The results are presented in the tables 1-2.

We can see, that the results are similar in respect of parameters that are similar in both groups (table 1), but this results considerably change, if we change the context of experiment (table 2). The case of this difference can be described as fallows. There are many fields and county roads around Ferapontovo and this is the important factor influencing the choice of a country road as the main image in group 1. In Moscow this factor lacks, the context becomes more usual for participants and in group 2 we can observe another result.

Table 1. A described person

A person		Group 1 (%)	Group 2 (%)
A man	Child	0	2,3
	Teenager	3,1	2,3
	20-29-y-old	6,2	2,3
	30-59 y-old	50	52,4
	60 and older	0	2,3
	Indefinite	6,2	8,8
	Total	65,5	70,4
A women	Child	0	2,3
	Teenager	3,1	4,5
	20-29-y-old	6,2	0
	30-59 y-old	0	2,3
	60 and older	0	2,3
	Indefinite	0	0
	Total	9,3	11,4
Indefinite		25,6	18,2

Table 2. A road and the landscape around

A road and the landscape around	Group 1 (%)	Group 2 (%)
Highway	18,8	11,4
Street in a city	9,4	25
Country road	43,8	22,8
Path in the forest	12,5	22,8
Other	9,4	9
Indefinite	6,3	9

The choice of the season is changed in a similar direction. Nobody selected the winter in group 1 (time of experiment was summer) and 11% selected the winter in group 2 (time of experiment was winter).

Discussion

The present research is the beginning of a general investigation of the sentence denotation structure. These results have a qualitative character and reveal the problem points for further researches. There are two basic findings from the present study.

First, the sentence denotation structure isn't homogeneous, some its elements are more important for humans than others. This statement conforms to the E. Rosch's investigations of human categorization (Rosch, 1975; Rosch, 1978)[4], but, unlike Rosch's assertions, the structure changes when event context becomes different .

Second, the sentence denotation structure isn't an external in respect of a person characteristic, but this is the result of a person, language and the external world interaction. This statement defines the principal feature of quantum approach, which distinguishes it from two described above paradigms. It is impossible to talk about the sentence meaning without the interaction with person. The sentence have only probability to get a meaning in the act of interaction. The meaning comes into being in this act. The most frequent and consequently the most probable interactions cause its base elements. However the frequency of these interactions can change with changing the socio-cultural situation. If we describe these changes and following semantic transformations, we will be able to describe language as a dynamic system.

Appendix

Results and discussion for the second pair. The structure of groups: group 2 is the same as in the first pair; group 3 consists of 26 persons (7-8-year-old, gender: m – 14, f – 12, September 2008, Moscow[5]). The results are presented in the tables 3-4.

We can observe that in group 3 a) the walking person became considerably younger than in other

[4] One can say that Rosch's results are a particular case of a sentence denotation structure studies for the type of sentences «There is X (color, furniture, bird etc.)».

[5] Children not wrote the reports, they drew the pictures and then explained them.

one and the m.-f. ratio approximated to 1; b) a street in the city is the only dominating picture. It is interesting that one of the most frequent images of the street is a pedestrian crossing (15,4%). The causes of these results are as follows:

- Children of 7-8-year-old don't master language as the social phenomenon and they don't feel language limitations which adult participants feel.
- Their consciousness is egocentric and they see in the walking person themselves or their parents (they often told about that in their comments).
- Their social experience is firmly connects with the city and a life in the country passes beyond them.

Table 3. A described person

A person		Group 2 (%)	Group 3 (%)
A man	Child	2,3	7,7
	Teenager	2,3	11,5
	20-29-y-old	2,3	15,4
	30-59 y-old	52,4	15,4
	60 and older	2,3	0
	Indefinite	8,8	0
	Total	70,4	50,0
A women	Child	2,3	34,6
	Teenager	4,5	7,7
	20-29-y-old	0	0
	30-59 y-old	2,3	0
	60 and older	2,3	0
	Indefinite	0	0
	Total	11,4	42,3
Indefinite		18,2	7,7

Table 4. A road and the landscape around

A road and the landscape around	Group 2 (%)	Group 3 (%)
Highway	11,4	3,8
Street in a city	25	65,4
Country road	22,8	3,8
Path in the forest	22,8	7,6
Other	9	15,6
Indefinite	9	3,8

Results and discussion for the third pair. In this pair group 2 is the same as before and group 4 consists of 42 French participants (18-29-year-old, gender: m – 8, f – 34, December 2008, Toulouse). The results are presented in the tables 5-6.

We can see that the most frequent walking person in group 4 is younger, than in group 2, and the women is more frequent instance of this person in group 4, than in group 2 (table 5). This can be connected with two factors: *a person* in French is in the feminine gender (in Russian, repeat, – in the masculine gender); Russian culture is more traditional than French and a man of middle age is more typical for it then a young man or women.

On the other hand, it is evident that for French participants *a road* is a country road and a path in the forest and isn't a street in the city. The results of group 4 are similar as the results of group 1, not group 2. There are different ways to clarify why this is the case. There is one of possible explanations. Toulouse isn't a megapolis and the students of Toulouse university have an experience of a country life. The Moscow rhythm of life is more far from a country life than the Toulouse one.

Table 5. A described person

A person		Group 2 (%)	Group 4 (%)
A man	Child	2,3	4,7
	Teenager	2,3	0
	20-29-y-old	2,3	23,8
	30-59 y-old	52,4	16,7
	60 and older	2,3	7,2
	Indefinite	8,8	2,4
	Total	70,4	54,8
A women	Child	2,3	0
	Teenager	4,5	0
	20-29-y-old	0	21,4
	30-59 y-old	2,3	0
	60 and older	2,3	9,5
	Indefinite	0	2,4
	Total	11,4	33,3
Indefinite		18,2	11,9

Table 6. A road and the landscape around

A road and the landscape around	Group 2 (%)	Group 4 (%)
Highway	11,4	0
Street in a city	25	4,8
Country road	22,8	50
Path in the forest	22,8	23,8
Road to the see, beach	0	7,1
Other	9	9,5
Indefinite	9	2,4

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