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Dynamic Theory of Meaning:
New Opportunities for Cognitive Modeling[1]

Introduction

Recent works in cognitive modeling (I mean first of all development of neural networks approach) have achieved considerable success in technical aspects, in the answering to the question: "how to model?" This paper on the contrary will be focused on the complementary question: "what is to be modeled?" (as it seems promising from the psychological perspective).

It is obvious that quality (aptness, reliability) of any model whatever depends on the quality of the previous description of a phenomenon, that is being modeled.

Therefore, quality of cognitive models of the linguistic phenomena depends on the quality of the description of the processes that take place in human psyche while realization of linguistic meanings.

The first stage of description is fixation (identification) of the entities. Therefore, limitations in the ability of entities fixation affects powerfully the whole endeavor of linguistic phenomena cognitive modeling. Vice versa, new opportunities in the most primitive entity fixation may result in emergence of new perspectives, trends, classes of models.

Stating of the problem

Contemporary cognitive psychology follows contemporary linguistics that possesses no other means of fixation of the meaning except the natural language words, or logical categories. (The difference between words and categories will not be significant for the approach that we would like to present). Moreover, the words in general are understood simply as the strings of symbols be they visual (letters) or auditory (phonemes).

This dependency, this inability to fixate meaning in any other form than that of the words appears at least in two ways.

First, at the level of concrete (computational) models that according to some methodology (connectionist or based on the calculation of propositions or some else) may be trained to produce desirable consequences of the strings of symbols. Nevertheless, it is evident that production of desirable strings is very far from the human usage of language, because humans deal not only with the symbols but first of all with that what is signified by the symbols (see, for example, Bonjour L. 1991).

Second, at the level of building theories – much more sublime and much more influencing at the same time. We can point at Fodor's (1975) "language of thought" idea as an example. "Language of thought" susceptibly resembles natural language with the "sentences", "propositions" and so on. The metaphor of language once applied leads to rather strong assumptions like that of brain's ability to "calculate" sentences in some computer-like fashion. The least on the one hand is very far from being supported by physiological data, on the other hand again leaves without consideration the content of symbols.

Another example of aforementioned dependency is the well–known "Lingua mentalis" by A. Wierzbicka (1980). In spite of all her attempts to point at some reality beyond the natural language she always stays within the forms of the least. As the result it is not clear (as it is not also in the Fodor's case) whether "language of thought" permits to be methodically distinguished from the natural language or not.

If we remember a much earlier "language and thought" affair, that of Vygotsky's origin, we'll also find that he cannot say something about meaning in a form of a thought without reference to meaning that is expressed in the form of language. He stops at pointing to some intermediate station of "internal speech" the meanings of the "words" of which are more "condensed".

We hope that these examples are enough (although we could multiply their number considerably) to feel that contemporary science experience problem in fixation of entities that enable natural language understanding and production.

The lack of appropriate theoretical tools for fixation of these entities inevitably inclines scientists to extensive usage of metaphors in building of the theories. (Please, refer to well known works of McCormac(1985), and Lakoff & Johnson (1980) for many examples). If you are not able to fixate the entities precisely you simply have nothing to do but to use metaphors, e.g. fixate them "somehow" and approximately.

But metaphor obviously is not a completely reliable friend of a scientist. Although possessing some explanatory power, in longer term, metaphors always threaten with ambiguity and ever increasing risk of confusion.

The Issues

There is a whole Gordian knot of closely interrelated methodological problems that result in the contemporary state of affairs in this field. We shall start from seemingly less of all having practical meaning and most methodological ones and finish with those that possess probably the greatest and most immediate application value.

1) *Circulus vituosis* in mutual relations between linguistics and psychology. Psychology follows linguistics in all the cases concerning grammar, semantics, theory of meaning, etc. It simply does not have its own psychological grammar, semantics, theory of meaning. But linguistics in its turn applies to psychological (in their grounds) phenomena like "linguistic competence" those actually are based on the agreement of native speakers about correct or incorrect usage of some words in some contexts. But what are the grounds for such agreements? By the existing *circulus vituosis* they are principally can not be approached because linguistic terms themselves stay without psychological explanation but at the same time prevent psychology to reach the processes of meanings realization, using its terms and approaches! By such an approach language turns out to be some absolutely separated area within the psyche and it becomes incomprehensible how can it be connected to all the other psychic phenomena.

2) Although linguistic theories are dealing with the ***results*** of meaning realizations they do not explicate these processes within the words. Therefore, a theory of psychological ***dynamics*** of meaning realization should be developed, if we want to understand how these processes occur in humans. The concepts that describe meaning realizations should be consistent (or identical) with the concepts that describe the psychic life, if we want to answer the first and crucial question: "how it is possible that words may express the psychic states?"

3) A word's meaning appear as something fixed. If so then how can the existence of many meanings of a single word be described? How can one and the same string be used in many different situations, but be at the same time one and the same word? To

apply to the context means nothing, because it stays unclear what in the word realization stays identical independently of any context and what changes depending on it. To pretend that everything in a word realization changes depending on the context is absurd, because if so, then what are the grounds of this word's usage instead of any other one? The problem of metaphor may also be referred to in this context. How can we describe what is in commons between an object and metaphoric use of a word that describes this object in the metaphoric sense? In the most cases they have nothing in commons sensually, then how do they relate?

In order to answer the question of the grounds for choosing words in speech in a unified manner we obviously have to deal with some entities of meaning that are of a finer grain than the words.

4) The problem of introspection. The only one suitable way is misleading!

I think, that not a single scientist (working in the field of related matters) would refuse to have an immediate access to the processes of meaning realization that take place in human psyche. It would have been a very nice thing "to take and see" how it is all really done by our mind!

But how to do it?!

It is obvious that meaning realization is an intrinsic process of the human psyche. According to its nature, it has to be grasped through some kind of introspection. However, the old 19th-century associative and sensualistic introspection encountered too many difficulties, and at the dawn of the 20th century a "psychological crisis" broke up. As a result, the idea of introspection itself in Anglo-American psychology was discredited for decades.

The way that directly leads to phenomena is abandoned. Only through the logical intuition, that is in a misty and controversial manner is referred to as not "psychological", we have an access to meanings that are expressed in words. So linguistic intuition is based on logical one and the least is not "psychological". Proceeding from such assumptions mainstream linguistics and psycholinguistics developed throughout the whole 20-th century. And these are the issues of aforementioned *circulus vituosis*.

Of course, to treat logic inference or meaning realization (on which the inference is based) as a separated from the activity of psyche is absurd. But at the same time such a position has at least too long historical roots to be simply ignored. Moreover, revelation of the source of the puzzle will bring us directly to the core of the problem and make it possible to enter the new theory of meaning.

The case story

The history of this case ascends to the famous discussion between Frege and Husserl (see. Foelsdall D. 1958). Or, to be more precise, to Frege's critique of Husserl's attempt (see E.Husserl, Philosophie der Arithmetik,1893) to construct foundation of mathematics on such a vague concept as "Vorstellung" ("predstavlenye" in Russian, "representation" in English).

Frege has proved his fame of the sharpest logician by pointing at a following crucial detail. "Speaking about the truth of representations we always have to specify who had such representations and when, whiles it is absolutely unnecessary when

speaking about the truth of arithmetic statements. 2x2=4 is true, independently on who makes such a statement and when."

Under the influence of this critique Husserl has changed his initial position and became famous "antipsychologist" in the foundation of mathematics and logic. In his next work (Logical Investigations, 1900) he, contrary to the 19-th century mainstream ideas and his previous attempts stated, that psychology cannot be the science that could lay foundation of mathematics and logic. In order to avoid long discussion, that would lead us to the fields of history of science and philosophy let us say simply that this idea of psychology's discrediting was very well assumed by the most of philosophers and scientists and the current state of affairs formed. It simply was much more convenient not to think about the psychological mechanisms of language and speech and let all the sciences develop in their own way.

(We leave aside the everlasting competition of continental and analytical philosophy and different reasons upon which this or that scientist adopted this or that views. Our position is that psychology can learn a lot from both of these European traditions of philosophy, as well as not from only the European ones, and therefore it should not sacrifice new possibilities of its development for the sake of this or that philosophical school's seeming advantages).

Although, Husserl was puzzled by the specific relation of logic and mathematics to consciousness, world and temporality, he was not going to surrender and leave this relations without clarification. The truth of logic and mathematics is depending neither on individual subjects, be they gods, centaurs or humans, nor on the time or space. They are, neither temporal, nor mundane. But they are somehow constituted by consciousness and by the human consciousness in particular! Main peculiarity of Husserlian approach was that he always insisted on the immediate access to this constitution process from within the consciousness itself, i.e. on some kind of introspection. But what kind of introspection should be adopted? Or to say in another words, what should we look for in our inner experience?

Following long tradition ascending to John Locke psychologists were looking for elementary sensations and their associations from which, as they believed, our psychic life consists.

Such a way provoked many problems. First of all, elementary sensations changed too rapidly and the data collected from different scientists varied too much.

But the crucial point in the story of "old introspection's" decline and fall was the discovery of "imageles thoughts". It seemed—as it still does now[i]—that introspection was limited by imageles thoughts.

Elsewhere[ii], I have discussed the problem of relation between natural science approach, old sensualistic introspection and Husserlian phenomenology in some greater detail.

Phenomenology, Natural Science and Sensualistic Introspection

H.L.Dreyfus (1982) stated the problem of Husserlian Phenomenology interpretation in non-Husserlian terms. Intentionality is undoubtedly the central point of Husserlian teaching. According to the most widespread formulation of Husserl and his exegetes, intentionality is the directednes towards an object. But object according to Husserl exists (for us) due to the process of its constitution in consciousness. It is

obviously that only due to the constitution process identity of different objects is maintained. For example, representatives of some cultures often refer to spirits as an explanation of their everyday life events, while it is not characteristic for representatives of some other cultures.

Taking this into consideration and basing on the plenty of places in Husserl's teaching[iii], it is possible to propose the following interpretation:

 intention is that which enables something whatever to be identified with itself.

Correspondingly, intentionality maintains the *Washeit* ("Whatness") of objects and their ability to be identified for the moments of "inner temporality."

Husserl many times insisted on the "imageless" character of intentions speaking about their "pure ideality". He stated that to deal with these "pure ideal references" is a key feature of his analyses that distinguishes it crucially from all the previous tradition of psychology.

How it is Possible to Explain Intentions from the Natural Science's Point of View

In several works it was demonstrated that phenomenological analysis and analysis being conducted from within the naturalistic paradigm can show (Dreyfus H.L.1982, 1996) and really do show (van Gelder T., 1996) remarkable coherence.

Contrary to a widespread opinion (that ascends to Medard Boss - it was he who said, that one will sooner find the wooden iron then construct naturalistic phenomenology, see Condrau, 1992, p.91), this coherence was never denied by Husserl himself and even desired by him.

In "Amsterdaemer Vortraege" Husserl stated that, during the transition from phenomenology to psychology the primary basic principles of phenomenology have to be enriched by the content that constitutes the *a priori* of natural sciences[i].

To one of such *a prioris* (a statement that defines specific point of view of a scientific area) belongs distinguishing between a processing unit and a unit that activates it. *To every contents (i.e., thought) in our consciousness corresponds some processing unit, this contents being a result of its activity*. This unit has to be "switched on" (activated) in order for this content might be experienced as a sensation.

Intention is the kind of connection that activates a processing unit while sensation (or in a more complicated case – an image that contains intentions also) is the result of this unit's activity.

In a great number of his works Husserl describes how object constantly changes, while ideally being the same. He also pays attention to such a phenomenon as the intention of "something whatever." The resulting content is constantly changing due to the changing number of participating connections, but while the system works correctly it always can identify through which units connections occur.

Intention identifies not the contents itself but the unit that produces / transports this contents

Intention, so to say, denotes the "knowledge" of the psyche concerning "where" this or that content is located or "how" it can be acquired.

In computers—at the lowest level—the memory address plays a role analogous to the role of intentions.

Inevitably, the intentional nature of consciousness must be universal, simply because, in order to be able to function, every "part" of the psyche (down to the neurons) must "know" its closest "partners" with whom it works.

Speaking in a more physiological fashion[v], intention corresponds to the efferent (descending from the relative center of the CNS) way of activation spread, while realization (fulfillment) to the afferent (ascending from the peripheral zones of the CNS).

Comparison of the Ways of Introspection

Now we can better understand the peculiarity of Phenomenological (Husserlian) introspection in comparison both to the whole of our everyday living and the kind of introspection that was applied in the 19th-century psychology. In our everyday life we deal with our representations of outer world that are (according to aforementioned *a priori*) results of our neural units activity. Correspondingly, within the naturalistic attitude, introspection had to distinguish between elementary sensations and to find out how the more complicated contents of consciousness are built of the former through the mechanisms of association. But in order to understand the functioning of our psyche we have to be able to trace the logic of these units activation, not merely gaze at the results of their activity.
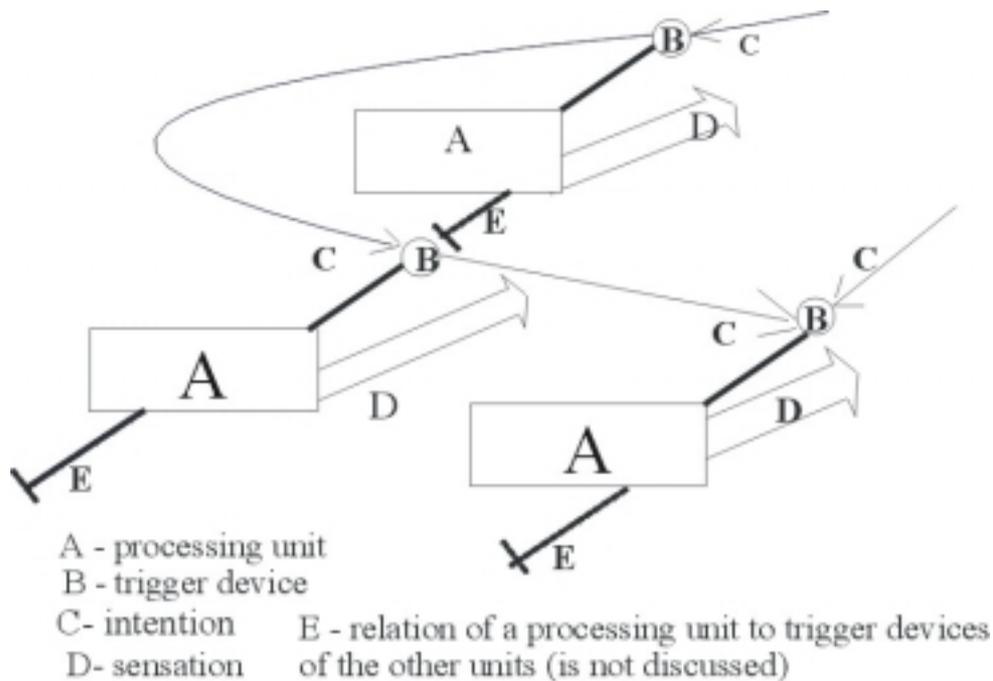
Being rather sublime but not at all difficult for experiencing and understanding the difference between the two types of orientation (towards sensations and towards intentions) is important. In order to feel that identification of thought (intention) may be separated from the identification of its content (sensation) let us consider the following situation.

When we had lost our thought and then tried to remember it, didn't we think about it? We considered one thought but it was not the right one; then another, but it wasn't the right one, either. It means that we were able to establish the identity of that particular thought with itself, despite the fact that its contents was unavailable to us.

Finally, we found the thought that we had lost. It means that we identified the thought itself with its contents, or, in the terms of Husserl's "Logical Investigations", the intention itself with its realization (fulfillment), or in our terms we identified the "switching on" device with the device that produces desirable contents.

In concrete analyses we can treat intention just as a pure ***reference*** to something either known (experienced) or unknown (will be experienced).

Figure1. Intentions and *a prioris* of neural science.

A - processing unit
B - trigger device
C - intention
D - sensation
E - relation of a processing unit to trigger devices of the other units (is not discussed)

If we look at Figure 1 we will see that sensations correspond to the ascending arrows, while intentions to the descending. During a response to a stimulus the number of participating devices grows. Correspondingly, the amount of afferent response (ascending arrows) grows as well. In order to reveal the patterns of our consciousness activity, correspondence between intentions and realizations has to be controlled. Otherwise, the flow of realizations becomes uncontrollable, which results in a failure to perceive what exactly they are realizations of.

In the sensualist attitude scientist expects identification of sensations from which consists a content of consciousness under analyses. Correspondingly, in order to permit ever more sensations to enter to the always limited scope of consciousness, reflection has to descend to ever more partial, transitory and dependent contents of the living-through processes. That actually was the case in the 19-th century psychology.

 That is why a critique of such practice (from different directions in the end of the 19th—beginning of the 20th century[vi]) was absolutely justified. However, it does not mean that this is the only possible way of introspection.

On the contrary, successful identification of intentions permits to stop descending of reflection at any desirable moment. Once identified intentions might be traced. It makes it possible also to identify new intentions in the neighborhood of the actual, which automatically means ascending in the level of a phenomenon consideration.

 Due to this advantage Husserlian introspection permits the identification of intentions with their realizations and then, through the procedure of eidetic reduction, the discovery of the invariant intentional structure of the phenomenon under consideration.

Dynamic theory of meaning

Procedures of phenomenological analyses that were elaborated by Husserl permit us to reveal intentional structures of phenomena of the meaning realization.

Intentions serve as the entities of meaning those are of the finer grain than the words.

Being the _forms_ of understanding, linguistic meanings say about transformations of a certain content. But they are not bonded to this or that content, at least at some level that is higher than that of the primitive sensations. Identity of the content is guaranteed by intentions of a lower level.

Therefore, we can describe meanings as the intentional transformations and do it with abstraction from the content of the lower level (content of sensual data first of all, but also content of some more primitive intentional structures).

What are the first and most primitive intentional modifications, those can be used to describe dynamics of ever more complicated transformations and structures?

Husserl pointed out that the universal form of any living–through process is the form of inner temporality[vii]. Inner temporality according to him is constituted in the following set of basic intentional modifications:

Impression - this term refers to any kind of perception be it of outer or inner world, but what is most important to the moment of "now" versus just-happened and retained.

Retention. - this intentional modification provides ability to connect different contents (intentions) into one whole, provides possibility of synthesis.

Actualization ("Vergegenwartigung" - German) these term states for any acquisition of a content from memory, (like in the process of recognition or remembering of something). Through this modification a content (intentional structure) becomes contemporary, actual for the consciousness.

Protention - projection of what is retained to what is expected - primary expectation - ground for goal setting, anticipation, desire, consciousness of future - the act that is common for all of them.

We have to emphasize that all the modifications that were described above are intentional modifications, every protention is the protention of something, every impression is the impression of something and so on.

Intentional modifications serve as the most primitive entities of a meaning realization. Basing on their identification in inner experience it is possible to construct models of the meaning realizations and to check them experimentally.

There is also some special form of intentional modifications visual fixation. To fixate the entities visually is always the first step of a scientific endeavor (Hilbert D. Bernays P. 1934, pp.20-21). Please refer to the following web-site for details:
http://www.psychol.ras.ru/strukt/ALMAEV/ALMAEV.HTM .

Methodology of Experimental Study

The basic assumption of experimental study was that:

(A) word(s) is (are) being used in expression when there is correspondence between intentional structures of situation of outer and/or inner world and intentional structures of word(s) in judgment about this situation.

In order to evaluate this hypothesis we arranged dynamic scenes (computer animations) the apprehension of which had (according to our understanding) the same structure of intentional modification as was revealed through phenomenological analyses of a word's meaning.

The subjects were asked to establish correspondence between scenes and the words from the list of those that were analyzed by us.

If we have correctly reconstructed the correspondence of intentional structures of situations and words, then experimental subjects (intellectually normal, adult, native speakers) will establish the same correspondence as we did.

An Example

Let us show construction of dynamic scene on the example of particle "tolko" that is Russian analog of English "only", as it is the most simple and transparent case.

This particle's meaning realization has following steps:

1. protention of primary multiplicity of intentions;

2. selection of one of them which then is fulfilled;

3. while leaving without fulfillment the others.

Correspondingly, the first group of dynamic scene's frames must contain several objects (to provoke protention of primary multiplicity of intentions)
Then we have to select one of the objects.
Then we have to express fulfillment of intention that is defined by it on the background of the others objects intentions fading out. For example, we can do it by enlarging its size with simultaneous diminishing or even demolishing of other objects. We can simply leave it to stay while all the other disappears.

 Uniting all the groups of frames we arrange dynamic scene which then can be administered via PC to experimental subjects.

With the help of such an approach we managed to provoke usage of such particles that usually cannot be perceived as something spatial.

For more examples and details please refer to
http://www.psychol.ras.ru/strukt/ALMAEV/ALMAEV.HTM

        Later on we have found that basic intentional modifications should be completed with the two independent dimensions of the psychic energy management (see N. Almayev. The Concept of Psychic Energy and the Phenomenon of Music// Analecta Husserliana, in press.) We define "psychic energy" as the information resource that is

necessary for the maintenance and development of intentional relations (i.e. relations of identification).

The dimensions corresponds to:

1)function of energy demand, (i.e. reservation of resources for further identification. In the neural network modeling it preliminary might be described as increasing of a "weight" of a connection).

2) function of available energy evaluation.

Language and image

According to the long-lasting dream of mankind about "robots", a serious real-world artificial intelligence (AI) device will have to deal with the real world situations and understand human speech. I.e. transform information from the visual (first of all) form to the form of natural language. In order this problem is to be solved relation between image and language has to be thoroughly investigated. This problem is elaborated nowadays within the field of psychology that is called "categorization". Sensualistic implications are not less powerful in this field than in any other field of psychology. As the result the categories from the parts of speech that have few or not at all references to something sensual (verbs, particles, prepositions, conjunctions) are almost out of investigations. It also seems very important (if we want to move in the direction towards the real world) to transit from investigation of relations between static objects and single words to dynamic scenes with interacting objects and phrases that correspond to them. Foreign language learning and the problem of adequate translation are relating closely to the problem of correspondence between sentence and scene.

There is also a rather peculiar topic also relating to the problem of visual scenes understanding – development of iconic communication (Beardon C., Dormann C., Mealing S., Yazdani M., 1993).

Although, we are aware of the very limited number of works devoted to language and animation relations (Jones T. 1993, Tomlin,1998, Almayev N. 1997, 1998) this field, nevertheless, looks promising.

The main result of our experience may be summarized as the following:

Conditio sui qui non for the correct identification of a scene is its ability to provoke those sequences of intentional modifications that are necessary for the realization of the meaning of an illustrated word.

When people failed to recognize the scene correctly it always was due to the fact that some protentions that are crucial for a meaning realization were not provoked. There were two main reasons: 1) not proper time of the exposure of a sequence of frames; 2) implication that was not shared by the subjects.

Conclusion

This paper was devoted to the methodological and historical roots of dynamic theory of meaning. (Please, refer to works of N.Almayev[viii] listed below for more information). We've tried to show that the new theory of meaning can open new opportunities for the cognitive modeling due to its unique ability of tracing of the

meaning realization processes that take place in human psyche. We hope that dynamic theory of meaning will help to create new models of language processing those like human beings will be able to encode dynamic scenes into the natural language descriptions and decode natural language sentences into corresponding dynamic scenes.

Notes

[1] This work is supported by the Russian Foundation for Basic Research (RFBR) grant # 99-06-80-374.

[i] E.g., see P.N. Johnson-Laird, (1988) pp.15-16.

[ii] Almayev N. The concept of psychic energy and the phenomenon of music // Analecta Husserliana (in press).

[iii] This idea is expressed in many of his works, in "Amsterdaemer Vortraege" (Husserl, 1962) it is paragraph #7, especially pp.316-317. In "Ideen…"(Husserl, 1950) it is paragraph # 36, especially pp.80-81, also paragraph # 85 "sensuelle hyle, intentionale morphe", pp.207-212, paragraphs ##130-131.

[iv].Husserl (1962) pp.325-326.

[v] We mean first of all the physiology of activity as it was developed in P.K. Anokhin's and N.A.Bernstein's works. In American literature the work of Miller, Galanter, C. Pribram "Plans and structures of behavior" is close to this approach.

[vi] Adherents of Gestalt-psychology criticized it for "atomism" – inability to grasp the organizing role of the whole. Behaviorists accused it in the lack of objectivity. Husserl pointed at sensualism and associationism as the main troubles.

[vii] E.Husserl, *Ideen...* Ges. Werk. Vol. 3, (The Hague: Nijhoff, 1950.) p. 196; see also E.Husserl, *Erfahrung und Urteil* (Prag:Academia, 1939)" p. 190-194, and passim in the "Lectures about Inner Time-consciousness," as well as many others.

[viii] N. Almayev. Intentional Structures of natural language. //Psychologichesky Zhurnal. Vol.19 №5. 1998.pp.71-80 (in Russian). This work contains detailed consideration of relations between linguistic semantics and dynamic theory of meaning with the examples from Wierzbicka and Apresyan.
N. Almayev. Dynamic Visualization as the Method of Language Consciousness Investigation// Yazykovoye Soznanye: Formirivanye i Funkzionirovanye. Moscow, 1998.pp.77-86. (in Russian).
This work briefly describes practical applications of Dynamic Theory to the language learning.
N.Almayev The Grounds for Choosing Words in Speech. Thesis. Moscow, 1997. (in Russian)
Thesis contains examples of the Dynamic Theory descriptions of almost all of the parts of speech (verbs, nouns, adverbs, particles, prepositions, prefixes) as well as their interrelations and logic of dynamic scenes construction on the base of the meaning realization.

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[i] Op.cit. S.325-326.