1. The aims of the paper

In recent decades our way of putting questions about natural language has reached a stage at which the application of nonnumerical i.e. qualitative mathematics is not merely possible but also appears to be of heuristic value. The two milestones seem to have been the introduction of the theory of formal languages into the study of natural language syntax, a merit of N. Chomsky (see e.g. [1]) and the introduction of model theory into the study of natural language semantics, most influentially by the works of R. Montague [2]. Here we will only be concerned with this latter.

In spite of the growing interest in model theoretic semantics (MTS) the penetration of those ideas into linguistic thinking does not proceed very smoothly. There have been several serious objections to MTS, tantamount to questioning its relevance for natural language. It is often difficult to tell whether those objections concern MTS as such or only particular uses of it; nevertheless, let us list some of the more general—looking ones:

(i) MTS overemphasizes the descriptive aspect of language, taking no notice of the communicative one,

(ii) meaning (in particular, word meaning) is a lot subtler than MTS believes,

(iii) MTS makes meanings relative to an arbitrary model and thus loses contact with the actual reality people talk about,

(iv) MTS has no psychological reality,

(v) MTS is primarily concerned with truth, which is irrelevant for natural language,

(vi) MTS is but an exercise in translation (of texts of the object language into some metalanguage) and so on.

It seems that these claims can take the form of objections because MTS is conceived of as a mere device, instead of being a method, and the possibility for this is provided by its introduction in the form "My model of language is such and such" — that is, in a purely mathematical form, without telling from which respects it is intended to be a model of language and from which it is not. Therefore, when wishing to do away with those objections, we first have to make clear what questions MTS puts and can possibly answer about language. This will be the task of Section 3. Such a specification can hardly be fully satisfactory on its own, however: it also needs to be shown how other questions, which are outside of the scope of canonized MTS in view of Section 3 and which one would still like to put can be
handled within the same methodological paradigm. The rest of the paper will be concerned with with some of these.

In other words, in this paper we do not aim at creating brandnew notions. Our aim is to place MTS in a broader setting, that is, to provide a coherent framework in which a number of current notions may receive their proper places. This is also a precondition to being able to decide how to improve the models we have available at present.

2. Methodology

Our task can only be accomplished if we make our backround assumptions as explicit as possible. This section is devoted to such preliminaries.

2.1 Language is an objectively existing abstract system, which is to be distinguished from its realizations and is to be studied as something self-contained. Being an abstract system, however, language can only be approached through its realizations. The results of investigation will thus to a great extent depend on what we regard as its relevant realizations.

Apart from the study of mere texts, the question of realization usually arises when one wishes to complete the notorious sentence "Language is a means of . . .". In general people tend to agree that models of language must somehow account for the fact the language can be and is used in cognition and communication. This is probably so because we have a functional view of language and a certain kind of language user in mind, which can in most general terms be called an intelligent system (see e.g. [3]). The least that this implies is that whatever one states about language must be compatible with whatever one happens to know about intelligent systems. We will actually use a stronger assumption, namely, that it is heuristically useful to look at language as functioning in some intelligent system (IS). Therefore a fundamental characteristic of the method to be followed in this paper is activity-orientation.

The second assumption is that seeking a unique answer to the " . . . a means of . . ." question is not fruitful. There are several language—using activities in which different, theoretically important aspects of language can be most readily studied. We shall first of all correlate such aspects with particular functions of language. Those functions appear in various activities, sometimes quite mixed up, sometimes rather clearly. Therefore we need to select such activities in which given functions of language feature most independently and perspicuously, in other words, a simplest elementary activity necessary for realizing some theoretically important function. We then form a model of that activity and study the model in order to see what it implies for language. The last step is to abstract from peculiarities of the activity and concentrate on language.

This assumption also implies that language is to be handled with a chain, or hierarchy, of models, rather than one single model.
2.2 Before turning to concrete problems, it is in order to dwell on the way of modelling those activities a bit longer. Having selected an elementary activity associated with a certain function of language, we consider a system realizing that function and an object at which the system's activity is directed, or which directly influences that activity. We refer to this object as the environment of the system in carrying out that activity. In this way, the function under consideration is made relative to the relation between the system and its environment. Moreover, we describe this relative situation from the position of an ideal external observer, thus introducing a further level of relativization. Let us spell out the observer's function more in detail.

(i) When studying something one always expresses one's basic assumptions about it by placing oneself into the position of an ideal observer. For instance, one says "Let's assume a system which is engaged in cognition". This does not mean that in empirical cases one would be able to unambiguously decide whether it is or it is not. However, this not being the point in the investigation, one may well assume that one possesses the sufficient knowledge to be able to tell. Furthermore, we assume along these lines that the observer's knowledge about the system, the environment, and their relation is sufficient for this models to be adequate. Thus the nature of idealization we employ can be in each case expressed in terms of the ideal observer's knowledge about the sample situation.

(ii) We also assume that the observer possesses a (meta—) language suitable for forming models of the sample situation. In order to keep the properties of the object (language) and the metalanguage strictly apart, we must assume that the observer is external to the sample situation.

(iii) Points (i) and (ii) also imply that models are not "absolute" they are relative to the observer, both to his intentions and his limitations. It seems therefore methodologically useful to keep his position explicit throughout the discussion. We return to specific advantages of this at the end of Section 3.

3. Language in abstracto

3.1 The first question to put is: what is language in the most abstract sense and what are its basic components. (That is, we have an explication of syntax and semantics in mind.) Furthermore, we believe that this question is identical to the one model theory puts and therefore the nature of its answer is dependent on the conditions under which this question can be approached.

Can we take communication as the activity most representative of this problem? It is true that by studying communication linguists have gained revealing insights into the nature of language use but the aims are different in that case. As to our problem, we have to say that communication is neither simple nor transparent enough. It certainly has to do with semantics insofar as people "convey meanings" when trying to make themselves understood but in the
case of communication the main thing is not merely what a text means but also how that meaning can be made available to the partner, also relative to the particular goals the communicative act is directed at. In other words, communication in the normal sense involves a need of "adaptation" to the partner, which is certainly irrelevant to our problem. The need of adaptation could be avoided if we assumed the two systems to be perfectly identical (with respect to both their "assumptions about the universe of the discourse" and their "means of expression"); this would make the situation more transparent but not yet simple. The reason is that it would be doubling a single system, rather than taking two systems, and thus we would be left with the question of what it means for a system to have "assumptions" and "means of expression". All this means that we ought to reduce communication to a trivial case and then in fact abstract from everything that makes it communication proper.

Therefore we suggest to abandon communication because of the interaction of at least two systems and propose to study the texts themselves before studying their transmission. This indicates that we must first investigate language as possessed by a single system and used for cognition. We take that the cognitive activity is the one in which texts are primarily produced. Moreover, we will approach cognition from an angle which epistemological, rather than psychological.

3.2 In sum, we will consider an elementary cognitive activity as going on between a system and its environment, as modelled by an ideal external observer. By an elementary cognitive activity we mean that the system, possessing some language L, describes the objects in the environment. At the moment we abstract from the cognitive process itself, that is, from the possible experiments the system has to carry out, and from the goals of the system, from the precise knowledge obtained and its representation; furthermore, we also abstract from the internal organization of the system (whether it be a human or a machine and anything else). Our mere concern is the outcome of this activity, that is, descriptive texts and their relation to the environment.

Our dramatis personae will thus be a system S, the system's environment E, and an ideal external observer O. (We will pronominialize the system by "she" and the observer by "he", which has no significance aside from making the text more readable.)

To model this situation is a task of O; he forms models of S, of E, and of the S – E relation. In accordance with what we said above, as far as S is concerned, O only models her texts. A further important feature of O's modelling activity is that he models E independently of S. Note why it is so important: cognition is only possible if one distinguishes oneself from the object of one's reflections. In the present case we need not care about how S does so; nevertheless, this requirement is satisfied at O's modelling level.

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1 This is not meant to exclude texts that are usually only used in conversation (e.g. questions, commands, performatives) from the scope of our discussion. It is the range of points of view of modelling rather than the range of texts that is restricted (see e.g. [4], [5]).
In order that $O$ should be able to form the intended models, he must possess the following kinds of knowledge about the sample situation (and $O$ being an ideal observer, we assume he really does):

1. $O$ knows the level at which $S$ may perceive and describe her environment; in other words, he knows $S$'s sensitivity.\(^2\)

2. $O$ knows those fundamental aspects of $E$ that $S$ may describe.

(1)–(2) together ensure that $O$ models $E$ adequately with respect to $S$. Notice however that in spite of this adequacy, we cannot say that $O$ established "S’s model of $E". At present we are not interested in how the system represents her environment (those questions will be tackled in Section 4) and this is not a matter of chance: for speaking about $S$’s representation we first have to know what $E$ itself is like (which, in view of the assumptions in 2.2 means that we have to speak about $O$’s model of $E$). Without anticipating the

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2 The sensitivity of $S$ is actually manifest in the syntax of the language. For instance, let $L_1$ be the language of category theory, which handles objects and morphisms, without specifying what an object exactly is. Such an object may be a topological space or an algebra or a set etc. If now $L_2$ is the language of topology, or algebra, or set theory, then the sensitivity corresponding to $L_2$ is "greater" than that corresponding to $L_1$ since in $L_2$ one also takes the internal structures of $L_1$ objects into account.
discussion of representation, however, we can already state a point according to which Model (E) cannot coincide with "S's model of E":

(3) O knows that S is finite whereas E is both infinite and infinitely complex.

If we take infinity just in a spatial sense, we can say that, as a consequence of (3), S may never know in which part of E she is in. By infinite complexity we mean that E can be described at infinitely many different levels (say, at a "molecular" level, at a "meteorological" level, at a "touristic spectacles" level etc.), and having her fixed level of sensitivity, S may only grasp it at a finite number of levels. Therefore whenever S believes to be talking about some particular phenomenon, she is actually talking about all those possible ones that are identical from her respect but differ from each other in infinitely many other respects. With respect to the S-E relation this means that

(4) O knows that S's actual environment is accidental. The knowledge S may obtain at each stage of her cognition is compatible with infinitely many possible environments (differing in both "extension" and "depth"). The S-E relation is therefore uncertain: the texts of S always correspond to infinitely many environments, rather than a unique one.

On the basis of (1) - (4) O forms the following models:

The model of S will just be a system producing texts (more precisely, the material bodies of texts, whatever they should be). In case O happens to be a mathematician, Model (S) will be a formal grammar capable of generating the texts of the language.

The model of E is a metalinguistic description of the environment, adequate with S's sensitivity. For purely theoretical purposes, O only has to take into account that S has some fixed though arbitrary sensitivity, determining the possible character of the objects and phenomena of E S may describe. (When modelling some concrete language, S's sensitivity is also fixed though no longer arbitrary.) In case O happens to be a mathematician, Model (E) will be a mathematical object. Because of the uncertainty of the S-E relation, Model (E) is a class of models of infinitely many possible environments.

The model of the S-E relation is some correspondence between elements of texts and things in the world—models. In case O happens to be a mathematician, Model (S-E) can be a set of relations or functions.

We have reached the point where we may define language as it appears at this level of abstraction. By an abstract language LA we mean a triple (Model (S), Model (E), Model (S-E)). Furthermore, we call Model (S) the syntax of LA, and Model (E) and Model (S-E) together the semantics of LA. All these models are formed by an ideal external observer and are described in his own language.

3.3 Let us now spell out some of the consequences of this way of modelling language, which we also claim to be the very level of idealization that MTS employs.
(a) MTS takes the descriptive function of language as its point of departure but not out of sheer stubbornness. It does so because this is how the question as to the basic components of language can be answered most simply.

(b) MTS does not and need not have psychological reality because it has nothing to do with the representation of $L$ in the system.

(c) The fact that MTS assigns a class of environment—models to a language (or, in other words, refers to an arbitrary model of it) is not a mere consequence of the mathematical apparatus MTS uses: it reflects the epistemological properties of the modelled situation, that is, the necessary uncertainty of the S–E relation.

(d) As a consequence of (b) and (c), word meanings proper are not objects of MTS; MTS may only take cognizance of their identity or non–identity. For more details, see Section 4 on representation.

(e) As to the objection that MTS is but a translation and thus leads to infinite regression. This argument might be assimilated to the following curious rephrasal of Gödel’s theorem, which may bring out what is false in it: "The notion of consistency is useless, since you cannot prove that calculus$_1$ is consistent, within calculus$_1$. You have to use a metalanguage with calculus$_2$, whose consistency can only be proved within calculus$_3$... so you never can tell whether calculus$_1$ is consistent in an absolute sense". In other words, the requirement that you should be able to prove that your metalinguistic claim is consistent is equivalent to requiring that you should model your object and your own modelling activity simultaneously. This absurdity is excluded by making the role of the observer explicit, i.e. by making the definition of $L_A$ relative to an external observer.

(f) If already speaking about calculi, we may note that model theoretic semantics is not just an alternative to "calculus–semantics", since the question whether a calculus is sound and/or complete cannot be answered without telling what its intended class of models is.

(g) Note that we have not made any specific claim as to what kind of a mathematical apparatus is to be used, e.g. whether Model (E) is to contain classical relational structures or Kripke–models or intensional models or whatever else. That kind of choice depends on both the nature of the language O’s models need to be adequate with and on O’s own inventory of modelling tools. Here we may also note that truth only features in MTS as a metalinguistic device; to say that $\varphi$ is true in a model $m$ is but a mathematically comfortable way of expressing that a certain text (a sentence $\varphi$) corresponds to the situation modelled in $m$ (cf. the model of the S–E relation).

In accordance with the assumption in 2.1, $L_A$ is but one level in the hierarchy of idealizations one has to use when approaching language in its totality. Now we turn to the question of how a language can be represented in the system itself; its explication will hopefully also make the significance of $L_A$–idealizations clearer.
4. Language represented in an abstract system

4.1 We called language as defined as (syntax, semantics) an abstract language since when studying the cognitive situation we abstract from all properties of the system, except for one — we assumed S to have an arbitrary fixed sensitivity. (Notice though that even this was only made use of in modelling E, and not in modelling S herself.) \( L_A \) is not a system's language in the sense that a system might have it or use it; it is not even a language that systems might partially possess. \( L_A \) is an abstract construct, making the basic components of all such languages explicit. From a methodological point of view, \( L_A \) serves as a basis for investigating languages, used by systems, from the angle of their cognitive function.

Assuming that we shall once wish to construct some intelligent system IS we also have to explain what it means for a system to possess a language. For this, it is no longer enough to know what the basic components of language are — we also need to know how they are represented in a system. As a first step, we shall consider an abstract intelligent system and study the abilities necessary for representing and using some language in rather general terms. The concept of language to be formed on this basis is already more concrete than of \( L_A \); we define a general IS-language, one corresponding to the representation of abstract language in an abstract system. For short, we call it a representation language \( L_R \).

As we continue to study the cognitive function, the sample situation remains the same as we envisaged in 3.2. Nevertheless, this level being less abstract, the observer will be assumed to have some further knowledge about the situation. (Keeping in mind the synthesis problem we might alternatively think of this new situation as one in which someone, having the position of an external observer, introduces some language into an intelligent system; in that case instead of telling what O knows about S, we could tell what O grants to S.)

Our study being centered around semantics, let us assume S to have some text-generating device already (syntax). In order that S may use a language, however, she also needs something analogous to the semantics of \( L_A \). The reason why we may only speak of an analogue of semantics here is that semantics, by definition, contains an infinite class of models of E, formed and described by the observer. S might only possess such a thing if she could treat herself and her own environment from the position of an external observer; an assumption which would only complicate the picture but would by no means eliminate the problems we have to cope with if we do not make it.

Let us consider O's knowledge about the situation. In 3.2 O already recognized that S describes E at a fixed level of sensitivity. Now, coming closer to S herself, O postulates that S has some kind of a "perceptor", which determines the nature of her sensitivity (and through which she can receive influences from E — a precondition to internalizing it). Through this perceptor S gets pictures about her environment (the names "perceptor" and "picture" are intended to be most neutral as we continue to abstract from the specific organization of S; "pictures" can be thought of as S-specific changes in her internal
structure, resulting from environmental influences and not vanishing with the moment but remaining stable in \( S \). Pictures are assumed to be objectivistic in the sense that they are adequate representations of \( E \)-events, from some fixed point of view of adequacy.

Nevertheless, pictures cannot be said to be “\( S \)'s models of \( E \)” either. By a model we prefer to mean a result of some "software abstraction" (i.e. goal-orientated and deliberate). It is true that \( S \)'s pictures are "abstract" — e.g. if she has a perceptor through which she can only perceive heat, then her pictures will be a "heat-abstraction" of her environment but this is not a model because this is a result of "hardware abstraction" (i.e. \( S \) cannot help abstracting from everything but heat). As a consequence of these, \( S \) cannot help identifying her pictures with real \( E \)-phenomena either (i.e. she does not treat her pictures as her own states).

In sum, the set of pictures \( S \) gets about her environment constitutes her internal representation of that environment.

Let us now see \( O \)'s knowledge about the environment. At the level of \( L_A \) the observer did not need to care much about what the actual environment of \( S \) was like since he knew it to be accidental. At the representation level, however, this question also becomes crucial as \( S \)'s actual environment determines her possible experiences and thus the nature of her pictures; we assume that \( O \) knows what \( S \)'s actual environment is like. (Parallelly with saying that \( S \) has some arbitrary fixed sensitivity we can say that at this level \( O \) has to take into account some arbitrary fixed member of the class of models of \( E \).) We call \( S \)'s actual environment \( E - ACT \). It is obvious that the objective relationship between pictures and real phenomena is impossible to determine at the level of the system (since her fixed sensitivity and her fixed \( E - ACT \) make her irrevocably subjective), it is only possible to determine at the observer's level.

The set of (lasting) pictures in \( S \) constitute a **system-dependent representation of some \( E - ACT \)**.

The next thing for \( O \) to observe is that there exists a connection between \( S \)'s pictures and texts. (Some of the texts must be directly related to pictures whereas others only need to be reducible to them by operations.) This connection is granted to \( S \) from the outside so to say, by ostentive (deictic) definition. This assumption serves to emphasize the hardware character of the language represented (i.e. that \( S \) has no additional language to talk about this connection). As for the case when \( S \) has to apply this language to further \( E - ACTs \), see 4.3.

Having specified \( O \)'s knowledge about the sample situation, we can tell how he models it.
Fig. 2. Representation language

In the observer's metalanguage names of $S$'s syntactic units and descriptions of $S$'s pictures from pairs. These pairs count as definitions, definiendum being a syntactic unit and definiens being the description of a picture; their pairing models the connection between the respective items in $S$. O calls his own description of a picture the *meaning* of the syntactic unit it is assigned to. Notice the sharp difference between the statuses of pictures and meanings: in $S$ there are only pictures — meanings exclusively belong to O's metalevel.

Fixing the terms we shall use in connection with $L_R$: a *representation language is a pair* (syntax, interpretation), where interpretation consists of a set of meanings plus a meaning—assignment.

4.2 Let us now add a few comments on $L_R$.

(a) As opposed to $L_A$, the semantics component of which contains a class of models of $E$, $L_R$ contains no model of any environment whatsoever. Its interpretation component contains meanings, that is, a description of some system—dependent representation of some $E - ACT$.

(b) Semantics is objective (i.e. relative merely to the observer) whereas interpretation is subjective (i.e. relative to both observer and system). A corollary of this is that to an $L_A$ there correspond infinitely many $L_R$'s, in accordance with the possible subjective ways of representing some part of the environment.
(c) \( L_R \) is the level where word–meanings can be treated in the usual linguistic fashion, that is, by analysing them in terms of oppositions, features etc. In other words, "word–semantics" as opposed to "sentence–semantics" (as these terms are used in linguistic jargon) is a representation problem. The claim that meanings belong to the observer's metalevel does not contradict this: remember that in usual word–semantics one does not investigate what is actually in "people's heads", either. Furthermore, the fact that we treated the language represented on a purely hardware level (i.e. we did not assume the system to be able to talk about her pictures) makes no big difference in this respect. On the one hand, in the course of such an investigation one actually always ignores the metalinguistic abilities of the language–user. On the other hand, whatever metalinguistic abilities one may attribute to a system, those may not have the whole of her representation language in their scope: any system must have a purely hardware level language, analyzable for some external observer only. (For a treatment of word–meanings similar to ours, see Pavilionis [6].)

(d) The general treatment of the \( L_A - L_R \) relation would also require us to model the relationship between pictures and \( E - ACT \) and, further, to model the relationship between \( E - ACT \) and \( E \). These tasks are outside of the scope of the present paper.

4.3 Let us see what happens if the sample situation remains the same as in 4.1 with the exception that \( S \) is assumed to face more than one fixed though arbitrary \( E - ACT \). More exactly, we assume that in connection with one and the same syntactic unit \( S \) may form various pictures on the basis of several \( E - ACTs \) and she may also link them together. As far as this linking is concerned, there are basically two possibilities. The first possibility, which is actually very close to the situation sketched in 4.1 is that these pictures function as elements belonging to different \( L_R \)'s, with the possible variation that \( S \) may also be granted further quasi–metalinguistic devices for identifying the syntactic units related to those pictures. The \( L_R \)-model of this situation will in turn also contain a model of this quasimetalinguistic connection and a model of the relations between pictures assigned to the same syntactic unit. A more interesting second possibility is that \( S \) does not merely link those pictures together in the manner described above but she also forms some kind of a secondary picture out of them (where by 'forms' we may either mean some goal–governed software abstraction or just some hardware abstraction in the case of which those secondary pictures are actually formed by the teacher–observer and are built into the system). Such secondary pictures are conceived of as concepts that comprise the features common to all (primary pictures of) real phenomena that are associated with the same syntactic unit. The sharp difference between this possibility and the former one consists in the fact that in case \( S \) is faced with an \( n + 1 \)th \( E - ACT \), in the first case she has to wait as long as \( O \) also teaches her to handle this \( E - ACT \) as well, whereas in the second case she may apply the syntactic units she already has to the pictures she gets about this new \( E - ACT \), using the respective concept as a mediating device. In other words, although her concepts are formed on the basis of some designated \( E - ACTs \), these concepts are further applicable to brand–new ones as well, which grants a great amount of independence to \( S \) (a manipulated
kind of independence, though). We may also note that concepts (secondary pictures) are already quite similar to what we would like natural linguistic meaning to be models of.

Both possibilities agree in that they have important consequences for the $L_A$-level. So-called classical (that is, purely extensional) models of $E$ seem to be intuitively adequate for the more primitive situation which we described in 4.1, whereas the more complex cases of representation are matched by intensional models of $E$ at the $L_A$-level. Intensional models (or, non-classical models in general) differ from classical ones in that they regard different possible worlds or things occurring in different possible worlds as alternatives to one another, in other words, as possible realizations of one and the same thing. In this sense intensions are $L_A$-level counterparts to $L_R$-level conceptual meanings: meanings specify why the system applies the same syntactic unit to different things she encounters, whereas intensions specify how she would have to use them in all possible situations. The fact that $S$'s concepts are formed on the basis of a subclass of all possible $E$-ACTs can be reflected at the $L_A$-level by the use of meaning postulates as employed by Montague: meaning postulates being non-logical axioms, they can be thought of as restricting the class of all possible worlds to the subclass which conforms to $S$'s initial $E$-ACTs.

In sum, intensions and (conceptual) meanings belong to two radically different levels of idealization but still closely correspond to each other, which justifies the use of intensions as reflections of meanings at the $L_A$-level. The radical difference between them, however, makes it clear why intensional semantics may not be expected to account for traditional questions arising in connection with word-meanings: the meanings that are analysable in terms of oppositions etc. are par excellence $L_R$-level units (i.e. models of $S$'s pictures).

5. Goals and cognition

Very briefly, we may sketch a third level of abstraction in this paradigm, in which we also take the existence of non-linguistic components of $S$ into account. We may say that the functioning of those non-linguistic components can be at an abstract level characterized with a set of goals (e.g. that $S$ wants to survive, at least). In order for $S$ to achieve those goals she must have a perceptor adequate with her goals (e.g. if she has to be afraid of microbes, she must be able to perceive them so that she can avoid them). Therefore the kind of $L_R$ she has is a function of her goals. Obviously, this implies that goals are granted to $S$ at a hardware level, too. In the case of an intelligent system proper (e.g. if $S$ is an adaptive system) we assume that in addition to hardware-goals she can set a number of further goals in the course of her functioning, which also necessitates that she should be able to alter her sensitivity and $L_R$. This problem, however, belongs to the scope of the theory of intelligent systems rather than to the scope of linguistics, and since at present we focus on questions strictly connected with language we do not elaborate at this point here.
Notice that in Sections 3, 4 and 5 we did not talk about three different systems: the system remained the same but was viewed at different levels of abstraction.

Even if one does not wish to go into linguistic and mathematical details it is apparent that at least two large sets of problems are missing from the above treatment: (i) the application of the results of Sections 3 and 4 to more complex cases, approximating the complexity of natural language, and (ii) the treatment of communication in the same methodological paradigm. We are convinced that (i) and (ii) do belong here; nevertheless, they must be objects for further research.

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