

SKETCH OF A PARTIAL SIMULATION OF THE CONCEPT OF MEANING IN AN AUTOMATON

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Introduction

Under the influence of Miller, Brünér and Chomsky's ⁽¹⁾ studies people agree — generally speaking — that «a cultured language» constitutes one of the typical characteristics of our kind. This means that, in the attempts momentarily being made at simulating the important characteristics of mankind in an «automaton» ⁽²⁾, the problem of the simulation of the phenomenon «language» occupies an important place ⁽³⁾. This simulation of important human characteristics and of the language in particular, is of importance due to the great precision needed for this and due to the heuristic base which this approach offers.

With this article we hope to contribute to the simulation of the language, by simulation of a concept which is traditionally regarded as central for the language, but which today is repressed by many, viz. the concept «meaning.»

The repression of this concept «meaning» usually occurs based on the arguments in the nature of those, repeatedly formulated by Quine W.v.O. ⁽⁴⁾. The nucleus of this criticism seems to us to come

(1) CHOMSKY, N., MILLER, A.G., «Introduction to the formal Analyses of Natural Languages». Chapter, 11 pp. 269. In «*Handbook of Mathematical Psychology*», Volume II, edited by LUCE, R. D., BUSH, R. R., GANLANter, E., New York, Wiley, 1963.

(2) For the explanation of concept 'simulation' see, amongst others: KESSEN, W., «Discussion strong and weak simulation Mimic or Model» from «*Computer Simulation of Personality*», Frontier of Psychological Theory, John Wiley and Sons, Inc., New York, 1963., Our licentiate treatise «Schets voor een gedeeltelijke simulatie van het betekenisbegrip in een automaton» (sketch of a partial simulation of the concept «Meaning»), 1956, pp. 204-233.

(3) attempts at simulation: «*Computer Simulation of Personality*». Frontier of Psychological Theory, John Wiley and Sons, Inc., New York, 1963.

(4) QUINE, W.v.O., — «*From a logical point of view*». pp. 47-48, Logico-

down to the conception that «meaning» is a psychological — even psychologically a doubtful — element which certainly does not belong to language.

The discarding of this concept «meaning» then also wavers all the linguistic concepts which are based on «meaning» and requires either the rejection or the otherwise defining of these concepts.

Here we want to sketch a proposal of interpretation of the concept «meaning» by simulation. This proposal escapes — according to us — the criticism of Quine and others. A second advantage of our interpretation of the concept of meaning is, that it can be very well integrated in syntax, semantic and pragmatic and that thereby the traditional terms defined by means of meaning again become definable and their manipulability is preserved here ⁽⁵⁾.

In section I we have elaborated this sketch for simulation of the concept meaning. The results will be that the meaning of a sign will be reduced to a fragment of a specific type of program for an «automaton». In section II we have very shortly tried to demonstrate, by defining a number of linguistic concepts, the possibility of our approach. In section III we have very superficially pointed out a possible direction for explaining the genesis of what we call meaning, taking into account the important position meaning takes in our interpretation for communication. Finally, in a post-script, we have mentioned a few problems which present themselves in our approach of the language, and particularly for our approach with simulation of meaning.

We would also like to take this opportunity to thank Prof. L. Apostel, of the Ghent State University, without whom we would never have formed these conceptions, also Professors Noam Chomsky of the Massachusetts Institute of Technology, Harry Hiz of the University of Pennsylvania and J. Dopp of the Univer-

philosophical essays, Harper Torch Books, The Science Library TB 566 New York, 1963., — «Le mythe de la signification» from «*Cahier de Royaumont, Philosophie*», N° IV, Les éditions de minuit, 1962.

⁽⁵⁾ This has been extensively worked out in our above-mentioned licentiate treatise and also schematically in our article «Esquisse d'un essai de simulation de langage dans un automate en vue d'éclairer la notion Signification», *Actes du XIIIème, Congrès des Sociétés de Philosophie de langue française*, Genève 1966, *Le Langage*, Neuchatel, La Baconnière, 1966, pp. 223-226.

sity of Louvain, who by their indications have influenced the structure and the treatment of this work. For the imperfections we naturally remain solely responsible.

I. SIMULATION OF MEANING

In this sub-division we have attempted to discuss the most important properties of the automaton used, which — according to us — influence, or are closely related to, the concept of meaning as we simulate it.

In this frame we have endeavoured to work in the simulation of the concepts : *meaning*, *sign* and *denotatum*.

A. *Description of inputs, the transmission of this description to the description-model and the contents of the description-model.*

By the *description* of an input we mean a definite «datum», e.g. a binary number, that an input will cause the automaton to produce as one of its internal states, in function of the input-unit and of the main program, and in which form the input will further influence the activity of the automaton.

By *description-model* we mean a part of the memory-unit of the automaton, in which the descriptions of the inputs are stored.

In a digital automaton A ⁽⁶⁾ we have a number of places (*receptors*) along which the automaton can receive inputs. We call an input *accepted* when it gets a certain description, which is stored in the input-register. An *input-register* is a composition of memory-cells (storage) which constitutes a part of the input-unit and where descriptions (for us sequences of noughts and ones) can be stored.

We can compare the receptors to the receptors of a person such as hearing, touch, smell... The nature of the stimulus which is

⁽⁶⁾ We shall construct the sketch for simulation for a digital automaton. This, however, not because our theory is limited to a digital automaton and would not be extendable to an analog automaton, but because the explanation becomes easier, and also because we are more familiar with digital automata than with analog automata.

accepted by the input receptors (viz. which will receive a description to be included in the input-register), when these are ready to receive, is dependant on the characteristics of the input-cells (these are cells which form an input-receptor) and of the input-unit as a whole.

The descriptions stored in the input-register will be transmitted to the description-model, at the order of the main program (after having been brought by the abstractors (7) or not). They will be stored in the description-model according to a well determined strategy (8), a strategy which must see that as few identical descriptions as possible will be stored in different places of the model. In case the storage strategy establishes that the description is not yet stored in the model description, then, by order of the main program, this description will be transmitted from the input-register to a well determined place in the description-model. But, if the description appears in the input-register and if this description has already been previously stored in the description-model and has not yet been erased, then, by means of the storage strategy (storage program), this description must be reactivated in the model (activation e.g. by increasing the magnetism in the memory cells in question where this description is stored).

The following situation is also conceivable, viz. that in the input-register the descriptions are stored in order of appearance at the input-receptor and, once the input-register is full, the contents of this register is stored by means of the storage strategy just explained.

Now one could get the impression that only descriptions from inputs are present in the model. It is however not excluded that also results of compilations with elements already previously

(7) The essential task of an abstractor is the disregarding of an amount of information in a description, so that it results in a less great diversity or even an identity of certain descriptions or series of descriptions. Working out of abstractors i.a. CULBERTSON, J.T., *«Consciousness and Behaviour»*, pp. 83-126, W. Mc Brown Company, 1950.

(8) Explanation of different storage strategies in our above-mentioned licentiate-work, pp. 74-83; also HALLE and STEVENS, *«Speech Recognition: A model and a program for research»* from *«The Structure of Language»*, Readings in the Philosophy of Language, ed. by Jerry A. FODOR, Jerold J. KATZ, Prentice Hall Inc., New Jersey, 1964.

stored in the memory are admitted, after having been brought in an abstractor or not. It is also possible that information concerning internal conditions of the automaton can be stocked. We do not exclude either the possibility that, before any information is brought in, along input or internal observation, the description-model already contained description series (thus a priori elements). These may possibly be explained as necessarily or accidentally ensuing from the construction of the automaton.

With the data we have assumed up to now, solipsism remains possible, viz. in case every input would be an output of the automaton. Realism as well as idealism also remain possible.

B. *Description-model-program.*

A part of the descriptions of inputs will however, when they are transmitted to the description-model, not only activate their own description through the storage program. Through medium of the description-model-program⁽⁹⁾ it is possible that, when a certain part of the description-model is activated (this part we call «the activator»), another part of the model can also be activated (the activated). The inputs, of which the respective description possesses this property (of thus not only activating these cells in the description-model in which the respective descriptions are stored, but also other cells from the description-model) will actually be a subclass of the inputs. This class we call I_t . The class of the respective descriptions of the inputs which belong to I_t we call B_t .

C. *Output-program*

The output-program which regulates the activation of the output components and makes the necessary activation currents available for the activation components is dependant on the state of the automaton. The execution of certain parts of the output-program

⁽⁹⁾ The description-model-program is a program which determines the mutual dependance of activity of cells or groups of cells in the description-model.

can be dependant on the state of different parts of the automaton (control-unit, work-unit, input-unit, memory, work-memory, model description...).

If a part of the output-program is such that, in order to execute it, activations must be in two different parts of the automaton (one e.g. in the description-model and an other from the control-unit to the output-unit), then, when one or the other is present, we can say that there is a *disposition* for a certain output. However, as this 'partial' activation can be a necessary condition for various outputs, the result of this activation will thus be a disposition for a class of outputs. This class we call the *disposition class of the activation*.

Expressed generally, a disposition to an output is a state of a part of an organism at a certain moment, such that — under certain supplementary conditions — the output in question occurs ⁽¹⁰⁾.

So a disposition must not always be a certain activation in an automaton; sometimes a state of inactivity of a certain part of the model can be a necessary condition for an output. The inactivity of this part will then be a disposition for this output.

D. *Association- and meaning-programs*

These two programs, association-program and meaning-program, are part-programs of the description-model-program, which — according to us — one must clearly distinguish from one another. Both programs activate, on the grounds of activation of a certain part of the model, another part of the model. The distinction between both seems to us the main point to be determined, in the difference which it involves for a description, stored in the descrip-

⁽¹⁰⁾ Related definitions of *disposition* we find in — MORRIS, Ch., «*Sign, Language and Behaviour*», Prentice-Hall Inc., New York, 1946., — MOWRER, O.H., «Some Methods of Measurement», (*Psychological Review*. Monograph supplements, Vol. 52) 1940., — MOWRER, O.H., «A Stimulus-response Analysis of Anxiety and its Role as a Reinforcing Agent», (*Psychological Review*, Vol. 46.) 1939., — HULL, Cl., «*Principles of behaviour*», D. Appleton, Century Company Inc., New York, 1943.

tion-model, to be activated, namely by the association-program or by the meaning-program.

A first difference between the programs seems to us to be that, for the working of the automaton — besides for the description-model-program and for the output-program which produces the outputs as signs (for definition of *sign* see further) — the activator for the association-program (*associaturum*) will be of primary interest and the activated (the *associated*) only secondary. For a meaning-program we have just the opposite with the activator and the activated. A second difference between the two programs is that a description in the description-model which is activated by the meaning-program causes the same or almost the same disposition (see B above) at the output-program, as when this description would be directly activated by an input-description identical with this description (thus independant of the description-model-program). On the other hand, an element activated by the association-program, will cause another, or at least a less powerfull, disposition for the output-program than that caused by the same description, activated by the meaning-program or by input ⁽¹¹⁾.

We can make another distinction on the base of the nature of the factors which form both programs. The association-program will be formed on grounds of relations such as continuity, similarity, causality, etc... such as we then find back classically in Aristotle, Hume ⁽¹²⁾. The meaning-program will be *independant* of these factors (more over genesis of the meaning-program further see section III).

As the association-program will be dependant on the above-mentioned factors, a very high dynamism of the association-program will be possible. The meaning-program can also be dynamic, but only to a much lesser degree. The reason must be sought in the elements which determine the alternation of the meaning-program (see section III).

After all this, we can thus regard the *meaning-program* as that

⁽¹¹⁾ This is worked out in greater detail in our licentiate treatise, pp. 119-122, 134-137.

⁽¹²⁾ ARISTOTELES., περί μνήμης II, 451b 18-20, and HUME, «Essai sur l'entendement humain», III.

part of the description-model which possesses the three above-mentioned properties.

E. *Sign, meaning, denotatum*

The inputs or input-series of which the descriptions transmitted to the description-model are activators, we have called I_t (see B above). The inputs of which the descriptions are «activators» for the meaning-program we call I_m .

We deem it very likely that there are inputs of which the descriptions are «activators» for meaning- as well as for association-program.

The class of the descriptions of the inputs belonging to I_m , we call M_I . M_I is a proper subclass of B_t , viz. the descriptions of the inputs belonging to I_t .

M_I we call a proper subclass of the «signs»

That which has been activated in the description-model on ground of the meaning-program at a description which belongs to M_I , we call «*the denotatum*» of this description, which we have called a *sign*.

Of the signs belonging to M_I we can say that they are bound with pairs, triads, etc... of elements in the descriptions-model, as they can activate, by means of the meaning-program, one or more of the descriptions stored in the description-model.

A distinction must however be made between the case of one sign which is bound to various others and will be bound to those other descriptions in all contexts, and the case where a sign is relative to the context (viz. other activations) and which is in one context bound by the meaning-program to a certain description and in another context to another.

F. *Expansion of the sign-concept*

The explanation why a certain *sign* X, possesses the definite *denotatum* Y, is to be found in the meaning-program. Let us as-

sume that P_t is the part of the meaning-program which connects the sign X to the denotatum Y.

Of each part of the descriptive-series, which is necessary and sufficient so that a part of P_t will be executed (P_t which connects a denotatum to the whole descriptive series), we shall say that it 'has meaning'.

The meaning of every descriptive series will be, that part of the meaning-program which determines the working of the description.

This «meaning» determination has as result that, if there are descriptions which are not brought in contact with a denotatum, by the meaning-program but on the contrary execute operations on denotata, on meanings, or place relations between relations of signs with their denotata, or operations on these relations, we shall also say that these descriptions 'have meaning'.

Every description which has meaning, we shall call a *sign*.

To the problem whether the class of signs which possess no denotatum is empty or not, we are inclined to say «no». We ourselves regard, amongst others, the logical operators to be of this kind. For the «negation» we have worked out, in our already repeatedly mentioned licentiate work, an interpretation of the negation as an operator on «meaning»⁽¹³⁾. In this we have been strongly inspired by the interpretation of the negation by KATZ in «*Analyticity and contradiction in natural language*»⁽¹⁴⁾.

II. MEANING AND ITS RELATION WITH LANGUAGE AND WITH CONCEPTS ASSOCIATED WITH LANGUAGE

Starting from our definition of sign, meaning, denotatum, we shall here define a number of «concepts» to indicate the possibility of our approach.

⁽¹³⁾ Our licentiate treatise, pp. 177-186.

⁽¹⁴⁾ KATZ, J.J., «Analyticity and contradiction in natural language», from «*The structure of language*», ed. by FODOR, J.A. and KATZ, J.J., Prentice-Hall Inc., New Jersey, 1964.

1. Communication.

Communication, in the broad sense of the word, is the process of communicating a characteristic ⁽¹⁵⁾. In the narrow sense, *communication* is to us the process between different automata whereby, by means of signs emitted from the one automaton, *descriptions are activated in respective description-models, descriptions however of identical «data»*.

Signs which are communicable in regard to a certain automaton (automata), we shall call «*com-signs*».

2. Language

Language is a system of com-signs which however can only be combined in a sequence according to certain rules. The rules will be stored in a «*selector*». These rules are of two *kinds*.

Firstly all rules which point out the permitted sign connections, viz. which indicate categories from which the permitted sign connections are constructed. These categories are determined in function of the relation between the different categories. The totality of these rules, we shall call the *grammar*.

The second type of rules in the selector are those which determine the meaning of a sign, which consists of combinations of signs, in function of the meaning of these signs.

In order to indicate the desired denotata in accordance with these rules, a certain strategy must be followed to apply both types of rules. Different possibilities remain open here ⁽¹⁶⁾.

3. Connotatum

In the widest interpretation, it is everything which, when a sign of the series of signs denotes something, can possibly be activated

⁽¹⁵⁾ MORRIS, Ch., «*Sign, Language, Behaviour*», Prentice-Hall Inc. New Jersey, 1946, p. 118.

⁽¹⁶⁾ Two methods are sketched by us in our licentiate treatise, pp. 152-156, 168-169.

by the denotatum and for which the activation of the denotatum by the signs, via the meaning-program, is a necessary condition.

4. Morpheme

A *morpheme* is a language-sign which is meaningful, and which itself is not divisible into smaller meaningful elements, which are language-signs (Lazlo Antal, Bloch-Trager, Bloomfield) (17). The meaning of a combination of morphemes is a combination of the meanings of the morphemes which constitute it.

5. Phoneme

A *phoneme* is not a language-sign, but only a part of a language-sign (see note 18). The criterium to see whether two sounds *a* and *b* are different phonemes in a language is, if there is in this language a language-sign which, when we replace there in *a* by *b*, this language sign gets another meaning. This criterium is also treated, amongst others, by Quine (19).

6. Synonymy

Synonymy₁

Two language-signs are *synonymous₁* if the *meaning* of both language-signs is identical.

Synonymy₂

If two language-signs have one and the same *denotatum*, but not

(17) LAZLO, A., «*Questions of Meaning*», Mouton & Co., The Hague, 1963., BLOCH-TRAGER, «*Outline of Linguistic Analysis*», Baltimore, Linguistic Society of America, 1940., BLOOMFIELD, «*Language*», New York, Holt, 1933.

(18) HJELMLEV, «*Prolegomena to a theory of language*» pp. 25, Baltimore, 1953., LAZLO, A., «*Questions of meaning*», pp. 71-73, Mouton & Co, The Hague, 1963.

(19) QUINE, W.V.O., «*From a logical point of view*», Harper Torch Books, The Science Library TB 566, New York, 1963.

necessarily one and the same meaning, nor one and the same connotatum, they are *synonymous*₂.

Synonymy₃

If there is one and the same *connotatum* for two language-signs they are *synonymous*₃. According to the nature of the dividing classes which we differentiate in the connotatum, we can construct further concepts of synonymy, viz. with one and the same special type of connotatum.

7. Polysemy

The meaning of a language-sign is that part of the meaning-program which determines the working of this language-sign. It is clear that in such a definition of meaning no *polysemy* is possible. In the meaning of a language-sign, however, «branch instruction» can appear, so that relativation to a context is possible, and that, dependant on the context, a different denotatum is connected to the language-sign, or in other words, a certain partial meaning of the sign is chosen, dependant on the context.

8. Homonymy

Language-signs are *homonyms*, when *they are similar* ⁽²⁰⁾ *to each other, and each have a different meaning*. This similarity must

(20) In our licentiate thesis pp. 205-232, as also in the article «An explication of the concept 'analogy'» to appear in «*Studia Philosophica Gandensis*, 4, 1967, Ghent», we have attempted two ways to formalize and quantify «analogy» relative to an automaton. Our first interpretation of «analogy» seems to us to be synonymous with «similarity».

We have succeeded in proving that our quantification function for analogy is a distance function. One gets 0 with identity (for the automaton) and 1 with maximal difference for the automaton. Now one could define that, when the analogy between two inputs for an automaton are smaller than 0.20 and more than zero and when both signs have different meanings, then one has homonymy.

be determined relative to an automaton and relative to a certain language. The descriptions of inputs are in internal relation with the language in question.

9. Definition

The *definition* of definiendum is a series of language-signs such that there will be synonymy between the definiendum and this series of signs. According to the kind of synonymy that we use, we can have different kinds of definition-concepts. By means of definitions, new language-signs can be introduced into a certain language, viz.

- a) if there are outputs which, when their description would have meaning, would be com-signs,
- b) if there is a meaning given to these elements, which is identical — as agreed — to the meaning of a series of language-signs,
- c) if a grammatical category is added to the com-sign.

In order that this should be possible, there must be signs belonging to the language-signs, which can indicate that a certain description will receive the meaning of a series of other language-signs. It must also be possible to indicate by means of language-signs that a description must be treated as if belonging to a certain grammatical category. By the introduction of the concept «definition», we have the possibility of expanding a certain language-system.

10. Translation

The *translation* of a sentence from one language into a sentence of another language, if hereby one means that both sentences are completely synonymous in meaning, is — according to us — usually impossible. We think that two sign-series from different languages can have the same meaning, but usually this isn't actually so. With *translating* one generally means: the *translating of a sentence from one language into a sentence of another language, but in such a way*

that both would be denotata-synonymous (synonymous₂). The following passage from Lazlo Antal ⁽²¹⁾ typifies our conception well: «Translation as a process is nothing more than an activity in which a denotatum is rendered by the meanings of language into which the translation is made».

We do agree, that our pessimistic view of meaning-translation must be either justified or refuted by actual research.

III. GENESIS OF THE MEANING-PROGRAM

In our description of communication between automata, a number of conditions must be fulfilled so that communication would be possible ⁽²²⁾. In the first place we must mention, in connection with this, that an identical meaning-program must be present in the automata between which communication is possible. How can these conditions be fulfilled?

One possibility for solution, which we shall not work out here, is to include the different automata, between which communication is possible in a certain language, as part-automata of a complexer automaton ⁽²³⁾.

The program of the more complex automaton will determine the program of its parts, which are themselves automata. This complexer automaton can then possibly determine the program (and the subprograms) of its parts, so that communication between the parts is possible. The dynamics of the program of the complex automaton (total-automaton), will determine the dynamics of the

⁽²¹⁾ LAZLO, A., «*Questions of Meaning*», Mouton & Co, The Hague, 1963.

⁽²²⁾ Our licentiate treatise, pp. 146-150.

⁽²³⁾ For this see e.g. VON NEUMANN, J., who describes the working of a Turingmachine, of which the parts are themselves Turingmachines. This in «Probabilistic logics and the synthesis of reliable organism from unreliable components» in «*Automata Studies*», (C.E. Shannon and J.Mc Carthy, eds.), pp. 43-98, Princeton University Press, New Jersey, 1956.

The same idea we also find in BURKS, A.W., «Computation- behaviour and structure in fixed and growing automata» in «*Self-Organizing Systems*», Papers of the Interdisciplinary Conf. on Self-Organizing Systems, Chicago, 1959, (M.C. Yovits, ed.), pp. 282-311 Pergamon Press, New York, 1960.

programs of its part-automata. Possibly, the dynamics of the programs of the part-automata will also determine the dynamics of the program of the complex automaton.

The translating possibility between different languages can possibly be explained by the introduction of total-automata of the second degree, which have total-automata, total-automata of the first degree, each containing a certain language, as parts. The program of the total-automaton of the second degree will determine the programs of total-automata of the first degree, which are its parts, so that translation of denotata or of meaning is possible.

Another solution for the necessary agreements in automata, so that communication would be possible, might be sought in the effects of the nature of the inputs on different automata with identical properties and of which the programs are formed and evolved on the base of certain characteristics of the inputs to be received.

A combination of both these possible directions in the search for a solution may be the most fruitful.

IV. POST-SCRIPT

When reading this article many will want to ask themselves different questions. Perhaps first of all people will ask themselves to what extent our concept of meaning, which we have explained and defined by means of simulation, will be usable for natural languages. This problem we certainly want to leave unanswered for the moment. But we would, however, like to point out that the conceptions of meaning of Lazlo Antal, Wittgenstein (*Philosophical Investigations*) Christensen, Lewis, Morris⁽²⁴⁾ also follow the direc-

(²⁴) LAZLO, A., — «*Questions of meaning*», pp. 7-95, Series «*Janua Linguarum*», series minor XXVII, Mouton & Co., The Hague, 1963., — «Content, meaning and understanding», pp. 7-63, Series «*Janua Linguarum*», series minor XXXI, Mouton & Co., The Hague, 1963., — «Meaning and its change», pp. 14-29, from «*Linguistics*», June 1964 (6)., — «*Linguistics*», December, 1963 (2). pp. 16-26., — Review: Niels Egmont Christensen on the nature of meaning», from «*Linguistics*», December, 1963 (2), pp. 85-96., MORRIS, Ch., «*Foundation of a theory of Signs*», Prentice-Hall Inc., New York, 1946., WITTGENSTEIN, L., «*Philosophical Investigations*», Oxford, 1953., CHRISTEN-

tion of our interpretation of meaning, which actually can be reduced to the hypothesis explaining *why such a sign corresponds to such a denotatum*.

Another problem which we shall also leave unanswered for the moment, but which certainly is very important, is the problem how the meaning of a word from the natural languages must be determined in the cases where it is necessary that it must be determined, and with which criteria it can actually be distinguished whether a sign possesses meaning or not (according to our interpretation) for a certain person.

SEN, N.E., «*On the nature of meanings*», pp. 233, Mundsgaard, Copenhagen, 1961., LEWIS, C.I., «*An analysis of Knowledge and Valuation*», pp. 133, Lasalle I, 11, Open Court, 1940.

Ghent

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