

# Information and Philosophy

## Some preliminary remarks

Information is not a traditional philosophical term. In Scholastic philosophy the word "informatio" is sometimes used as meaning "the process of giving a form to matter". In Modern philosophy the word has mostly disappeared and, in the sense of communication, it never had a philosophical meaning. Indexes to the works of philosophers such as Descartes, Spinoza, Hume and Hegel do not even mention the word. Also the philosophical dictionaries of Eisler, Lalande and Baldwin seem to regard only the Scholastic meaning as a philosophical one. Considering that the processes connected with the receiving and transmitting of information belong to the most important human activities, we cannot but be surprised by this situation. It is true, of course, that part of the problems related to information is treated under the heading of such concepts as perception, knowledge, intelligence, experience, learning, and language, but it is clear that, in this way, the aspects these notions have in common were neglected.

During the last fifteen years this situation has apparently changed. We do not have in mind the works of philosophers who use the word in its common sense meaning. A typical example of them would be Bertrand Russell, who makes frequent use of it <sup>1</sup> apparently without considering it as a philosophical term ; symptomatic of this is his not giving a definition of it and his not mentioning it in the index to his work. We are more interested in works such as those of Wiener, Ruyer, Bonsacq, Costa de Beauregard and others, who doubtlessly use the word with philosophical import. <sup>2</sup> At any rate, in their expositions they explore areas which traditionally belong to the realm of philosophical inquiry, in which their objects are, for example, the theory of knowledge and the notions of structure, order, form and organization.

<sup>1</sup> e.g. RUSSELL, B., *Human knowledge, its scope and limits* ; pp. 71-77.

<sup>2</sup> BONSACQ, F., *Information, Thermodynamique, Vie et Pensée*. Paris, 1961.

COSTA DE BEAUREGARD, O., *Le second Principe de la Science du Temps. Entropie, Information, Irréversibilité*. Paris, 1963.

RUYER, R., *La Cybernétique et l'Origine de l'Information*. Paris, 1954.

WIENER, N., *The human Use of human Beings*. Boston, 1954.

Considering this growing interest in the concept of information, it is surprising that few attempts have been made to give it an exact and general definition. There are some who, like Russell, neglect the problem of definition entirely; others, like Colin Cherry, doubt the possibility of arriving at an exact definition or, like S.S. Stevens, hold that each science demands of this word a specific definition peculiar to that science. Still others maintain that the concept of information needs no definition, the *measure of information* containing all its meaningful aspects.<sup>3</sup> Wiener and Ruyer offer somewhat vague definitions which, nevertheless, present some important aspects<sup>4</sup>. A more serious attempt at definition has been made by Mackay; he however considers only what we could call "man-to-man information" and does not deal with communication of information, neither from man to machine nor from machine to machine.<sup>5</sup>

We agree with Wiener, however, that it makes sense to talk about information in connection with machines as well as with men.<sup>6</sup> Consequently, it is our intention in this paper to give a definition that will be broad enough to cover all these forms of information and, at the same time, to indicate the aspects these different forms have in common.

In rebuttal to Wilkinson, who has remarked that to distinguish "information" from "quantity of information" is meaningless, we might point out first that information is always regarded as something which is communicated, so that the question may be asked how this communication process happens and in what way it differs from other forms of communication such as communication of calories in metabolism. Besides this question of what is information, another possible question is how one bit of information, one communication, can differ from another. Apparently, the notion of "quantity of information" will provide us with no answer to the first question: the measure of a thing does not tell us what it is.<sup>7</sup> As to the sec-

<sup>3</sup> "Our strictly operational view of this measure makes it meaningless to distinguish between *information* and *quantity of information*" WILKINSON, J., *The concept of information and the unity of science*. Phil. of Science, XXVIII, (1961), pp. 406-413.

<sup>4</sup> "L'information au sens ordinaire du mot est la transmission à un être conscient d'une signification, d'une notion, par le moyen d'un message plus ou moins conventionnel et par un pattern spatio-temporel ..." RUYER, *o.c.* p. 7

"Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it." WIENER, *o.c.* p. 17.

"Messages are themselves a form of pattern and organisation", WIENER, *o.c.* p. 21.

<sup>5</sup> MACKAY, D.M., *Operational aspects of some fundamental concepts of human communication*. Synthese, IX, pp. 182-189.

<sup>6</sup> "It is my thesis that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feed-back". WIENER, *o.c.* p. 26.

<sup>7</sup> "It is always important to distinguish between a physical property (attribute, quality)

ond question, it seems also that the quantity of information provides no criterion for distinguishing between communications. Upon the birth of his child Mr. Jones can give us two kinds of messages, e.g. "1" (it is a boy) or "0" (it is a girl); because these messages are equally probable, each message has the same quantity according to the selective information measure (Shannon). Nevertheless, these are two different communications.

Against the objection that communication between machines and communication between men cannot be compared because there is too great a difference of level between them, we can put forward that an attempt at comparison is more representative of a scientific attitude than is the a priori statement that a comparison is impossible. Moreover, in the study of very complicated forms of communication such as perception and language, it may be very useful to start from a more simple level and to search whether it is possible to reduce the more complicated forms to the simple ones.

The general definition, whose composition is the purpose of this paper, will not be a purely formal one based on axioms, but rather will initially draw from the everyday usage of this term, for we hope that this usage can teach us something about the essential features of information.

It is typical of the pre-analytical usage of language that we employ the same word for a set of partly different objects without being conscious of why we denote them by the same name. Moreover, it is a fact that for some objects we know without any doubt that they belong to a given class and for others that they do not. In many cases, however, there remains a number of objects of whose classification we are uncertain. Our method of analysis will be such that we will begin with one large class, which is determined by a small number of criteria and to which all objects to be studied certainly belong. Further, by comparing subclasses of this head class, it will be possible to us to establish new criteria until we can determine with certainty the limits of the class to be defined. It is evident that the meaning of this word resulting from the final definition will be somewhat different from the pre-analytical meaning (by virtue of its greater clarity, for example). Moreover in selecting the criteria there is a certain degree of free choice. A right choice will be one which permits us to deal with a greater number of problems.

Following this method, we will begin our investigation by stating that all forms of emitting and receiving information can be subsumed under the general notion of *influence*, either of a system upon its surroundings or vice versa.

We speak of systems because we wish our definition to be as general as possible. To realise our objective, it is not necessary to give an exact definition of "system", although we are of the opinion that it is possible to arrive at such a definition through set-theoretical and topological means. We will use this word in an intuitive way as is mostly done in cybernetics and physics. Describing it more precisely, we might say that by "system" is meant every set of elements which, by some physical, chemical, or like features, forms a certain unity which is distinguishable from its surroundings.

We can distinguish first an *absolutely isolated system*, which has no interaction with its surroundings ; it is clear that such a system exists only as an abstraction. Next to be considered is an *unisolated system*, viz. a system which, over its whole surface, is subject to interaction with its surroundings. Examples of such systems are rocks, planets, clouds etc. Finally we consider a *relatively isolated system*, viz. a system "which is influenced by the rest of the Universe, but only in certain specified ways called *inputs*, and influences the rest of the Universe but only in certain specified ways called *outputs*." <sup>8</sup> Living organisms and machines can be considered as such relatively isolated systems. By *influence* we mean every factor bringing about a change either in the system itself or in its relations with the surroundings.

Not all forms of influence can be called information. There are, for example, forces which work upon the system as a whole, viz. changing its location, or heating or destroying it. Let us call these *global influences*. Examples of such influences are all kinds of radiation, gravitation, magnetism, pushing and pulling. In everyday language no one refers to information in connection with *global influences*. A locomotive pulling a train gives no information to it, not does a boxer who knocks out his opponent. It is typical for global influences that they have an immediate effect and show an aspect of interaction, e.g. the "action and reaction" in mechanical processes and the changes of entropy in heating processes. It should also be stressed that all forms of influence, regardless of how small they may be, always possess in some way this global feature. To be distinguished from *global influences* are *local influences*, i.e. factors bringing about a change in the system only through the inputs, and in the surroundings only through the outputs.

Of course, these local influences can only exist in connection with relatively isolated systems. With closer examination, we see that these systems transform the energy supplied to them from one form to another, and they are often capable of storing energy (e.g. batteries of cars, glycogen reserves in the

<sup>8</sup> Cfr. GRENIEWSKI, H., *Cybernetics without mathematics*, London, 1961. pp. 9-10.

human body). These systems do not necessarily react immediately as in the case of global influences. Since in most cases a particular input or output can receive or emit only one particular form of energy, distinguishable states of the inputs (outputs) are varied only according to the amount of energy involved. A system with local influences, which can *transform* energy (i.e. the form of energy of the input is different from that of the output) or *store it* (i.e. the amount of energy at the output is not a function of the amount at the input at a given moment) will be called an *energy-system* or *E-system*. Besides these E-systems there exist other relatively isolated systems which can transform or store *matter*. Such are systems which change the external form, the physical state, the chemical or atomic structure of the input matter (e.g. grinding, evaporation, crystallisation ...). In many cases this transformation is accompanied by a process of sorting by which the output matter is classified according to some criteria. Let us call these systems which transform or store matter *matter systems* or *M-systems*.

It is evident that in practice it is difficult to make a clear distinction between E-systems and M-systems. Because energy is necessary in every transformation of matter almost all M-systems have energy inputs. Moreover, in many E-systems energy is supplied or stored in the form of matter (A steam engine transforms coal into movement; energy is stored in the body as glycogen.)

Consequently, the criteria that we use in distinguishing E-systems from M-systems can be determined only by our interest. When we make use of only the energy output as is the case for a steam or gas engine, we will speak of an E-system. When we make use of only the matter output, as is the case for all systems which sort or act upon matter, e.g. mills, then we will speak of M-systems.

Besides these E- and M-systems there are others we consider to be both E- and M-systems, because their energy in- and output as well as their matter in- and output are of interest to us. Living beings are examples of such complex systems. Food ingested contains components to be transformed into matter, (e.g. tissue), and into energy, (e.g. movement and heat). It must be said that living beings are a very special case: because the most important E- and M-transformations are used primarily for the growth and maintenance of the system itself, the significance of the outputs is not so great as in artificial E- and M-systems.

As previously mentioned, information can be only a *local* influence. A system which can receive, store, transform, or emit information—in short an *information-system* or *I-system*—must be either an E- or an M-system.

Not all local influences, however, are regarded as information: the food of living beings, the fuel which makes a motor run, the electrical current which keeps an apparatus working, are never called information. This is equally true of the labour a machine performs (movement), and of electric current out of a dynamo. Thus, we must establish further criteria that will enable us to distinguish I-systems from ordinary E- and M-systems. Because the examination of M-systems is hardly relevant to our study, we will look to E-systems in order to find the difference between an ordinary energy influence and information.

To aid us in our search we will examine again everyday usage of language. In general one speaks of information when referring to the influences which men undergo through language or through the senses. A concrete example of such influence is presented by the system "chauffeur of a car", who sees traffic signals and reacts to them with certain movements of hands and feet. This is a very simple system because the reactions depend directly on the observations and there is no stage of storing. He has certain energy influences for its input (light streams) and for its output (movements of the steering wheel, gas and brake pedals). He will stop on red and move on green; intuitively we accept that what the light signals supply him is *information*. What then is essential in distinguishing such a system from a usual E-system? We contend that the essential characteristic of I-systems is that in them there exists a one-to-one relation between the distinguishable states of the input and those of the output, as exemplified by "red-stop" and "green-go".<sup>9</sup> In ordinary E-systems there can also be a one-to-one relation between states of the input and states of the output, but here a change of state of the output will be determined by the quantity of energy at the input, whereas in I-systems the relation between the quantities of energy is not necessarily significant, because any one-to-one relation is sufficient to realize an I-system. In other words, it is not the *quantity* but the *form* which is the important factor. By a *form* of the input we understand a distinguishable state of the input. Once there are two distinguishable states, it is possible to form an infinite number of complex distinguishable states by combining those two elementary states: with a series of  $n$  consecutive states it is possible to form  $2^n$  complex distinguishable states. By extension we can also give the name *form* to such a *complex distinguishable state*. A further extension of this notion is found in the case of many simultaneous inputs, each with at least two distinguishable states.

<sup>9</sup> Since no actually existing system is perfect, this definition is to be considered as an abstraction. The one-to-one relation between input and output is an ideal which is approached as much as possible.

We can now define an *I-system* as a system in which the output is dependant on the *form* of the input. Still another extension of the notion of form provides us with a definition of *information*: an energy influence with a certain *form*, i.e. which causes an input of an information system to take a distinguishable state.

Every communication of information will thus always have an energy current as substratum. The consecutive states of the input can be continuous; in such a case we speak of analogous information. The states of the input can also be discontinuous; then we speak of digital information. An E-system can be used as an analogous I-system, because in most cases there is a correspondence of form between output and input, viz. when the amount of energy in the output is a function of the energy of the input. (Variations in quantity can be looked upon as variations in form). In this way a wind mill, which is an E-system, can also be used as an I-system to provide information about wind velocity. One can, however, speak only of information if the difference in form is used effectively. Different criteria can be established to ascertain whether the form aspect is preserved. One of the most important criteria is that when the form aspect is preserved, it ordinarily will be amplified. Further, if the system possesses a reservoir, it is mostly easy to determine whether the form is preserved in the storing process. In a usual E-system, one cannot know in what form the energy has been stored since the quantity of energy at the output is determined by the system which uses it, whereas in I-systems the form is preserved since the output influence cannot be altered by the system making use of it. The energy of a car battery, for example, can be unloaded in various ways not dependant on the manner in which it was charged: on the contrary, a record can be played on a phonograph in only one way, the one in which it was recorded (in this case at the same speed). A final method of distinguishing E- from I-systems is to examine the influence of noise. In E-systems noise does not significantly disturb the usage of the output; it can merely retard it. In I-systems, however, its influence is far greater: it can make the usage of the output impossible.

One should not think that only highly complex forms of energy, such as air vibrations, radio waves, or electric current, can be used as bearers of information. It is equally possible to transmit information by mechanical means, since it is sufficient to establish a one-to-one relation between some states of input and output. Watt's regulator for steam engines is an example of such a mechanical device.

Thus we can say that with I-systems there exists a one-to-one relation between states of the input and states of the output. The fact that a definite series of states of the output corresponds to a definite series of states of the

input, we can express by saying that the output reacts to the *form* of the input. Since these states stand in a one-to-one relation with some states of the energy stream which influences the input, we can also say that the output reacts to the form of the energy stream, i.e. to its distinguishable states. (This notion of distinguishable state must be seen in relation to a receiving apparatus: an energy stream can have a class of states which are distinguishable by one receiving apparatus and not by another).

Since a criterion for I-systems is the preserving of the form of the energy-stream, the notion of information will be closely related to the notion of form. Hence our first attempt at defining information will be to say that *it is a local energy influence which takes a certain form.*<sup>10</sup>

With this definition as the point of departure, we encounter the following difficulty: when an energy influence has a certain form which has not yet or cannot be detected, can we consider it then a bearer of information or only after the employment of a detecting apparatus?

Here it is useful to make a distinction between *communicated* information and *observed* information. We speak of communicated information when the form of an energy stream that influences an input B corresponds to the form of the output A of another system. Therefore it is necessary that before the communication, there existed a one-to-one relation between the class of states of output A and those of input B (e.g. our chauffeur cannot react meaningful to traffic lights if the relation "red-stop, green-go" has not been previously established). We will call the system with output A a *transmitter* and the system with input B a *receiver*. In this case we can certainly say that the energy influence is always a bearer of information because in principle the form can be detected. When there is no longer a receiver (a telegraph office which is destroyed, inscriptions which cannot be deciphered) this poses no problem, for at any rate, there is in principle a one-to-one relation between the transmitter and a well defined receiver, although the latter does not exist actually.

We speak of *observed* information when the form of the energy stream that influences an input has no correspondence to the form of the output of another system; together with this stands the fact that observation is not dependant on a preestablished one-to-one relation. Examples of this observed information are all kinds of radiation emitted by systems such as the sun and the stars, also mechanical influences which act upon inputs, and thus all natural phenomena of which our senses or instruments can

<sup>10</sup> Since the form is the important aspect, it will be clear that the same description can be given in connection with M-systems. Consequently, we can say also that information is every local influence which has a form.



detect distinguishable states. Here we can say that the energy stream becomes a bearer of information as soon as a one-to-one relation is established between forms of the energy stream and forms of the input of an I-system. The philosophical viewpoint called *Realism* admits that the states of an energy stream correspond to different states of objects or systems which emit it. For this reason, one says that the energy stream gives *information about* an object, as the sun-rays give information about the sun.

According to our definitions, the statement "The system I receives information *about* object O" means nothing other than "there is a one-to-one relation between certain states (classes of states) of O and certain states of the input of I; this one-to-one relation is established via certain forms of energy stream E (E being a local *influence* of O and I)." Also, it is presupposed that O did not have a one-to-one relation with I prior to the influence. We can, of course, receive information also about the energy stream itself. Such is the case when we establish a relation between I and E only and not between I and the emitting object O, e.g., when the object is not known (cosmic rays) or is not the subject of examination (the study of light phenomena).

The statement "a system I'' receives information *from* a system I'" means nothing other than "(1) there is a one-to-one relation (established by a local influence) between states of the input of I'' and states of the output of I', and (2) the states of the output of I' are themselves related to the states of the input of I'." Consequently the system I' only conveys the form of an E-stream and is not the origin of it. The origin of the form of an E-stream, i.e. the origin of a communication, is always found in a *state* of a system or an object. This state effects and determines a certain form of an E-stream, and this form of an E-stream makes the input of an I-system assume a definite state.

From this viewpoint the question of the "origin of information" appears to us to be no great problem. Observed information always originates in a state of an object which can emit an energy stream; communicated information originates in an I-system which conveys observed information. This simple scheme can, of course, become exceedingly complicated because of the capacity of some I-systems to store the results of observations and to manipulate them in a variety of ways and also because of the possibility of comparing information received from different objects. Further, I-systems can systematically induce changes of forms; consequently, partly information from and partly information about the system will be received. Finally, the form of the E-stream can be altered by a great number of independent factors. In this case it may become very difficult to reestablish the one-to-one relation with the original information (or form). In referring to such situa-

tions, one ordinarily speaks of noise and systematic noise. It is generally said that information is lost through this process. This way of speaking can lead to confusion. Firstly, the energy stream always possesses a well determined form which brings about a well determined state in the input ; in this sense the input always receives information, i.e. a one-to-one relation is established between the E-stream and the input. That which alone can be lost is the one-to-one relation between the input of the receiving system and the output of the *transmitting system* or the *emitting object*. If noise appears either in a transmitting system or in the stream itself, i.e. if a change of form takes place, nothing happens but a *substitution* of one or more new objects for the original. Instead of representing the state of one object, the E-stream then represents the state of a complex of objects and systems. This new state of the E-stream is a possible state selected from such a great class that it is impossible to establish a one-to-one relation with this extremely complex class of states. This means that the E-stream provides us no longer with information about this complex of objects, but only about the E-stream itself. Between those two extreme cases (a one-to-one relation between forms of the input and states of a determined object, and the absolute impossibility of determining an object) one can have forms of E-streams which are mainly determined by one object or system and partly by other influences. One can say that here the ideal of a one-to-one relation is approached. The degree of approximation to a one-to-one relation between the emitted or transmitted and the received E-stream can be called the *quantity of information* of an E-stream about an object or about the output of a system ; this quantity Shannon calls the *transinformation*. Much confusion could have been avoided had the notion of quantity of information been limited to this transinformation.

Now one can ask what is the *function* of I-systems and of information. E-systems are used to transform or store energy so that it can be employed when and where it is needed ; it is clear that one of the fundamental requirements is that as much as possible the quantity of energy is maintained. On the contrary, we find that in I-systems the quantity plays no significant part, since the one-to-one relation is the determinant factor. Consequently, the transformations performed by an I-system can be of various kinds :

- (1) form variations of a weak energy stream can be transformed into form variations of a strong energy stream and thus can be made perceptible to other systems (e.g. amplification of electrical current) ;
- (2) variations of very strong energy streams can be transformed into weaker streams, which again make them perceptible to other systems without destroying them (e.g. various forms of measuring instruments, for high voltages or temperatures) ;

- (3) variations of an energy stream can be transformed into variations of another energy form (e.g. electrical energy into mechanical energy) which makes possible the control of all kinds of steering mechanisms ;
- (4) the form aspect can be preserved in a reservoir which permits storage of the perceptions and regulations just mentioned and their recall at any moment ;
- (5) the results of a transformation can be such that the variations of form can be transmitted accurately over great distances ;
- (6) energy or matter variations can be multiplied infinitely so that they can be used at any place or time for perceptions and regulations.

As soon as an energy stream is transformed in one of these six ways, and thus the form aspect is actually being used, we shall call it an information-bearing stream in the strict sense of the word. The systems which perform one of those transformations are I-systems, while systems in which the form aspect is lost are ordinary E-systems ; the energy stream received by E-systems we will not consider as information-bearing, although in most cases it potentially is.

As has been noticed, amplification processes take place in a great number of actually existing I-systems. This is easily understandable since amplification is often indispensable in making weak energy currents mechanically useful and even in making them perceptible. Furthermore, this amplification is also necessary to transmit form variations over great distances. On the basis of these remarks one is inclined to think that the amplification is the outstanding characteristic of information and that all reception of information is accompanied by one or another form of amplification. All I-systems then would be amplifiers.

An interesting study following this trend of thought was presented by G. Simondon at the Colloques philosophiques de Royaumont, 1962. He starts from the principle that a system must be in a state of *metastability* to be able to receive information, i.e. that there is a high potential energy which can be released by a small quantity of energy : the *information*. Here he considers two fundamental forms of amplification. *Transductive amplification (amplification transductive)* can be found, for example, in saturated solutions ; by adding a small crystal (information), the metastable state is changed into a stable one through a process which extends in all directions. Transduction occurs also when a spark ignites a quantity of explosives and when an impulse traverses nerve fibres.

The notion of transductive amplification he uses as a model for psychosocial processes such as the spreading of rumours. The essential mark of this mode of propagation is the necessity of a certain recovery time before a metastable state can be established. For a nerve fibre this recovery time

is 1/1000 sec, for psycho-social phenomena it may be weeks or even years. Moreover, there is also *modulating amplification (amplification modulatrice)*, the typical example of which is the triode. Here we have a constant power supply at the cathode. By emission of electrons a current flow to the anode through a grid, and small voltage changes in the grid cause important corresponding variations of the current which flows from cathode to anode. A strong current is thus controlled or modulated by a weak one. This mode of amplification occurs frequently and, as a matter of fact, the majority of the energy streams which are called information are used to control energy in this way. Finally Simondon examines a synthesis of both those forms: the *organizing amplification (amplification organisante)*. According to his exposition, the transductive amplification shows a characteristic of direction and by that fact brings about a progressive change of structure in its working area; it has, however, a passing and unstable feature. The modulating amplification possesses a stable character: the regulation here is excellent but not progressive; the aspect of change in structure is lacking. The organizing amplification is a mixture of these two types of amplification and must be looked upon as a regulated change in structure. This organizing amplification we find in the evolutionary processes of living beings and in the changes of regulating structures in society.

Although his insights into the three modes of amplification which provide models of some psychic, biological and psycho-social phenomena are of great interest to us, still we question whether it is wise to consider those processes as the pre-eminent information processes. Firstly, in considering transductive amplification as an informative process, Simondon deviates from the everyday usage of language. To regard a quantity of explosives as a system which receives information from a spark, seems to us an extreme extension of the notion of information, since such a system can receive that information only once, due to its being destroyed by it. In this way every flammable system would receive information from a flame because a transductive burning process occurs. Likewise every object which is in a metastable state with respect to gravitation (e.g. a rock on the top of a hill) would receive information from a push which forces it out of the metastable state.

This conception deviates in two ways from that which we offer. Firstly we wish to speak of information not in connection with all kinds of objects or systems, but only in connection with *relatively isolated systems* (systems with input and output), for we desire a notion of information applicable to living beings and machines. Any further extension of this notion would lead to many complications. Everyone may, of course, choose his own criteria, but there remains the question of how to describe most clearly the

phenomena. Secondly, we consider only *local* influences as information, while Simondon seems to include also in his concept some global influences such as destruction or a total change of structure.

We are not even sure that psycho-social phenomena such as spreading of rumours take place in a metastable state, unless this notion is extended so much as to include the spreading of diseases by microbes and viruses.

With respect to the modulation amplification we agree fully that in a great number of cases the steering character of information is very important, and that often energy streams bearing information must be amplified. Is it, however, true that this amplification element is so essential? Is it not rather true that the correspondence of form is the fundamental characteristic of which amplification indeed is a frequent example? Not every transformation, however, needs to be an amplification. In a loudspeaker, for example, the electrical current coming from the amplifier is transformed into sound waves without amplification; in the primitive magnet telephone the sound waves were transformed into electrical current, also without amplification. According to our viewpoint information is here also transmitted, although it is not being amplified. The magnet telephone is an I-system just as is our modern telephone, in which modulation amplification does take place. Everyone agrees that by amplification the possibilities of manipulating information have been greatly expanded, but in principle this is only an extension of the ability to establish *form-correspondences*.

Summarizing we may say that we call information any local influence which has a certain form, provided that this form is used. The use of the form includes that this influence is received by an I-system. An I-system is a relatively isolated system which is able to transmit, transform, or store form. In an ideal I-system there exists a one-to-one relation between the form (the distinguishable state) of the input and the form of the output. Although many I-systems are amplifiers, the amplification is to be regarded as but one out of many possible form manipulations. In this context we can say also that one communication differs from another in the fact that it is another form of a local influence and so corresponds to another state of the input, and refers to another state of the emitting or transmitting system.

Since the purpose of this study was to define this notion of information, the reader may ask himself why it is entitled "Information and Philosophy". Our original intention was to deal with some philosophical problems related to the notion of information. We realized, however, that it would immediately lead to confusions to work with a concept the meaning of which is vague and nebulous in everyday speech, and even in some scientific works. In order to establish a more precise definition it was necessary to define some

auxiliary notions. So, in stead of dealing intensively with strict philosophical problems this study developed into being a mere introduction.

Among the problems we wish to examine in another paper is that of the *origin of information*. It is our intention to criticise the opinion of Ruyer a.o., for whom this origin seems to be something mysterious. As we have already mentioned, according to us, in principle, this problem is not so complicated ; but it will be more difficult to show how, in practice, *observed information* is transformed into *communicated information*. In the same context it will be also necessary to examine the relation between our concept of form on one hand, and the meaning of this word in everyday speech and the notions of order and structure on the other hand.

There is another class of problems we hope to study with this definition as starting point, viz. all those related to the concepts of *meaning denotation* and *truth*. Our first notion will be that of *pragmatic meaning* ; the pragmatic meaning of a form of an input being the reaction (the state of the output) it causes. In other words, the pragmatic meaning of a communication is the use the system makes of it. In the language of bees, for example, the pragmatic meaning of a certain dance is nothing else than a well defined trip to the food which is induced by it. Next to this pragmatic meaning we will have to consider *semantic meaning*. It will be a very difficult task to explain how it is possible that some systems can receive semantic information. A form of an input has semantic meaning when it refers to the state of the system which causes this form (via the form of a local influence). Semantic meaning in the case of the dance of bees would be a certain idea which it elicits in them, viz. an idea of food in such direction, at such distance. Of course it is problematic whether the dance of bees has such semantic meaning, but this example demonstrates that the distinction with pragmatic meaning can be made.

Once we have come to an explanation of the origin of information, as well as of the transition from pragmatic to semantic information, we would like to show how the notions defined by us are related to the concept of *quantity of information*. The importance of this concept varies according to the kind of system one is talking about. We can have to do with learning and non-learning systems in the case of pragmatic information, and with systems which construct a model of their world in the case of semantic information. In pointing out the relation which exists between quantity of information and the kind of systems which receive it, we hope to understand better in which degree the uncertainty of messages has a subjective and an objective character.