I.2 · Language as Information

A lecture delivered in the series "On Language," sponsored by the Bavarian Academy of Fine Arts, in Munich and Berlin, 1959. Published in Die Sprache: Jahrbuch Gestalt und Gedanke, *vol. V (Munich, 1959). A preliminary concept of information is introduced in order to deal with the question of whether language can be rendered unambiguous in the service of science (cf. Prefatory Note to Part I). When quantified, this preliminary concept corresponds to "information" in the sense of information theory. The philosophical status of the preliminary concept remains unclear, but a connection is shown with the Platonic-Aristotelian concept of form. This topic is taken up again in III.5.*

Permit me to introduce a lecture bound to become difficult, because of its theme, with a remark that lacks the requisite gravity. The old Goethe, in one of his *Maxims,* has another person address him with the following question:

> "How was it you succeeded so well?
> 'Tis said you really do excel."

His reply is:

> "My dear, I was clever in what I wrought:
> On thinking I never wasted a thought."

First of all, this is certainly a barb against Hegel. At the same time it expresses the magnificent intimacy of Goethe's bond with the world. Can the organ of thinking, which is given to us for dealing with reality, emerge unscathed from being employed on itself? Can one know oneself? The centipede, when asked in what sequence it moves its legs, started to think—and became unable to walk.

What situation do we find ourselves in at this symposium? In a free variation on Goethe's answer:

> "My friend, you've smelled the rat, I avow,
> I've never talked on language till now."

I will lose this innocence tonight. At least I will talk about language only in a restricted sense. I will talk about a particular aspect, about language as information. My topic, then, is not language as such, not all of language. That, perhaps, is the topic of our entire symposium. Perhaps it is never possible in a lecture to talk of language as such, to talk of all of language. Language can be made audible by speaking it. What we speak about could pertain to language. But language as such is not in this speaking; language itself is still behind the speaker.

In saying this, I have already indicated the structure of today's lecture. But why talk about information at a symposium on language? I have just been toying a bit with the term "about," with the concept, that is, of talking "about" something. It is perhaps in the exact sciences that talk about a particular, clearly defined object is at its most precise.

Information is a concept closely related to the exact sciences. The topic "Language as Information" asks for those features of language that nurture the growth of the exact sciences. On this point I invoke Friedrich Georg Jünger's lecture on "Language and Calculus," delivered here five years ago at the Symposium on the Arts in the Age of Technology, a lecture which no doubt provided a major impulse for the present symposium. I will first simply describe language as information, and then ask what information really means. This leads to the question of whether all that can be clearly thought and stated can be cast into a linguistic form describable in terms of the concept of information. In other words: can language be completely transformed into information? I do not wish to dismiss this question by simply pointing out linguistic forms that cannot be subsumed under the concept of information. Rather, I will try to show that the concept of information itself presupposes a kind of language that is untransformed into information. In so doing, I hope to contribute to the theme of our symposium. I hope to show that, when precise language is used in talking about something, language itself is still behind the speaker.

I cannot show this without the help of a certain degree of abstractness in the later parts of the lecture. The lecture will therefore be difficult and long. Perhaps a short list of the contents will prove helpful.

On several successive levels the lecture will repeatedly ask: what is information? The talk is in five parts:

a. Examples of information
b. Measurement of information
c. The calculus
d. Information as form
e. Can language be reduced to information?

All this is merely a report, not yet philosophy; for I leave open what language itself might be. Perhaps this is all one can do in a philosophical introduction to "language as information."

a) Examples of Information

I now ask, for the first time: what is information?

Information, in current usage, is the communication of facts. Information is what an Office of Information puts out, what is contained in statistical documentation, in diplomatic reports, in the records of secret services. One doesn't get far in politics or business without good information. Not that information serves only the egotisms of individuals or of powerful groups; it serves also the life of the community. Take a trite example: what would become of order in railroad traffic without the information contained in the schedule? Less obvious: unless the overseas producer and the domestic importer exchange information on supply and demand, we might easily lack our daily bread. When atomic energy started to affect the lives of the people, we physicists asked ourselves what we owed to our fellow human beings. The answer in the United States in 1945 was identical to our answer in Germany ten years later: the first and the least we owe them is full information. How can they decide questions affecting their destiny if they are ignorant of the facts?

The carrier of information is language. Important facts were and are conveyed from mouth to mouth. The messenger and the traveler were once all-important as harbingers of "new tidings." Even today the quickest source of information is the word spoken and heard—on the telephone, by our ruling circles; on radio or television, by everybody.

The written word has an advantage over the uttered word, however, if language is to serve as information. The sound passes, the written record stays. Writing, so to speak, "objectifies" information. It relieves memory, can be surveyed at a glance, and enables one to check back at any time.

Writing itself has a peculiar history. The most ancient writing probably developed from pictures. Hieroglyphics, the Sumerian script, and the Chinese script until our own day all consist of signs whose meaning seems no longer to refer directly to the picture form; these scripts are already the result of a process of abstraction. Nevertheless, each sign still refers to the meaning of a single word. A big new step in abstraction was taken when the Akkadians used the Sumerian signs, not in accordance with their meaning, but in accordance with their spoken sounds: it was then that syllabic writing started, followed by alphabetic writing, in which the script sign stands not for the meaning but for the sound of a word.

One might ask why I am talking here of progressive abstraction. Is not the sound of a word something more palpable than its meaning? Indeed, it is; but the reflection on the word as something which doesn't merely signify its referent but which has a body of its own, a sound pattern of its own entirely divorced from its meaning—this reflection can rightly be called abstract, and its result is an abstraction.

Information theory is the name of our contemporary science of information based on precisely this abstraction. Its origin lies in communication technology. Sending messages by telegram is expensive. One of the Hasidic rabbis of whom Martin Buber tells us said one could learn something from all modern inventions; from the telegraph, for example, that all our words are counted. Information theory does not deal with the deep meaning of this saying, but the two are related in an abstract sense. How can one transmit information as economically as possible; i.e., how can one communicate a given piece of information using as few signs as possible; or, conversely, how can one convey as much information as possible in a message of given length? As much information as possible—i.e., one has to learn how to measure the amount of information in a message. What is the quantity of information?

b) Measurement of Information

In asking for the measure of information, we pose the question "What is information?" a second time, in a more rigorous manner now because of the quantitative setting.

Let me begin with a simple example. If I wire: "I am glad to be able to arrive in Munich at 5 p.m. on Monday, January 19," then I am being wasteful of words. It is polite to express pleasure, perhaps I even feel pleasure, but this is not necessary information. The "I" is superfluous, since "arriving" by itself establishes the identity of the person traveling and the person arriving. The employment of excess words, such as "at" in conjunction with "5 p.m.," is called *redundance.* Redundance simply means superfluousness. This concept is closely connected with our search for the quantity of information. Redundant expressions contain the same information several times over. If an expression is divested of all redundance, i.e., each bit of information is expressed once and only once, a message will result whose length is a measure of its information.

The telegram seeks this goal; it avoids redundant expressions as much as possible. This makes sense, however, only if the transmission itself is free of error; if the text is garbled, one is grateful for redundancy because it at least gives one a chance of restoring what has been lost. A natural language is full of redundance: a lack of superfluousness would mean poverty here. It often contains redundancy only in the subtle form of a background context of meaning, or of an appeal to something that is already familiar. Thus, if I wire to someone in Munich who is expecting me there, no new information is transmitted by stating that it is in *Munich* I will arrive; merely by saying "arriving 5 p.m." I am implying where. To be sure, a telegram with explicit mention of the point of arrival is richer in information than one without; but the total information conveyed to my Munich acquaintance, which the telegram contains only in part anyway, is not thereby augmented. How valuable redundancy can be in speech is shown by our experience on the telephone, or in listening to a foreign tongue: in both cases, even if one understands only every second or third word, one can still follow what is being said.

Let us now try to formulate the shortest possible wire text. Day of the week and date are not both required. The date would suffice; even better, in wiring "Monday," it is clearly the coming Monday that is understood. And instead of "5 p.m." I can say, international style, "1700." The wire now reads: "Arriving Monday 1700."

What I have just described can also be named using the terminology of literary history: we are dealing with the development of a linguistic style, the "telegram style." The origin of this style lies in a reflection on a feature seemingly extraneous to language, i.e., on the mere number of words. But in life nothing is purely extraneous. An essential aspect of language expresses itself in this style. An essential characteristic of that which can be spoken about at all shows today—more clearly than in any of the earlier modes of speech—in the language disciplined for maximum information; and the pure telegram style is, so to speak, the parade step of this drill. I wonder how many people are still around who know what a superfluous and baroque piece of art the parade step was. Is the elimination, in the telegram style, of all that is superfluous itself a baroque delight, an exorbitance? I am not being entirely serious. All of us sense the one-sidedness of this style; it is sometimes felt to be so dangerous as to amount to the destruction of language. But in what sense is it so? We accuse the language of our era not of having an excessive concentration of content, but of lacking content; of lacking form or of having an overabundance of empty forms, not of being parsimonious. Isn't the parsimonious language of science and of factual accounts the most impressive linguistic phenomenon of our time? But perhaps it is this absolutization of a one-sided aspect that causes the non-informational aspects in language to wilt.

It is not my task tonight to describe the non-informational aspects of language. Rather, I must make as plain as possible the extent to which language can be information; identifying a language clearly delineated as information will help us to recognize language that is more than information.

I will first make the concept of information in information theory a bit more precise. We asked: "How can one measure a quantity of information?" Is it sufficient to eliminate all redundancies and then count the words that remain? "Arriving" and "will arrive" convey exactly the same information, without redundancy, one expression using one word; the other, two. The word is therefore not a reliable unit of information. Nor is the letter. The long word "automobile" tells me no more than "car," or the German *"Auto,"* or the Danish *"bil."*

But there is something we can learn from the wiring of letters. When the telegraph was invented, there was only one way of signaling: one could depress the key to close the circuit or release the key to break it. How can one represent the twenty-six letters of the alphabet with this simple alternative? Morse used two positive signs: a short and a long burst of current. To each letter he assigned a sequence of these dots and dashes. If the individual sign, as in the Morse code, has only two possible forms, one talks of a yes-no decision. In English-speaking countries a single yes-no decision is called a "bit" of information. "Bit" is meant to be short for "binary digit." It helps that "bit" also means "small piece." Information can be measured if one knows the smallest number of small pieces needed to transmit it.

A yes-no decision distinguishes between two possible cases; given just the dot and the dash as signals, one could telegraph only in a language containing precisely two letters. Two yes-no decisions in succession can represent four possible cases; with the four "binary" signs: "dash-dot," "dot-dash," "dot-dot," "dash-dash," one can telegraph four letters. Three yes-no decisions allow one to distinguish among eight cases, four among sixteen, five among thirty-two. Thus one requires at most five elements for an alphabet of twenty-six letters. (Four would suffice, if signs were allowed to differ in length: one could then take 16 @ 4, 8 @ 3, 4 @ 2, 2 @ 1, altogether thirty different signs.)

In the reduction of all information to yes-no decisions we have the principle according to which modern computers (the "electronic brains") operate. Computers represent numbers by means of sequences and breaks in current flow, just as we described it in the case of letters. 1, for example, is represented by a current burst lasting one hundred-thousandth of a second. 2 is a burst and a break of the same length. 3 is burst-burst. 4 is burst-break-break, 5 is burst-break-burst, 6 is burst-burst-break, 7 is burst-burst-burst, 8 is burst-break-break-break, etc. To add two numbers, one sets up the two sequences of bursts and breaks in two separate circuits which then interact electronically to produce a third sequence of bursts and breaks corresponding to the sum of the two numbers. If the apparatus is correctly designed, this happens automatically. Here we have the modern version of a program already realized by Pascal and Leibniz in the form of the first mechanical computers, which let a machine instead of the human mind perform calculations that follow a well-defined scheme. One can say today: every process of thought capable of being translated into a pattern of operations in accordance with a well-defined scheme of sequences of yes-no decisions can be turned over to an automatic device which will then execute the operations in a manner usually quicker, more comprehensive, and freer of error than man is capable of. One can even state numerically how much information such a device can process per second.

There are, as far as I know, good physiological reasons for assuming that the neural networks in the brain also work with sequences of yes-no decisions (response or non-response of the nerve fiber). The vistas opened up by this idea do not belong to my present theme, however. The following reflection returns us to the theme of language.

c) The Calculus

In transferring to an automatic device all operations of thought that follow a rigid scheme specifiable by us in advance, we have by no means transferred all possible operations of thought, nor even all those that we might be inclined to label "exact." One can act according to a scheme, for example, only if someone has previously designed that scheme. The design of a scheme is an act of thought that precedes the scheme. We are inclined to think that performances in accordance with a particular scheme can be no more exact than the thought which designed that scheme. However that may be, the design of a particular scheme is surely not an act of thought which follows that scheme.

But could one perhaps invent a scheme that tells us how to design schemes of operations? A device, in the extreme case, that produces programs for other devices, or maybe even a device that automatically performs whatever can be thought exactly?

This thought is still imprecise; we can make it more precise by facing the difficulties in the path of its realization.

A device can process only information given to it unambiguously. Numbers constitute the best example; that is why the devices actually built for the automatic execution of thought-analogue processes are usually computers. But the scheme to be followed by such a device cannot (or at least cannot to begin with) be communicated to it in the form of a sequence of numbers. Instead, we must say in words what is to happen with the numbers. Opaque though it be to information theory, so-called "natural language," the language in which ordinary people communicate, cannot be done without, at least not at the start. And it would do no good to transform its letters into the yes-no decisions of Morse code. For now it is not a matter of communicating telegraphically with someone who will understand us. Now, not the words, but the meanings of the words are to be put into a form capable of being processed according to a scheme. Is such a step conceivable, perhaps on the basis of some preliminary manipulations? It seems to have been Leibniz who first posed this question with full clarity. Can we find signs to represent, not the linguistic name, but the clearly understood meaning of every concept needed by thought? Can we invent operations with such signs to represent any admissible operation of thought, so that all correct thinking would be mirrored in such operations and controlled by them, even as the operations in algebra mirror and control our thinking about numbers? The calculus of modern logic is the modest execution of a small part of Leibniz's program. It represents the furthest reduction of language to its unambiguously manipulable informational content. On a new level of abstraction, it turns back from natural to formalized writing.

For an example, let me give you a few formulas taken from the simplest part of logical calculus, the propositional calculus. This calculus treats the relations between entire sentences, the so-called "propositions," without reference to their internal structure. I write the letter "a," for example, and agree with you to regard it as an abbreviated form of the proposition "the sun shines." Let "b" stand for "it is raining." Fixed signs (which differ, unfortunately, among the logical schools) are used to represent words that express constantly recurring logical relations. Thus I write "$\wedge$" for "and" and "$\vee$" for "or." "$a \wedge b$" now means: "the sun shines and it is raining"; "$a \vee b$" means: "the sun shines or it is raining." The arrow "$\rightarrow$" means "if-then"; for example, "$a \rightarrow b$" means: "if a, then b," or "if the sun shines, then it is raining." In terms of content, this sentence is usually false. We now introduce the negation, designated by a bar above the letter: "$\bar{a}$" means "not a," or "it is not true that a"; thus in our example, "it is not true that the sun shines," or, shorter, "the sun does not shine." Whether the two interpretations of "$\bar{a}$," i.e., "not a" and "it is not true that a," are really as equivalent as I treat them is a deep question which I cannot discuss here.

I now say "$a \rightarrow \bar{b}$" in words: "if the sun shines, then it is not raining." In terms of content, this sentence, too, is not necessarily true. It is always true, however, that "$\overline{a \wedge b} \rightarrow \bar{a} \vee \bar{b}$"; in words: "if it is not true that the sun shines and it is raining, then the sun does not shine or it is not raining." This is always true, because it is a logical, not a meteorological fact. In accordance with a very general law already formally established in the highly developed logic of late scholasticism, "$\overline{x \wedge y} \rightarrow \bar{x} \vee \bar{y}$" is true no matter what propositions are substituted for "x" and "y." To put it more generally: "if x and y are not both true, then either x is false or y is false, independently of the propositions x and y." As a result, one can always substitute the formula "$\bar{x} \vee \bar{y}$" for the formula "$\overline{x \wedge y}$" in a "calculation" carried out in the logical calculus. The universal logical law reappears in the calculus as a universally valid rule of calculation.

In today's lecture the logical calculus serves us neither as working tool nor as a subject for investigation, but merely as an example. I ask: Can we expect that all we are capable of thinking may one day turn out to be thus communicable? Can we, to return to our theme, thus transform into information all that language can express? I don't choose to escape this question by pointing to poetry or to other modes of language seemingly distant from science as counter-examples (because that would be a cheap way out). It would already mean a lot if we could assign an information-theoretical meaning to these challenging, if not completely clearly formulated sentences of Wittgenstein's:

"What can be said at all can be said clearly; and whereof one cannot speak thereof one must be silent."[1] The desire to think clearly is common to philosophy and the sciences; in literature, too, it can be salutary. Should we surmise that one can think clearly only what can be said clearly; that one can say clearly only what can be unambiguously expressed in terms of information; that one can express unambiguously as information only what can be written in the form of a calculus? As the result of this third section, may we interpret clarity in terms of information, and information in terms of the concept of a calculus?

d) Information as Form

We can test the truth of these conjectures only if we can be sure of having understood their meaning. Do we know with sufficient clarity what we mean by information? I have used several examples to introduce the concept of information. I said that the telegram is or contains information and that the logical calculus is or contains information. I have explained how one measures the quantity of information, namely by counting the yes-no decisions. I have conjectured that only what we can write down in terms of a calculus counts as information. But I have not said what information really is. Socrates would not have been satisfied with me.

We will not answer the question as to the essence of information exhaustively, but we can work on it. And we know from Socrates how the question as to the essence of a thing can promote our knowledge, even though we must in the end leave this question unanswered. To have understood precisely this is after all the mark of the man who dares not call himself *sophos*, the wise man, but only *philosophos*, the lover of wisdom.

I just said: "The telegram is or contains information." Why the "or"? Evidently I did not know whether the telegram is the information itself or merely contains it. Children that we are of an age dominated by Cartesian concepts, we are inclined to ask: "What is designated by the term 'information'? A material thing—for example, the printer's ink on the actual telegram—or something in our consciousness—i.e., whatever it is I think when I read the telegram?" This question bothered the information theorists of our day, and they came to a result

[1]L. Wittgenstein, *Tractatus Logico-Philosophicus* (New York: Harcourt, Brace and Co., Inc., 1922), p. 27. —Translator.

that perhaps bothers them even more: neither. Information is neither something material nor something in consciousness. Both interpretations fail to do justice to the objective character of information, for whose sake the concept of information was introduced in the first place.

Let us assume that the printer's ink on a piece of paper is the information. Then what I wrote down in Hamburg when I sent off the wire and what the addressee in Munich holds in his hands is not the same information, since the pieces of paper are not identical; but information is supposed to designate precisely what these two pieces of paper do have in common.

Let us assume that information is the thought process in the mind of the person thinking the contents of the wire. Then what I thought when sending the wire and what the addressee thought on receiving it is not the same information. Information is not one or the other act of consciousness but what is known by the act of consciousness, something that is common to these conscious persons who are otherwise so different.

Today we are beginning to get used to the idea that information must be regarded as something different from matter and consciousness. What one has thus discovered is an old truth in a new guise. It is the Platonic *eidos* and the Aristotelian form, expressed in such a way that even twentieth-century man can learn to obtain a glimpse of them.

Even the origin of the word "information" gives us this hint. If you look in a Latin dictionary under the verb *informare,* you will find that its original meaning is "to form," "to fashion," and that its metaphorical meaning is "to fashion in the mind," "to represent to oneself," whence *informatio* as "image," "representation," "concept." Our definition of the word stems from the Middle Ages, when it was used as meaning "instruction." *Informatio,* then, is something like bringing form into matter, or matter into form. Whatever the several authors may have thought in particular, *informatio* can be understood only in terms of the terminological pair "form and matter"; it is, in its origins, foreign to the terminological pair "consciousness and matter." If you wish to locate information in consciousness, you would have to talk of the transcendental, not the empirical consciousness. But in our age most people would regard this recourse to transcendental philosophy as the explanation of an obscure matter in terms of one even more obscure; I will therefore not refer to it again. Rather, I will take "information" to be "form," or "pattern," or "structure," without further explanation of the concepts presupposed by these terms. This "form" can refer to the form of all kinds of objects or events perceptible to the senses and capable of being shaped by man: the form of printer's ink or ink on paper, of chalk on the blackboard, of sound waves in air, of current flow in a wire, etc. Our "form" is not identical to the geometric form, since the printed telegram and the acoustic message of the telephone operator both contain the same information. Information belongs to a higher level of formal abstraction; and again, I do not define what "level of formal abstraction" means. Information is something that can be perceived by man, can be understood, can be thought. But it is not the mental act of thinking; rather, it is what this thinking thinks, it is the thought itself, in the sense in which I can say that two people think the same thought.

Not every form or structure, even if of a sufficiently high level of abstraction, counts as information, however. At least two further attributes are required: language and unambiguousness.

What do I mean when I say that information is linguistic in nature? I surely have not defined what language is; that is the very theme of our symposium. As I use the term in this lecture, I ascribe a linguistic character even to the abstract form of writing and to the current flow in computers; but I do not ascribe it to the shapes of plants or stars, or to such manmade things as the shapes of foodstuffs, like the outline of a roast or a cake, however subtle the art with which these are prepared, or to the shapes of technical instruments. I cannot draw the boundary with precision, but I cannot do without the distinction between linguistic and non-linguistic form.

Anyone who always seeks the precise definition of terms may now feel disappointed. Have we not just tried to clarify the very unclear concept of language by referring back to the concept of information —be it at the cost of a one-sided interpretation? But if, conversely, we now define information by recourse to language, we get into a circle. At the end of my lecture I will try to show in what sense this circle is meaningful and unavoidable. This circle seems to me to be the precondition for precision in thinking. But I must first make myself clearer.

One could try to explicate what I have just named the linguistic character of information by means of another concept that does not contain the term "language." "Communication" offers itself, for example. One could try this: "Information is a form that serves in communication." The "serves" here must be understood as potential; a book no one has read and the current flow in a computer unperceived by anyone are not actually someone's communication, but they are the sort of structures that can be considered communication. The term "communication" suggests that language does not relate merely to an isolated consciousness, to a Cartesian *res cogitans*, but that it is essentially interlocution, communication between persons. I won't follow up on this remark; it is merely the eyelet through which the threads that connect with the other lectures may be drawn.

I must, however, deal with a possible objection. Modern biologists speak perfectly legitimately of information—in genetics, for example. A set of chromosomes contains in its genes the information that determines the phenotype of the individual (to the extent that the phenotype is in fact genetically determined). The "letters" with which this script is written have even been discovered. There are merely four different chemical compounds which, laid end to end in long helixes, determine through their sequence the entire genetic type. One estimates that the informational content in the nucleus of a single human cell is comparable to that of a library containing a thousand volumes. Information-theoretical concepts are clearly applicable here if they are anywhere. But there is no one here who talks, no one who communicates something or understands what is being communicated to him.

I cannot think of an apt reply and I suspect that, at least tonight, I am not meant to be able to think of one. One could of course cut through the knot by trying to define information without referring to language or communication. In that case, information—i.e., measurable quantities of structure—exists in nature objectively, and we merely register what is there. One could equally well suspect that it is the nature of our thought process in its linguistic articulation which makes us pick these aspects out of the infinite manifold that is nature; we approach nature with the search for information-like structures in mind, and thereupon find them. Every attempt to define information non-linguistically shows how difficult it is to keep these two points of view apart. We can, for example, call information every form that can be described by enumerating a finite number of yes-no decisions; but even this seemingly objective definition refers back to our means of description ("enumeration," "decisions"). I suspect that an exact analysis of any other definition would yield similar results. It is not a matter of course, on the other hand, that we can find such clear-cut yes-no decisions in nature, or indeed that we can find an apparatus so obviously intended for such decisions as are the chromosomes. This is not merely a case of retrieving Easter eggs hidden by ourselves; we came upon *these* Easter eggs totally unexpectedly. Is there a pre-established harmony between nature and language?

It may be that, in the present context, the most naïve mode of expression is also the most apt: the mode that assigns linguistic categories even where no speaking or listening consciousness exists. In the relation between the chromosomes and the growing individual, it is *as if* the chromosome were talking and the individual listening. The metaphors on every scientist's lips are witnesses thereof; e.g., to say that chromosomes *prescribe* the manner of growth, or that growth *obeys* this prescription. Everywhere else in this lecture I use a concept of language that presupposes human beings as speakers; that is why I suspect that I am not really meant to solve this problem with the conceptual means to which, for the sake of achieving preliminary clarity, I am today restricting myself. I therefore now turn back from information beyond human language to language as information.

Not every linguistic form is information. Information presupposes unambiguousness. Heraclitus' saying that war is the father of all things can be a deep truth for the very reason that it is not information, and it cannot be information because the terms "father" and "war" are not unambiguous. In fact, if they meant what they normally mean, the saying would be nonsensical. But these terms are also not simply redefined so as to be valid speculative concepts in the philosophy of Heraclitus. A better explanation is that ambiguity is an essential ingredient in any speculative concept used correctly. Surely the meaning of the saying in our example, as it slowly dawns on us, forces the terms into their multiple meanings, thereby hinting at that real relation among the different meanings of a single term which we must perceive in order to understand the whole saying.

The interpretation of language that leads to the concept of information aims to avoid such arts as these. No one can enumerate the yes-no decisions that would render precisely each of the many meanings of Heraclitus' saying. A formula written in the calculus of logic, on the other hand, is meant to be information. Each of its signs is supposed to be unambiguously defined, and its particular composition ought to signify unambiguously a particular proposition.

e) Can Language Be Reduced to Information?

In conclusion I now return to the question: Is it possible, in principle, to reduce language to information understood in this way? Not that everything expressible in words must necessarily fall under this concept of language; but is the concept itself at least clear enough to enable us to define what Wittgenstein termed "saying clearly"? I am inclined to answer in the negative, or at least with a *non liquet.*[2] My reason is that every attempt at transmuting a part of language into unambiguous form already presupposes the use of natural language, ambiguities included.

We must first examine the extent to which the term "unambiguous" is itself unambiguous. We can, for example, define a calculus by listing the signs that occur in it and stating into what formulas they may be combined. If we do this with care, no doubt remains that it is unambiguously clear what combinations are or are not to count as formulas in this calculus. But by no means have we thereby decided what these formulas are to mean; definitions are needed to settle that. As an example I cited the rudiments of the propositional calculus. I said: "$\wedge$" stands for "and," "$\vee$" for "or," etc. The calculus can be considered unambiguous (called an "interpreted calculus") if these definitions themselves are unambiguous; i.e., if each definition refers to precisely one object or concept. But how can I ensure that a definition is unambiguous? Most of you probably unhesitatingly accepted my designation of "$\vee$" as "or." Now I ask you: Is this "or" the same as the mutually exclusive "either-or"? When I read "$a \vee b$" as "the sun shines or it is raining," did I mean it in the sense that "either the sun shines or it is raining, but not both"? It may look as if I meant it in that sense, but it is not so. You agreed with me that "$\overline{a \wedge b} \rightarrow \bar{a} \vee \bar{b}$" is certainly true; i.e.: "if it is not true that both the sun shines and it is raining, then the sun does not shine or it is not raining." If this "or" meant the same as "either-or," then the consequent would imply the impossibility of the sun's ever not shining when it is not raining. But this can in fact very well happen. "$a \vee b$" must therefore mean "either a or b or both"; otherwise, our formula would be false.

This clarification came easily, because the problem has long been known to logicians. Can we be sure, however, that our interpretations do not contain ambiguities hidden to us? The definitions make use of natural language, thus of concepts whose unambiguousness has not yet been tested. Perhaps these concepts can be rendered unambiguous by means of further definitions. But will we ever arrive at primary concepts that are unambiguous in themselves? The problem is analogous to the problem of proof in a deductive science. Theorems are proven

[2]Formula used by Roman jurors when unable to reach a verdict for lack of evidence. —Translator.

from axioms. Do we know of axioms that are certain in themselves? It was traditionally taught that concepts unambiguous in themselves, and axioms certain in themselves, do exist. This assumption worked well in mathematics from Euclid to Gauss. Philosophy became discredited when it couldn't follow suit, when the *fundamentum inconcussum* of one philosopher was immediately challenged by his successor. The methodological self-awareness of mathematicians became more acute, however, with the discovery of non-Euclidean geometry and the subsequent reconstruction of the foundations of mathematics on successively deeper levels. Viewed with sharpened methodological self-awareness, Euclid's axioms appear not to be self-evident propositions; rather, they are propositions that cannot be deduced from other propositions. Some highly self-evident propositions show up in the text as theorems, because Euclid saw how to deduce them from other propositions; conversely, a proposition as opaque as the axiom of parallels appears as an axiom because Euclid rightly saw that he could not deduce it from other axioms. Under Cantor's influence, mathematicians tried in the nineteenth century to seek absolute certainty in the concept of the set; since 1900, this attempt has failed because of the discovery of paradoxes in that concept. Certainty was then sought, under Hilbert's influence, in the concept of a calculus; this attempt failed, at least in its original version, with Gödel's proof of the formal indecidability of certain meta-mathematically[3] true propositions. Lorenzen's resolution, which makes the best sense to me among those available today, rejects the idea of proceeding from axioms and instead appeals to our intuitive understanding of schematic operations. Perhaps the clearest explanation of all this is found in the work Tarski published in 1933 on the concept of truth in formalized languages. We constantly talk of true and false propositions. Do we really know what "true" means in this context? Is this an unambiguous term?

The classical definition of truth is *adaequatio rei et intellectus*, the correspondence between fact and intellect. With regard to formalized propositions we might say: a proposition is true if the matter of fact holds which it asserts. Letting "p" stand for an arbitrary proposition, this definition amounts to saying: "The proposition 'p' is true if and only if p." To use an example often cited by Heinrich Scholz: "The proposition 'Mars is inhabited' is true if and only if Mars is inhabited." At first glance, you may feel inclined to say that such a definition is possible but trivial. In fact, however, it is not trivial—it is not even

[3]The author follows German custom in using the common term *inhaltlich* ("contextually") to mean "meta-mathematically." —Translator.

possible. It is non-trivial. The sentence p (in our example, Mars is inhabited) occurs twice, with two different meanings. First p appears in quotation marks. "p" is a name of the proposition p; its function is to point to the proposition.[4] Certain well-known propositions are named in a different manner. For example, we refer to the "Law of the Excluded Middle," to the "first sentence of the Bible," etc. But one cannot assign every possible sentence a name of its own. It is therefore convenient to point to a proposition by placing it in quotes. A proposition in quotes is named but not asserted. On the second occasion, p appears without quotes; here p is being asserted conditionally. We say: "If p, then something is valid." The "something" is that the proposition "p" is true. The second mention of p thus presupposes that we already understand the proposition. Tarski's definition therefore rests on our prior acquaintance with language. A spoken sentence "p" and the fact p corresponding to it can indeed be compared only if we can express the fact linguistically. Only when one has understood this can one understand the definition; that is why I called it non-trivial.

But the definition is impossible, for it leads to a self-contradiction. Let "p" be the proposition: "The sentence I am now saying is false." Upon substitution, our definition reads: "The proposition 'the sentence I am now saying is false' is true if and only if the sentence I am now saying is false." The sentence I am now saying is "p"; therefore, what I have said, in short, is that " 'p' is true if and only if 'p' is false."

This, too, is an old joke, known in antiquity as the paradox of the lying Cretan. In our usage, the paradox shows that not *every* proposition may be substituted for "p." Thus Tarski's definition cannot be valid in full generality. Can we still claim to know what a true proposition is?

Tarski has investigated the matter more fully than I can now report to you. I can only hint at the way he chose out of the dilemma.

He does not consider truth to be unambiguously definable in the context of natural language. Provided it is expressed in the language one uses to talk about the calculus, rather than being part of the calculus itself, the definition given above can be applied in the case of a "formalized language," i.e., a calculus. Tarski calls the language one uses to talk about a calculus the meta-language. One can then substitute any proposition of the calculus (or a meta-linguistic name designating that proposition) for the first "p"; for the second p one must substitute the meta-linguistic proposition that designates precisely the

[4]Strictly speaking (see below), I should have written: " 'p' " is a name of the proposition 'p.'

same fact. In our example from the propositional calculus: "The proposition 'a ∧ b' is true if and only if the sun shines and it is raining." The set of propositions whose truth is defined is thereby reduced to the set of propositions within the calculus; and we can always construct the calculus so as to exclude self-contradictory propositions of the sort we discussed.

One can take a further step and write a calculus for the meta-language, thereby defining a truth concept for the propositions of the calculus. To do this, we require a meta-meta-language. No matter how many steps of this sort are taken, the higher-level truth concepts will always apply to the calculi, never to the natural language. But the calculi can be interpreted only by employing natural language, and only if we presuppose that we can distinguish, for all practical purposes, between true and false propositions in the natural language.

Here we come face to face with the unavoidable circle mentioned above. As far as I can see, this circle characterizes all exact thinking. I have exemplified it in logic; in another, equally long lecture I could just as well trace it out in physics. Language wholly transmuted into information represents the hardened tip of a non-hardened mass. No one discoursing on language ought to forget that language can appear as information. No one discoursing on information ought to forget the converse: that language can be information is in turn possible only against the background of a kind of language which has not been transmuted into unambiguous information. This insight does not settle the question of what language really is, but it does cast some light on one aspect of the question.