THE CRITERION OF PREDICTABILITY

ANATOL RAPOPORT *

OUR PROBLEM is to examine the significance of predictability as a criterion for truth and as a measure of freedom. In connection with this inquiry, we shall also examine the significance of true propositions in human affairs.

I. *Verbalized Conflict*

The abstraction 'Truth' plays a central role in a broad range of human activity. It is intimately connected with imperatives of human behavior. In early childhood we are taught that when we utter certain words in certain circumstances, we are 'telling the truth,' and that when we utter other (or even the same) words in other circumstances, we are 'not telling the truth'; and moreover that the former behavior is preferable to the latter.

'Truth' is further connected with 'Reality,' and in this connection has vast ramifications. Tremendous outpourings of mental activity throughout milleniums had as their object the definition and elucidation of 'Truth' and 'Reality.' Metaphysics and later epistemology revolved around these objectives. 'Truth' is also strongly entrenched in ethics as is evidenced by identical designations for 'truth' and 'virtue' in some languages. 'Truth' is supposed to be some object sought in modern science or at least in

* Captain, U. S. Air Corps, now stationed in India; author of 'Newtonian Physics and Aviation Cadets,' *ETC.*, I, 154-164. Pianist (concert); mathematician (Ph.D.); semanticist.

philosophy of science. So many are the connotations of this short word that it pervades even esthetics, as is shown in the expressions 'true art,' 'poetic truth,' etc. Finally 'Truth' is thought to be embodied in human conflicts, because almost all conflicts are usually verbalized into utterances that appear to be propositions. A group of individuals asserts, 'A is true,' while another group asserts, 'B is true, therefore A is not true.' The actions of each are then attempts to curb the actions of the other.

Actually such verbalisms of conflict are seen to be simply declarations of behavior or intended behavior and must be distinguished from judgments about the external world. However, the fact that they appear as formal propositions, subject to classification as 'true' or 'false' is significant, as we shall attempt to show. The following are examples of verbalized conflict.

EXAMPLE 1.

First Savage: 'This female is mine' (where 'mine' as applied to females denotes certain behavior).

Second Savage: 'No, she is mine (and therefore not yours).'

Each then acts in such a way as to deny to the other opportunities of behavior defined by the expression 'my female.' Such actions result in withdrawal from the sphere of influence of one or the other or in injury or death of one or both or all three.

EXAMPLE 2.

First Tribe: 'This land is ours.' Again 'our land' is associated with certain behavior.

Second Tribe: 'No, it is ours (therefore not yours).' Each tribe then acts in such a way as to deny to the other behavior which signifies 'my land.' Result: depopulation or impoverishment of one or both tribes.

EXAMPLE 3.

Heretic: 'The earth revolves around the sun.'

Inquisitor: 'No, the sun revolves around the earth. (Therefore the earth does not, etc.).'

Inside the skin of both the heretic and the inquisitor both utterances are defined in terms of behavior. The utterance of the heretic is really a declaration of intention to behave in a certain way, namely, to imagine a fixed framework of space, in which the sun is stationary, while the earth and the planets revolve around it. Perhaps this declaration includes an intention to induce other people to imagine a similar picture. It is this *behavior* of the heretic which the inquisitor intends to prevent. He first tries (if he is a conscientious inquisitor) to induce the heretic to behave in another way, namely, to imagine within the same fictitious framework of space a stationary, centrally located earth with the celestial sphere revolving around it as described by Ptolemy. On the verbal level and in the pictorial imagination the two pictures are incompatible. Finally, the inquisitor takes other steps to prevent the behavior of the heretic incompatible with his own, and the consequences are painful and often fatal for the heretic.

EXAMPLE 4.

First Monarch: 'Prince A is the rightful heir to the throne of X.'

Second Monarch: 'No, Prince B is, etc. (therefore Prince A is not).'

Steps are taken by causing groups of people to behave in such a way that similar groups of people under the control of the other monarch are curbed or annihilated, and the behavior of people indicated by the symbols 'A (or B) is the rightful heir' is made impossible.

EXAMPLE 5.

Hitler: 'A group of people defined as Germans are superior and destined to control, rule, etc.'

Others: 'They are not, etc.'

Appropriate steps are taken with well known results.

The verbalized contradictions given in these examples are contradictions of intended behavior and have nothing to do with 'objective truth.' In fact, if they are to be considered as propositions at all, they are seen to be propositions about the inner state of affairs of the adversaries, and, properly stated, may all be true. Contradictions arise when these utterances are considered as propositions about the external state of affairs, independent of the speaker. Examine the first two examples. The utterance 'This female is mine,' made without further assumptions embodies no verifiable fact. Only its grammatical structure gives it the appearance of a 'proposition.' In reality it is only a signal connected with certain acts. The same is true of the utterances in Examples 4 and 5, taken from actual history. But there may be objections to the assertion that Example 3 is likewise only a behavior contradiction. To a modern informed person it might seem that the heretic and the inquisitor are arguing about a verifiable fact, that it is only necessary to assume an 'objective point of view' in order to investigate the question at hand and decide who is right. Most

informed people suspect the anti-scientific clericals of the Renaissance of sinister 'suppression of truth,' fanaticism, etc. However, a somewhat deeper analysis indicates that in pronouncing such judgments we make certain tacit assumptions, namely that 'objective investigation,' as we understand it, is a preferable method of truth seeking than faith in established authority. In other words, to accuse the inquisitor justly of 'suppressing the truth,' one must assume that the heretic's conception of 'truth' is more justified than the inquisitor's, and if this assumption cannot be further justified, it is again merely a declaration of behavior. It was futile for Galileo to 'prove' that objects of different weights fell at equal speeds. He assumed that his contemporaries should believe what they saw, while they were skeptical of observed phenomena, since the latter might well have been optical illusions originating with the Devil. Is this skepticism less justified than the skepticism of the modern physicist, who will pronounce a swindle any demonstration of perpetual motion no matter how convincing, because it is contrary to the 'Law of Conservation of Energy,' *i.e.,* contrary to vested authority? Well, yes, it *is* less justified, but the justification of the modern point of view must be clearly formulated. Yes, the priests of Pisa were wrong, and the modern physicist right. Yes, the question of the movement of heavenly bodies is to a certain extent a question of observable truth and not of individual behavior, but this must be shown and the *extent of the observer's participation* determined. It is not at all 'obvious.'

In Hayakawa's *Language in Action* the function of language in establishing coöperation between human beings is discussed. This coöperation is established by the extension of the functions of individual nervous systems to include by inter-communication the experiences and observations of others. In this article we approach language from the point of view of its functions in· *resolving conflicts.*

Human beings engage in two kinds of conflict, namely 'man against nature' and 'man against man.' Man's success in the first kind of conflict depends very largely on successful coöperation with other men. Here the survival value of language as a coöperation establishing agency becomes apparent. But the success of one man in the second kind of conflict often means the failure of another man. Hence language will have a survival value if it also succeeds in resolving or eliminating this kind of conflict. This function of language will be examined here.

Man-against-man conflicts are usually verbalized into utterances that have the appearance of contradictory propositions. Each pair of such utterances seems to be on one of three levels.

CATEGORY 1. *Conflicts of incompatible behavior.*

(1) 'This female is mine' $(\overline{1})$ 'She is not.'

(2) 'This man is my slave' $(\overline{2})$ 'He is not.'

The contradictions seemingly embodied in these utterances arise from the verbal form, which gives them the appearance of propositions about the external world. When translated into propositions concerning the internal state of affairs of each speaker, the *verbal* contradictions are resolved, for (1) becomes:

(3) 'My nervous impulses lead me to behave so and so toward this female.'

Proposition $(\overline{1})$ becomes:

(4) 'My nervous impulses are such that unfavorable reactions occur inside my skin when you behave as stated.'

Obviously propositions (3) and (4) may both be true. But the 'nervous impulses' described will usually themselves lead to conflict. Hence we call the behavior associated with such pairs of utterances incompatible.

CATEGORY 2. *Compatible behavior leading to conflicts on the verbal levels only.*

(5) 'Oysters are tasty'   (5̄) 'They are not.'

(6) 'The music of Bach is more inspired than that of I. Berlin.'

Again when these utterances are stated as propositions concerning the internal states of the speakers, they cease to be contradictory. Verbal conflicts arising from them can be resolved by both sides recognizing the 'subjectivity' of their assumptions. The *conflict of behavior,* however, remains. Usually such conflicts of behavior do not lead to destructive struggles. They are on the 'tolerance' level. Still it is sometimes desirable to resolve such conflicts, especially those of esthetics. Attempts are made to do so by appeals to 'valid esthetic truths.' In this article we shall not investigate the question of existence of such truths. We shall, however, investigate the question of the possibility of establishing criteria capable of resolving the conflicts of:

CATEGORY 3. *Contradiction about the external world.*

(7) 'This pencil is red'   (7̄) 'It is grey.'

(8) 'Vancouver exists'   (8̄) 'There is no such city.'

(9) 'Gremlins do not exist'   (9̄) 'They do.'

(10) 'The atomic weight of oxygen is 16'   (1̄0̄) 'It is 17.'

A *restatement in the form* 'I believe that . . .' does not resolve the contradictions between these statements as in the case of Category 2. If my friend believes the propositions (7̄) through (1̄0̄) I consider him color blind, queer, superstitious, and misinformed. If he has a sufficient number of such beliefs, I consider him a menace and insist on his confinement in an institution or at least seek to eliminate his influence in human affairs. But how can I justify my attitude? How am I more right than the bigots of the Middle Ages or the savages, who persecuted people for 'rational' notions that did not tally with theirs?

We need a universal criterion for truth. If such a criterion were recognized by a vast majority of human beings and were proved of survival value, many conflicts between man and man and between man and nature would be resolved. Utterances leading to conflicts could be broken down into propositions about the external world, and the propositions referred to the criteria and evaluated. In fact, if the civilizing process is considered as a conflict-resolving one, this has actually taken place in many instances, but of course not often enough.

It is by no means certain that each assertion and its denial can immediately by inspection be placed into either of the three categories. Even examples given are classified according to the prevailing notions of 1945, that is, in such a way that a majority of the readers of this article will probably agree on the category. Thus almost every one will agree that the question of Vancouver's existence falls into Category 3, but certain quaint people will insist that gremlins have an 'existence' independent of extensional verification. The pair of utterances

(11) 'God exists'   (1̄1̄) 'God does not exist'

will probably be placed in the second category by people said to be 'tolerant,' while not so long ago it belonged to the first. On the other hand there was a time when the contradiction (2) was clearly in the third category, when the status of a man's slavery was a question of objective investigation of facts and definitions. It must be stressed, then, that at different times different contradictions fall into different categories of verbal conflict.

Now it is evident that conflict will be reduced to a minimum if and only if as many contradictions as possible fall into Categories 2 and 3, and as few as possible into Category 1. In fact, it is possible to make a quantitative definition of civilization in terms of the distribution of contradictions in the three categories, where, while the significance of the second category is not at first clear, the least weight of the first and the greatest weight of the third category can be taken to be the signs of higher civilization. However, this point of view is connected with serious difficulties, as will appear below.

Very probably the beginnings of social life (apart from animalistic family life) began with verbalization of behavior. It became possible for two males to get along when the simple behavior of taking possession of a female (simple reaction to environment) was verbalized into a *symbol* 'This female is mine,' which would produce a semantic reaction in the other male *contrary* to his natural reaction to environment, namely, an inhibition against taking possession of that female. This metamorphosis of the *behavior,* 'This female is mine' into the *proposition,* 'This female is mine' is the beginning of social behavior based on semantic reactions. This process can be roughly described in terms of the historical semantic systems, taboos, magic, re-ligion, philosophy, science. In a way these manifestations indicate a certain shift from the first category of contradictions to the third and in some cases to the second.

One is tempted to assume that any shift from the first to the second and third categories or from the second to the third represents an advance of civilization if civilization is defined by elimination of conflict and a broadening of knowledge. However, the difficulties of this interpretation are many, as was suggested above.

On the basis of this evaluation, it would, for example, have to be concluded that a stratified society with well-defined, legally established castes, including a caste of slaves, is more civilized than a society in which struggles for the abolition of slavery and caste occur, because under the former the question of an individual's status in society would come under Category 3, while in the latter it would come under Category 1. It would also seem that a society based on rigid taboos is more civilized than a society where great freedom of individual behavior prevails, because in the former questions of behavior come under the third category, while in the latter they come under the second. It would also seem that physics in which absolute space and time frameworks are assumed is more advanced than a physics in which they are not assumed, for certain concepts are precisely defined in the former (*i.e.,* simultaneity), while in the latter they depend on the observer, and thus many 'contradictions' involving them come under the second category.

In order to clear up these difficulties, let us examine the steps in the resolution of conflicts.

Contradictions of the first category are either between man and man or between man and nature. An example of struggle

between man and man has been given above in the verbalized behavior, 'This female is mine.' Examples of struggles of man against nature are seen in the verbalizations of behavior such as 'I am hungry,' 'I want shelter,' 'I have a stomach ache,' etc. The change of these declarations into propositions is the first step in resolving conflict. Thus rules can be set up which determine just when a female is 'mine.' If these rules are obeyed, conflicts do not occur. Similarly rules of behavior can be established on the basis of propositions by the process of 'time-binding,' which prescribe the satisfaction of wants, how to obtain food, how to build houses, how to cure stomach aches. Thus the behavior symbol, 'I am hungry' becomes associated with knowledge of the external world expressed in the proposition, 'If soil is cultivated, seeds sown, etc., bread results, which appeases hunger,' or 'If these herbs are eaten, stomach ache ceases.'

Note, however, the vital difference between man-man and man-nature relationships. Investigations based on experience and measured by success of predictions were possible very early in the struggle against nature; but in the case of man-man relationships, the superstructures of semantic relations multiply so rapidly that the notion of 'truth' becomes totally divorced from prediction. But the man-man relationships have also an influence on the man-nature relationships and become intermingled with them. The taboos of social behavior merge with the taboos of demonology, and the fruitful time-binding verbalizations of nature-conquest such as 'If seed is sown, bread will result' are supplemented by or even replaced by a maze of magic with no survival value.

One must keep in mind that an abundance of 'settled' questions does not necessarily mean that conflicts between man and man or man and nature are resolved. Vast civilizations have crumbled and are now crumbling because of reliance on 'settled' questions. In a primitive society the relationship of each man to his neighbor and of each man to nature is fixed by a system of taboos and rules of behavior. But if these taboos and rules are not reducible to *more general* and fewer rules, they must be classified as declarations of behavior (utterances of the first category). For example, 'One must not plant seed, because this involves tilling the soil, and breaking the soil is taboo' is a logical deduction of a 'valid' conclusion and belongs to the third category of utterances, but the major premise 'Breaking the soil is taboo' belongs to the first (irreducible) category, and it is on this level that conflict is bound to arise. Similarly 'You must not undertake public works, because government must not engage in business, because acquisitive competition is always preferable to coöperative effort' is a 'logical' conclusion based on a premise of negative survival value.

According to our proposed criterion for civilizations, a higher civilization constantly strives to reduce the number of its unassailable assumptions, to leave only those most generally acceptable. A tolerant society (with many questions falling into the second category), other things being equal, is more civilized than a rigid one, because all the conflicts in the second category are reducible to a single proposition of the first, 'Differences of compatible behavior are tolerated,' while in a rigid society the patterns of behavior are supported by an involved system of arbitrary assumptions, beliefs and superstitions of no survival value, potential instigators of conflict and inhibiting factors in the quest for greater knowledge and freedom. Other things being equal, a democratic society is more civilized than a caste society, merely because the funda-

mental postulate of democracy, 'All men are created equal' (a declaration of behavior) is *simpler* than the involved postulates of the caste system and therefore probably more generally acceptable.[1]

It appears further that the problem of survival and elimination of conflict is not solved by simply verbalizing behavior into propositions. Propositions, in order to be tools of survival, must be 'a reflection of reality,' that is they must be 'true,' and this brings us to the conclusion that the elimination of conflict and survival depend on the recognition of 'true propositions.' Only in this way will the substitution of semantic reactions for direct reactions to natural environment have a survival value. The vague sensing of this is probably reflected in the wide preoccupation with 'truth' characteristic of human thought.

We are now ready to restate our quantitative definition of civilization. The highest civilization is a state of affairs in which the maximum number of conflicts between man and man and between man and nature are resolved by verbalizing these conflicts into a series of true propositions, which serve as a guide for behavior. In what follows we attempt to show that the truest proposition (those of greatest survival and conflict-resolving value) are those which rest on the fewest assumptions and from which most predictions are deducible.

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[1] The reader is begged not to confuse the *declaration of behavior*, 'All men are equal' (Category 1) with the *proposition*, 'All men are equal' (Category 3). In the Declaration of Independence it is certainly used in the former sense and remains a valuable postulate (Hayakawa's *directive*) for building a conflictless society. Used in the latter sense, it is seen to be simply a false proposition. The two categories are often deliberately confused by many fascists, 'professional Southerners,' etc.

II. *The Criterion of Predictability*

In the name of religion and philosophy men have made steps toward the investigation of truth. Their systems begin generally with dogmas and tacit assumptions. Around these systems of more or less fruitful logic, notions of 'truth' arise. None of the systems has been consistently successful from the point of view of either survival value or resolving conflicts. Only science, especially physical science, has succeeded in building a system of natural knowledge, limited in scope, approximating the ideal indicated above. The method of modern theoretical science, Assumption - Deduction - Conclusion (Prediction)-Verification, has a partial analogue in religion and law, Dogma-Interpretation-Judgment. The reasons for the stratification and inefficiency of religions as bases for elimination of conflict are many; so are the reasons for the sterility of metaphysics and philosophy as methods of securing knowledge and resolving conflicts. But their obvious and prominent shortcoming is the shortcoming of all non-scientific systems, the total lack of a vital scientific measuring stick, the criterion of predictability.

We should like to show that predictability is the *only* yardstick of truth; that on the basis of predictability and universally accepted undefined terms (terms involving structure and order relations only), a positivist conception of the universe *including* man can be gradually approached; that the positivist conception is synonymous with the elimination of conflict and the acquisition of freedom (defined below). We should like to show that the recognition of the criterion of predictability for truth may lead to basic principles of behavior recognized as tending to preserve the greatest harmony between will and reality (sanity) through

the closest adjustment of nervous processes to the structure of the universe.

The introduction of the ethical problem in this connection is not relevant. No one doubts that there exists an optimum range of temperature for the human body, an optimum intensity of reaction of the retina to light waves. It is not too far fetched to assume that there exists an optimum pattern of nervous reactions to the presence of other human organisms, which the old metaphysical apostles dubbed 'Love thy neighbor.' 'Love thy neighbor' has not been very successful as a guide to behavior not because it is 'contrary to human nature,' etc., but *because it has not yet been defined in terms of behavior on the colloidal level.* Ethics has never been effectively geared to other investigations, where predictability could be effectively applied. If this were done, it might seem possible to develop a 'general ethics,' of which the ethics of various cultures would appear as special cases and would become amenable to evaluation in terms of survival value. It can perhaps be shown that 'virtue' as a social behavior within a certain social framework depends on nervous reactions not much different from those of good digestion or from favorable reactions to the sound of a major triad.

Happiness, which a hero of *War and Peace* defines negatively as the 'absence of illness and remorse,' may constantly approach more precise definitions as the physical, colloidal nature of both illness and remorse become known. Social science may then become a study of conditions which will guarantee this state to a maximum number of individuals. It will merge with medical science, simply dividing with the latter the spheres of influence.

Present day anthropology in its quest for 'objectivity' and as a reaction to earlier naive, self-centered views of the Occident, often falls into the other extreme, namely, that of complete relativity of *all* values, in effect a denial of the existence or the possibility of existence of general human criteria of evaluation. Following Spengler's cue, it often denies the existence of any general evolutionary principle of culture, allowing only the evolution of *cultures,* destined to go through incipient stages, maturity, old age, and death.

Present-day philosophy of science, frightened by the wreck of Euclidean, Newtonian, and Aristotelian frameworks of thought, falls into what seems a sophisticated pessimism and speaks of the 'impossibility of complete knowledge.' It wistfully looks to 'Ultimate Reality' (which no one has ever expressed in operational terms) as on a promised land forbidden. We suggest the abandonment of God-seeking. We suggest a steady and infinite approach to reality measured *quantitatively* where more knowledge means more predictability with less assumptions. In the fields of ethics and social sciences our goal is a description of 'happiness' and 'virtue' in operational terms. Such a description of 'freedom' will be attempted here. It involves the criterion of predictability.

The criterion of predictability is possibly as old as language. Its conscious and systematic application, however, is a recent thing. The older concepts are the undefined and static terms, 'Truth' and 'Reality.' But the history of human thought has often been a monstrous growth of hopelessly involved networks of propositions, completely divorced from what we today would call 'reality.' To the Greeks a true proposition was a verbalism derived by certain rules from other verbalisms accepted as 'self-evident.' Euclidean geometry was the most glorious achievement of Greek thought. Fran-

cis Bacon declared the supreme criterion for truth to be experiment. All progress in the search for truth consisted of refinement of experimental methods, broadening the range of experimental activity and developing a language of deduction —mathematics. Experiment and mathematical deduction, supplementing each other, constitute the chief tools of scientific research. This method may be said to be founded on the criterion of predictability. Our purpose is to show that not only the natural sciences but all meaningful knowledge is based on this criterion and to back up this assertion with the definition of civilization given above, now restated in quantitative terms:

The highest civilization is a state of affairs among human beings where a minimum of conflict, a maximum of freedom, and a maximum of knowledge prevail.

Conflict has been defined above. Freedom (more fully discussed below) means maximum predictability of one's own behavior. Knowledge means maximum predictability with minimum assumptions about the external world. In this connection we shall show that:

1. Mathematics, the most positivist of sciences and the most effective (contradiction-proof) of languages, bases the truth of its propositions entirely on the principle of predictability.

2. The hidden contradictions of ancient dilemmas are easily laid bare by the applications of this criterion.

3. The criterion is semantically significant as a tool of dialectics.

4. It has possible applications to the social sciences.

5. It is intimately connected with the notion of 'freedom.'

6. It is connected with the notion of 'reality.'

The method used will be the transla-

tion of *all* meaningful propositions into a language of verifiable predictions. When prediction is unconsciously incorporated into meaning, its importance will be stressed. A proposition will be defined 'true' (a quantitative term), 'false,' or 'meaningless' according to whether it can be stated as a set of predictions which are realized (the extent of realization is the measure of truth), or a set of predictions which are not realized, or whether it cannot be stated as a set of predictions.

Our first object of analysis is mathematical truth.

III. *Mathematical Truth and Its Physical Counterpart*

The preciseness of mathematical propositions becomes evident through the realization of three of their characteristics:

1. Mathematical notions are defined and propositions deduced from the undefinables and postulates of the particular system in a *finite* number of steps.

2. The Law of Excluded Middle is applicable to mathematical reasoning.

3. Each mathematical proposition is immediately, obviously, and uniquely translatable into a prediction, in fact, is equivalent to one.

These conditions we shall define as the conditions of *positivism*. All knowledge will be evaluated in terms of its approximate satisfaction of these conditions.

As an example of positivist knowledge, we shall examine an elementary discipline of mathematics, say euclidean geometry. The first condition of positivism is obviously satisfied by the propositions of this discipline with the exception of the propositions involving incommensurables and limits. To establish these, higher disciplines of infinitesimal analysis are invoked, that is, the postulates not ordi-

narily among those of euclidean geometry are added. The second condition is involved in the very method of proof. The third condition is not quite so obvious. What do these propositions predict? The answer is that they predict phenomena which take place inside our skins. The only fruitful meaning of these propositions is contained in predictions of the following type: 'If you assume these postulates and follow rules of reasoning (which also must be stated) you will inevitably come to the conclusion stated in the theorem.'

To show the significance of this explicit restatement of mathematical propositions, let us examine the confusion which is so often associated with mathematics. The difficulties of high school and college students are well known, but confusion is not confined to them. The balking attitude of the ancients toward infinity and infinite processes is reflected in present-day attitudes of the 'intuitionists.' There are still people who say that the real number system is 'meaningless.' The superstitious fear of 'imaginaries' is only half-heartedly disspelled by most teachers of mathematics. In my own student days I also gazed at the equation

$$(12) \qquad e^{\pi i} = -1$$

and suspected it of being a gigantic hoax. My doubts were about the *existence* of such operations. Their reality becomes clear only through the realization of their content, which is nothing more than, 'If you assume such and such and follow certain rules of reasoning, you will conclude this and that.'

The study of mathematics, however, began as a natural science, not a 'psychological' one. To this day many people assume the propositions of mathematics to be propositions about the external world, for example about physical space, when as a matter of fact, an additional assertion is needed to connect the two,

such as 'The structure of the universe is reflected in the structure of mathematical thought.' The omission of this assertion leads to confusion. The Greeks, instead of generalizing their mathematical thought to include mathematical analysis, gave up in despair, when they saw that their 'mathematical reasoning' did not tally with the physical situation. In other words they did not evaluate the power of their mathematics by the potentiality of predictability embodied in it. One of the best illustrations of this impotence of the Greeks is the Achilles Paradox,[2] a situation in which the structure of the universe is *not* reflected in Greek mathematics, devoid of infinite processes. Stated as a prediction, Zeno's contention becomes:

(13) Achilles will never pass the Tortoise.

The first step is to realize that this prediction can be on either of two levels, which the ambiguity of ordinary language does not disclose. Namely, it can be a prediction of an external phenomenon, *i.e.*, one about a physical Achilles racing a physical Tortoise, not overtaking it in any specified time.[3] To refute

[2] Although most readers are probably familiar with this fable, we restate it for the sake of completeness. Zeno says that Achilles, running ten times as fast as the Tortoise, who has a head start of say 100 yards, cannot pass it, because by the time Achilles will have run the 100 yards, the Tortoise will have advanced 10; by the time Achilles will have run 10, the Tortoise will have advanced 1, etc., *ad infinitum.*

[3] Mathematicians please note that every mathematical notion involving an infinite process (explicitly or implicitly) contains a prediction. In this case 'never' means, 'Name an instant, and I shall show that the event has not taken place.' Obviously that is not the sense in which Zeno uses 'never.' Compare also the 'epsilon' definitions of analysis. 'For every epsilon greater than zero there exists a delta such that, etc.,' can be restated as 'Name an epsilon, and I shall exhibit a delta.' The crucial

this prediction, one need only perform this or an equivalent experiment. To many 'practical' (read unimaginative) people, this is the end of the paradox. But there is also another interpretation of the prediction, namely, as a prediction on the logical (mathematical or psychological) level. The prediction does not at all concern Achilles. It concerns events which will take place *inside your skin*, *i.e.*, it maintains that *if* you start with assumptions as stated *and* follow reasoning as prescribed, then you will come to the predicted conclusion. What of it? The sophist stated the assumptions; *he* set down the rules of reasoning which we must follow (*i.e.*, examine the relative positions of the two contestants at moments specified by *him*); and then *he* interprets the result into the conclusion 'Achilles will never pass the Tortoise.' The surest way to refute the significance of the paradox is to accept the conclusion as determined by the sophist's method, but to remind him that the conclusion is simply on the 'logical' level, where the logic is the sophist's, not ours, and that if it does not tally with the physical phenomenon, it simply means that the sophist's 'rules of reasoning' lead to predictions on the logical level which do not tally with phenomena on the physical level, *i.e.*, the structure of *his* logic does not correspond to the structure of the physical world.

'But is there a better logic?' asks the sophist.

There certainly is. In that better logic, which *does* tally with physics (at least in this experiment), it is not true that an infinite number of finite intervals necessarily add up to an infinite interval, as the sophist tacitly assumes. It becomes

clear that the infinite sequence of moments examined by the sophist all lie within a finite interval of time (the time it takes for Achilles to travel $111\frac{1}{9}$ yards (see footnote). In that more accurate logic the prediction 'Achilles will not pass the Tortoise' becomes 'Achilles will not pass the Tortoise within the interval of time examined, *i.e.*, the time Achilles needs to run $111\frac{1}{9}$ yards,' and this prediction *does* tally with the physical situation.

It is seldom emphasized that the predictions of mathematics are not predictions about the external world but about events inside our skins. In grade schools (even in high schools) theorems are often 'demonstrated' to youngsters by measurement. It may be that these are sound pedagogic methods as far as they go. It may be that the immature mind is unable to grasp or is indifferent to 'abstraction' (we mean, of course, abstraction of higher orders). But it may also not be true. And if it is not, then tremendous amounts of nervous energy are wasted in establishing connections *tacitly* between mathematics and the external world (two different levels of abstraction) which later preclude fruitful developments along the lines of abstract thought, namely, the study of mathematics, because paths that are struck in that direction are obstructed by special applications on lower levels. What efforts are needed later to induce students to think in terms of imaginaries, which 'contradict the laws of algebra' (it has been drilled into them that 'you can't take the square root of a negative number'), to think of the calculus without geometric crutches, to develop the habit of conscious abstraction and generalization, the essence of all rational thought!

The connection between a mathematical proposition of, say, euclidean geometry and its physical counterpart is not

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importance of naming certain quantities *first* becomes apparent in uniform continuity, uniform convergence, and other refined notions of modern analysis.

an obvious thing. It must be established by a proposition involving another prediction, connecting the structure of one with that of the other, eg, 'The space in which we live has to the extent of ordinary measurements, euclidean properties, where straight lines are defined by paths along which light travels.' This proposition is not at all a proposition of mathematics. It is a proposition of physics and involves predictions about the external world, which may be verified to certain degrees of accuracy. In particular the measurement of the sides of a physical 'right triangle' would be a verification of a prediction contained in one of the theorems about such triangles. The definition of a physical 'straight line' is certainly needed. In our measurements we always tacitly use a criterion for 'straight line,' the path of a beam of light or a line of force of the earth's gravitational field or some similar thing, which we agree to call a straight line. The question whether it is 'really' a straight line has no meaning whatsoever.

In the realm of physics we find that knowledge which comes closest to satisfying the conditions of positivism is knowledge expressible by mathematical language. This means that the ultimate verification of the predictions rests on measurements of quantities, which, it is thought, are all reducible to the fundamental undefinables (space-time and matter-energy). The aim of positivist philosophy of science is the establishment of methods by which it will eventually become possible to reduce all knowledge to such measurements. The trend of all rapidly progressing sciences has certainly been in that direction. It becomes more and more evident that all 'qualitative language' is a temporary framework in which situations are given names to be used in manipulating them until their quantitative structure is discovered. The establishment

of the strictly quantitative structure of such seemingly 'qualitative' experiences as pitch and color are early classical examples of this tendency. The creation of modern mechanics, which has completely replaced the mystic 'tendencies,' 'wills,' and 'affinities' of matter characteristic of the metaphysical approach, is another example. Another is the chemistry of the nineteenth century, which reduced the descriptions of compounds to strict quantitative relations between elements. Another is sub-atomic physics, which did away with the qualitative differences between the 'elements' and substituted for them purely structural formulations.

The triumphs of quantitative analysis are not confined to the physical sciences. By means of powerful statistical methods and recognition of fractional predictability (mathematics of probability), human affairs en masse are likewise described and predicted. Developed in its applications to the social sciences, statistical probability now returns to physical science to explore the sub-atomic reality. To what is this unmistakable success of quantitative methods to be attributed? To answer this question is to examine how the criterion of predictability operates in resolving contradictions of judgment.

Whenever such a contradiction arises, and both parties desire to come to the same conclusion, the invariable procedure is to appeal to 'proof,' that is, to make (tacitly or explicitly) predictions based on each judgment, where it is agreed that the realization of a particular prediction is equivalent to the vindication of the judgment on which it is based. But it is important that both parties agree on what shall constitute proof. We shall analyze some trivial examples.

I maintain that one of two pencils is red, the other green, and my color blind friend maintains that both are grey. If

my friend is aware of his affliction, the authority of a third disinterested party will determine the issue, or, if he believes that I am disinterested, he will take my word for it. My friend may be a physicist and willing to test the color of the pencils by a spectroscope. At any rate, to agree, my friend and I must find a common ground on which we can make our predictions. Let us examine other cases.

How can I prove the existence of Vancouver, where neither my friend nor I have been? I can appeal to the authority of maps, to the authority of newspapers, to the authority of other men, or to the senses of my friend, if he is willing to take the trip. But are such authorities always reliable criteria? I probably appear very unreasonable to the fundamentalist preacher, who quotes 'authorities' on the six-day creation, and to the New Guinea native, who quotes equally unimpeachable 'authorities' on sorcerers. The appeal to the senses is by no means adequate. It is not appeal to the senses that established the heliocentric description of the solar system. On the contrary, it was the breaking of bonds imposed by the senses. If we establish the existence of microbes by appeal to the senses (refined) and refute the existence of gremlins by the same appeal, what can we say about the existence of atoms?

The question arises, does there exist a universal yardstick, a language of experience common to all human beings, so general that those to whom it does not apply may be termed insane, and their influence justifiably eliminated? Does there exist a criterion so basic that if predictions made in terms of it are realized, the truth of the proposition on which the predictions are based is immediately established?

The search for such universal criteria has gone on for a long time. The invocations of the 'Word of God,' declarations *ex cathedra,* and philosophical systems are attempts to establish such criteria. The homely maxim 'seeing is believing' is a rough statement about the conclusiveness of experimental evidence. However, it is far too uncertain. What is seeing? How about illusions and hallucinations? How about the vast realm of the invisible on which the modern notion of the universe is built? An appeal to the senses is certainly a first approximation in the search for reality, but we must go far beyond. The mechanics of the senses must itself be analyzed and vast networks of valid inference established. A chain of truths must be sought, backing each proposition about the external world, each truth being on a more fundamental, more general level than the preceding. An appeal to the senses' is only a link in that chain. What then is the last link? What are the undefinables of the system?

At least one such category of universal judgment is known to exist, the category of *order and structure.* To all humans 3 is more than 2. In the configuration A-B-C, B is *between* A and C. These notions are crude and subject to infinite refinement, but no refinement disturbs the *order* of the elements once established. Superstructures of measurements other than space come next: stronger-weaker, lighter-darker; louder-softer, where 'measurement' means the reduction of inaccurate 'subjective' perceptions to abstract quantities involving *order* and *structure* only. Multidimensional measurements, structure relations based on systems other than the real number system, such as the complex number field, matrix algebra, etc., flow logically out of the development of the language based on structure alone (mathematics). These are the undefinables on which every

141

meaningful prediction must be based. Obviously, it is not possible at the present time to reduce all knowledge to positivist utterances. Our present state of knowledge is a vast collection of suppositions, rules of thumb, working hypotheses, beliefs. We rely heavily on authority, because certainly verification in all or even in a significant number of cases is impossible. But a firm establishment of the fundamentals as attempted here is necessary to establish or to refute authority.

The greatest contribution of the West to humanity is science, the critical approach, the extensional investigation. Anthropology has shown us that our *mores* are as much infested with shibboleths of doubtful or negative survival value as those of many primitive societies. We must obviously reject the trader and missionary approach to the pre-literate society, which confined the 'civilizing process' to endowing the latter with shotguns, syphilis, and arbitrary taboos on his sex behavior based on Christian word-magic superimposed on his home-grown kind. Anthropologists, constantly confronted in their field work with tragedies of this type, are inclined to negate any 'absolute' standards in the evaluation of civilization and especially of ethics. This reaction is understandable considering the failure of applying 'our' standards to other cultures. Yet there is no reason why *general* standards cannot be found by which *both* our culture and other cultures could be evaluated. These standards have already been suggested in the existing literature of general semantics. *According to them we* evaluate our western science as having genuine survival value. Science can probably be safely 'sold' to every human being, properly approached. We must therefore firmly establish our 'authorities' based on the scientific approach. We

must show why the contention of the physician is more reliable than that of the medicine man; the statement of the biologist more reliable than that of a fundamentalist preacher; the theories of Franz Boas truer than those of Alfred Rosenberg. To test the reliability of authorities, criteria of knowledge must be universally established.

We have maintained above that the criterion of predictability is synonymous with the criterion of truth, and this leads to a definition of reality in these terms. The problem of establishing this, however, is vast. It involves the entire task of semantics, *i.e.*, that of clearly establishing abstraction levels in all reasoning, judgment, investigation, and discourse.

The task of education becomes a thorough conditioning of the human nervous system to permit it to establish habits only in accordance with *this* rationality, to reject any authority except that based on rational investigations, and, above all, to recognize and to resist the irrational actively and uncompromisingly (as 'rational and 'irrational' are here employed). The aim is the establishment of a new materialism and a new dialectics, more powerful than the old, a materialism which instead of minimizing the importance of that which is called the 'spiritual,' brings it within the sphere of its investigations by intimately linking psychology and physiology, physiology with biochemistry and biophysics, which in turn rest on operational positivist foundations. The answer to persistent believers in the 'supernatural' (there are surprisingly many of them among scientists) is that the 'supernatural' is a self-contradiction, because everything that happens is extensionally defined as the 'natural.' Similarly the postulation of the existence of 'unknowables' is simply a declaration of behavior that inhibits the search for

truth (greater predictability). The unknown should be regarded only as the 'not yet known,' while the 'unknowable' simply becomes meaningless.

IV. *Predictability and Freedom*

So far we have attempted to establish a quantitative description of civilization and have pointed out that 'truth seeking,' *i.e.*, investigation of criteria for true propositions (conflict resolving) is a vital activity in the civilizing process. Not the least important result of establishing such criteria is the abandonment of meaningless verbalisms, which for lack of an effective critique of meaning were thought to be unsolvable dilemmas. We have already exploded the Achilles paradox by applying the criterion of predictability. We wish to examine in this light one of the most significant of the old dilemmas, the so-called 'free will vs. determinism' controversy. As a preliminary study, we shall take up the well known barber paradox, which provoked modern thinkers to doubt the validity of 'propositions about all propositions' and has had reverberations in the recent critique of the foundations of mathematics. The paradox rests on a statement made about every inhabitant of a village:

(14) 'The barber shaves all those and only those who do not shave themselves.'

This statement supposedly determines the shaving habits of each inhabitant. The shaving habits of the barber as a particular inhabitant must then be inferred. But both the statements,

(15) 'The barber shaves himself,' and
(15) 'The barber does not shave himself.'

are incompatible with (14). This seems to destroy the 'law of excluded middle' and the syllogistic process of inferring the particular from the general.

The paradox becomes perfectly transparent when the proposition (14) is stated as a prediction, the veracity of the inhabitants being explicitly assumed. The prediction is about the result of a poll taken among the villagers. If every villager is asked to fill out a questionnaire consisting of two questions,

(16) 'Do you shave yourself?' and
(17) 'Does the barber shave you?'

then (14) is equivalent to the prediction,

(18) 'In every ballot "Aye" to one of the questions will be accompanied by "Nay" to the other.'

Now 'every' ballot means Jones' ballot and Smith's ballot, and . . . . the barber's ballot. But to the barber (16) and (17) are equivalent. Therefore he must answer 'Aye' and 'Nay' to both, if he is telling the truth as assumed. Therefore prediction (18) cannot be realized.

The technique of propositional functions, of course, resolves the paradox with equal success. The object here is simply to present semantic analysis in slightly different terminology linked with the predictability criterion of science, and which in other situations may prove simpler and more immediately applicable to experience. The challenge to the dilemmas of metaphysics, to babbling politicians, advertisers, advocates of White Supremacy, and other savages should be 'make a realizable prediction' instead of a vague 'prove it' or 'define your terms,' because the latter are simply invitations to more babbling.

The serious paradox which concerns us here is the old one about 'free will vs. determinism,' a favorite of theology but prominent in modern philosophy of science.

The question was usually blandly stated as 'Is there such a thing as Free Will or is every phenomenon including the actions of every individual predetermined?'

In idle verbal arguments, the exponents

of determinism are always able to establish an 'irrefutable case.' In answer to contentions such as 'I raise my arm by free will, because it is in accordance with my intention,' they are always ready to reply, 'But your intention is also phenomenon and was determined by a previous cause.' This, of course, contradicts the 'intuitive' feeling of free will ('But I can *choose* either to move or not to move my arm'), which in turn is countered by 'But your choice is again "determined," ' *etc., ad nauseam.*

The question has meaning only if predictions are made based on each contention. We find that predictions about 'free will' and 'determinism' are *predictions about predictions.*

What do we mean when we say that the stone is not free in its flight, but the bird is free—or at least, is more free than the stone? As far as we can analyze these judgments, we see that we are comparing simply the degrees of predictability concerning the behavior of the stone and the bird. In comparing the 'freedom' of any two individuals (entities whose behavior as a whole is studied), three bodies are involved, the two bodies compared *and the investigator, who makes the predictions.* From such a standpoint freedom can be quantitatively defined.

Let us now return to the bird and the stone. The observer, studying the habits of each, can now significantly say that the bird is more free than the stone. There is a wide range of conditions under which the behavior of the stone can be predicted. It can be placed in a situation where the forces acting on it are known, and its motion can then be predicted. The effects of temperature and pressure can be predicted, etc. The behavior of the bird can also be predicted, but far less precisely. Innumerable details of the bird's behavior cannot (1945) be predicted, such as whether it will turn its head, take off, chirp, etc. Suppose now that another observer knows more about birds than about stones. Does that mean that 'to him' the stone is more free? The question immediately arises about the 'real' degree of freedom of bird and stone. Again there is a quantitative definition of 'reality.' Judgments based on greater reality are judgments based on greater predictability. If the knowledge of the two observers is *combined,* greater predictability of the behavior of both the stone and the bird results. Comparative freedom of bird and stone determined by this greater knowledge is then more 'real.' 'Ultimate reality' can only mean judgments based on 'complete' predictability, a limiting concept.

What then is the degree of freedom of man? It is measured in terms of the predictability of his behavior and always involves an observer. The confusion arising from this question arises from the formulation 'Am *I* free?' Here both the object and the observer are taken to be identical. Actually the situation is very similar to that in the barber paradox. The latter is clarified by the recognition of the fact that whereas to every one else in the village the two propositions 'I shave myself' and 'The barber shaves me' are incompatible, to the barber they are identical. Similarly the statement 'I can predict *your* behavior' is to me equivalent to 'You are not free,' while 'I can predict *my* behavior' is equivalent to 'I am free.' A prediction of behavior is connected with the notion of 'I will,' or control. I can say 'This stone will now describe a parabolic arc' and then throw it. I have certainly proved that the stone is not free in this respect. But have I also shown that *I* am not free, since I have to a certain extent predicted my own behavior? If this point of view is assumed, the whole argument about free will becomes devoid of content, especially since it is

shorn of its emotional connotations, which gives it its vital historic significance. To say 'I shall do so' and do it demonstrates what people always have called 'freedom.' There is no reason why these connotations should not be kept. But their clarification involves a definition of freedom in terms of predictability. When the observer and the observed are different, greater predictability means less freedom; when they are 'identical,' greater predictability means greater freedom.

Let us examine the process of self-predictability further. Let us suppose that by a tremendously developed technique of observation, it becomes possible to predict the behavior of an organism completely. To be specific, let us imagine an apparatus into which the observed organism is placed and which projects the immediate future behavior of the organism on a screen—a fortune-telling machine. Fantastic as it seems, there appears no logical impossibility for the existence of such a machine. Let us now suppose that our illustrious scientist, the inventor, decides to perform an awesome experiment on himself, and he sees that he is 'destined' to commit murder or to be killed in an accident or to be involved in something equally unpleasant, a favorite and gruesome theme of romantic fiction. The fantasy immediately involves the old arguments about 'fate,' etc. The whole notion is immediately exploded when it is realized that self-observation in the ultimate sense of the word is impossible. I can contemplate my hand or my navel, but not my 'self.' In the statement 'I contemplate myself,' 'myself' can never be identical with 'I' (Korzybski's non-identity). The question 'What am I thinking of?' can have only a trivial answer 'I am thinking, "What am I thinking of?" ' The story of the well-known absentminded professor illustrates this

point. Deciding to overcome his handicap, the professor wrote down the whereabouts of his things when he retired. Upon rising he was gratified to find everything at hand. 'The clothes are in the closet,' he read, 'the shoes are under the bed; that watch is on the mantelpiece. Quite correct. But where am I? The last entry is "I am in bed," but the bed is empty!'

The recognition of the fact that 'self-observation' is impossible at once dispels the dilemma of 'fate.' Predictions about one's 'self' are not based on 'observation' in the sense that the predictions about the stone are. Therefore there is no such thing as inevitability of one's own behavior except where the knowledge (predictability) of this behavior is absent. It follows that *the ability to predict one's own behavior is equivalent to freedom, in fact, is the only content of freedom.*

The range of such predictions is of course decisive in determining the degree of freedom. This tallies with the popular notions. If Smith is in jail, he is to a certain extent not free, because the prediction 'I shall go to Vancouver' is unrealizable for Smith in a Chicago jail. It may seem at first thought that Smith in jail can predict more about himself than Smith out of jail, because of routines, etc. But in considering Smith's freedom we must consider also the *range* of predictions realizable for Smith, in other words, the range of his activities, the repertoire of his attainable desires, etc.

If Smith has learned to predict the behavior of Jones, Jones is not free relative to Smith. But if Jones is *also* able to acquire this knowledge about himself, then he becomes free, and Smith's knowledge of Jones' next move is again restricted. As an example, let us suppose that Smith has placed Jones into our prediction machine and finds that Jones is 'destined' to

raise his arm. If Smith is silent about it, *i.e.,* if knowledge is denied to Jones, it is conceivable that Jones' raising his arm is 'inevitable.' But if this knowledge is imparted to Jones, Jones immediately acquires the freedom not to raise his arm. This example finds its counterpart in psychoanalysis, which strives to impart to Jones knowledge about Jones accessible to the physician but not to Jones.

The progressive study of nature by man constantly reveals nature to be less and less free[4] (unpredictable). But the study of a man by himself on the contrary reveals (makes) him more and more free (self-predictable). Resolution of conflict between man and man through the increase of total individual freedom (self-knowledge) possessed by mankind, and between man and nature through the subjugation of nature to man is the object of collective existence. In this light we define civilization.

The seemingly insoluble difficulty in the 'free will *vs.* determinism' problem lay in the tacit assumption of the existence of an *observer* relative to whom man's freedom was considered. Since there is not the slightest evidence of such an observer, he must go the way of the 'supports' on which the earth was presumed to rest, the First Cause, the Ether, and similar semantic disturbances. In fact the verb 'exist' is meaningless when applied to things about which no predictions can be made. Man unconsciously assumed the role of that 'observer.' He was then talking in terms of self-observation and got entangled in a monster barber paradox. The tacit assumption of an 'observer' will appear again in the last context in which we shall examine predictability, namely, in connection with 'reality.'

[4] See the comment on 'unpredictability in modern physics' in the Resumé.

V. *Predictability and Reality*

Sir James Jeans in a recent book tells a gloomy parable. Somewhere a man who has no contact with the civilized world except a radio listens to signals given out by ships at sea, giving their name and position. The hermit records these coördinates and after years (or centuries) of such recording begins to build theories. His theories are both mathematical and empirical. For example he hears regular successions of pairs of coördinates and on the basis of their regular recurrence builds his mathematical theories. He will never record a longitude greater than 180, nor a latitude greater than 90 in absolute value. Furthermore, he will tend to hear more rapid changes of longitude at higher latitudes. Now this man begins to construct a mathematics, in which no number is greater than 180 in absolute value. He may make certain assumptions about space, time, and derive rules for handling the complex notions derived from these. He may discover a 'law of nature' which 'makes' the ships travel faster in the east-west direction at high altitudes. Later he may develop a 'theory of relativity,' whereby assuming a curvature of his space, he can dispense with this 'law of nature.' Each successive development of his theories will enable him to predict more and more accurately the position of each ship, or, to be more exact, the *signal* which he will receive at the time $t + \triangle t$ after having received a certain signal at the instant t.

'But,' implies Sir James Jeans, 'do these predictions, no matter how accurate, enable our physicist to know what a ship *is* and why they should travel at all?'

The picture seems tragic, because it denies this presumably knowledge-loving observer the knowledge of very interesting objects, namely ships, and the very interesting world in which ships are built

and sent on journeys. But in fact a tacit assumption is made that such knowledge *could* be available to him, if, say, he came in contact with the world.

This fable has an obvious connection with questions of 'ultimate reality,' which are still confronting some outstanding scientific philosophers, particularly those who saw the world of Newton crumble and fall about them, which must have been a painful experience for people not conditioned to the view that the collapse of man-made universes is a normal, harmless, in fact, a desirable occurrence in the progress of knowledge. The wistful statement is often made that man is doomed to ignorance of the world except for insignificant peeps, because his nervous system is so constructed that he is unable to grasp 'ultimate reality.' The isolated observer's 'knowledge' of the ships is indeed pitiful. A whim of the skipper, whose existence our physicist does not even suspect, will shatter all his painstaking calculations. However, even as I write these lines, I write them from the point of view of one who has seen ships and met skippers, and this is also the point of view of Sir James Jeans. If an analogy is to be permitted between our signal collector and the modern physicist, who presumably records nothing more significant than signals coming from 'ultimate reality,' then necessarily a tacit assumption is made that a point of view *exists,* from which both the physicist and that 'ultimate reality' are visible, and from which it can be seen that the 'ultimate reality' is hidden from the physicist forever because of his limitation.

We deal here with purely metaphysical existence, *i.e.,* an 'existence' which means absolutely nothing, as the 'existence' of Newton's 'Absolute Space' or the 'existence' of 'ether.' It means nothing because it is impossible to verify, that is, it is impossible to *make a prediction* concerning

it. I stress especially the sense in which 'impossible to make a prediction' is used here: it is used in such a way as to be synonymous with 'meaningless.' It is not used in the sense of 'physically impossible to verify,' as for example it is at present (1945) impossible to verify whether there are planets around Arcturus. This latter 'impossibility' is not intrinsic in the question, because it is conceivable (1945) that next year or next century telescopes or other means can be derived which will make it possible to determine the existence of such planets. By verification which makes a proposition meaningful I mean potential verification, *i.e.,* the possibility of making meaningful (1945) predictions. Once more it is stressed that no meaningful (1945) prediction can be made about 'ultimate reality' nor about an 'intelligence' to whom alone this 'ultimate reality' is discernible.

When philosophers speak of 'unknowable' reality, they mean 'knowable but not by us.' This unconscious assumption is expressed in analogies similar to the above. This in turn implies the existence of a recipient of knowledge of whom we know and can know nothing. But this again brings up the same ambiguity on a different level, because this 'undiscoverable recipient' if mentioned at all means 'discoverable but not by us.' The chain has no end.

Unknowable reality is as barren as any metaphysical ghost which contains a contradiction in its very definition: 'immovable objects,' 'infinite forces,' 'omnipotent beings' (can such a being create a stone which it cannot lift?). All of these are products of semantic disturbances. But let the rejection of the 'unknowable' never be construed as a vulgar point of view which denies the meaning of everything not in the range of immediate comprehension. On the contrary, the rejection of the unknowable brings vast undiscov-

147

ered worlds into the realm of the knowable. Allowances should be made for total revisions of verbal structures and methods. No meaningful question should escape investigation. No conclusion should escape doubt. No shibboleth should be held sacred except the one just stated. In the last analysis mankind *must* set up undefinables and unassailables, forming the foundation of its collective striving. Some of them, although not yet clearly formulated, are now being established or rather defended by force of arms. The object is to keep them *as few and as general as possible.* In this principle lies the answer to the dilemma of tolerance and democracy in its dealing with intolerance and demagogy. Does the principle of tolerance proclaim the tolerance of intolerance? It most certainly does not. Intolerance$_2$ of intolerance$_1$ *is not* intolerance$_1$. Hatred$_2$ of hatred$_1$ is not hatred$_1$. Similarly the establishment of a universal criterion of knowledge which is *operationally* equivalent to the destruction of shibboleths, is not a shibboleth.

RÉSUMÉ

The first step toward the resolution of conflicts associated with incompatible behavior is the verbalization of behavior.

Primitive verbalizations are 'declarations of behavior.' If they are propositions at all, they are propositions about the inner state of the speaker, not about the external world.

Verbalizations become propositions, *i.e.,* statements about observable reality[5]

[5] At some future date it may become possible to observe directly the inner state of affairs of an individual. At present, for example, the state of hunger of an individual can be roughly established by observing the contents of his stomach. Similarly the presence or absence of 'mental' and 'emotional' processes may some day be likewise established. At that time statements about the inner state will become propositions about observable reality, subject to prediction and verification.

when they tacitly or explicitly contain a prediction, the verification or the refutation of which establishes the truth of the proposition.

Contradiction of propositions can be resolved if the predictions they contain concern experiences common to both parties concerned.

One of the objects of general semantics is or should be the search for ultimately primitive experience common to all men and having the intrinsic structure similar to the structure of the universe.

It is hoped that such experience exists and can be made the foundation of a language whose structure is similar to the structure of the universe, *i.e.,* that such a language will enable men to predict all phenomena of nature of which man is a part (positivism).

The significance of 'unpredictability' in modern physics does not make meaningless the search for more and more generalized knowledge, because a clear realization of the 'unpredictable' is also knowledge. What is unpredictable individually becomes predictable *en masse.* Fractional predictability (probability) is a useful generalization. Moreover 'unpredictability' should be dated. Even if we discover that macroscopic predictability is composed of submicroscopic 'uncertainty,' it does not preclude some future more refined methods of both observation and reasoning, which will establish a higher level of predictability for the individual particles.

Predictability becomes freedom of the predictor and lack of freedom of that whose behavior is predicted.

Predictability is the sole content and criterion of knowledge (a definition of knowledge in operational terms).

Knowledge (predictability of the external world) and freedom (self-predictability) are the goal of collective

existence. Elimination of conflict through the establishment of very few and very general universals serves to channelize the efforts of humanity toward these ends.

ACKNOWLEDGMENTS AND GLOSSARY

The basic formulations of this article were inspired by the works of Alfred Korzybski and S. I. Hayakawa. This should be evident to any one familiar with them. A great deal of the terminology is taken bodily out of Korzybski's *Science and Sanity*. Specific credit is not given in footnotes, because the author considers both the formulations and the terminology as firmly established in general semantics. However, as a precaution against possible misinterpretation, a glossary of the terms is appended. Perhaps in some cases the author deviates from other writers in the field in the use of these words. Some may have somewhat more specific, some more general, meanings than those originally associated with them. The meanings indicated here are those of the terms as used in the context of this article. They should not be regarded in the sense of dictionary definitions but as the author's attempts to indicate extensionalization of the terms set forth here.

Behavior: Any discernible change of state of an object, particularly of an organism, *e.g.,* motion, digestion, change in temperature, etc. It is assumed here that more and more processes of life will eventually be described and explained in terms of behavior only. It is thought that the relative lack of success of the behaviorist school of psychology was due chiefly to the failure to discover the significance of behavior on the colloidal level.

Civilization: Defined in the article.

Colloidal level: Phenomena involving 'sensations,' 'consciousness,' 'emotional states,' and other more or less metaphysical notions are held to be changes of state in the colloidal structure of cells. It is hoped that such changes will eventually be discovered and minutely studied.

Elementalistic: Based on a false belief that various aspects of the same phenomenon are or can be completely separated. In alchemy a 'substance' was believed to exist independently of its 'properties'; in theology a 'soul' was believed to exist independently of the 'body,' in Newtonian physics time was believed to exist independently of space, etc.

Ethics: An attempt to evaluate human behavior, in particular behavior involving relations between humans, in terms of general principles stated in advance.

Freedom: Defined in the article.

Knowledge: Defined in the article.

Magic: A semantic disturbance in which certain patterns of behavior are associated with certain wish reactions in such a way that the performance of the former is believed to be accompanied by the fulfillment of the latter, *e.g.,* prayer about the occurrence of external events.

Metaphysics: A system of inquiry aimed at the discovery of 'ultimate reality.' Its goals, assumptions, undefinables, and methods were never clearly stated. It consisted largely of manipulations of words, confusing grammatical structure with the structure of 'reality' which it sought. Its questions often began with 'What is . . . .?' where the answer simply equated two sets of terms. It is assumed in this article that since these 'equations' provided no increase of predictability, the total value of metaphysics was at most zero. However, viewed in its historical perspective, it must be considered as a step in the development of the faculty of fruitful inquiry. Whether it did more harm than good is an open question.

149

Multi-ordinal terms: Those whose meaning changes with the level on which they are considered. In this article a technique is suggested for establishing the level of meaning by means of specific predictions. A very important multi-ordinal term is 'exist.' For example, the existence of women truck drivers can be established by the prediction, 'You will see a woman who drives a truck.' To prove the existence of witches on the *same level* of existence, a similar operational prediction must be made (*cf.* 'reality').

Non-elementalistic: (Cf. 'elementalistic') Applied to formulations which consider phenomena as a whole, *e.g.*, in modern chemistry 'properties' and 'substance' are not considered separately.

Reality: (multi-ordinal!) That about which verifiable predictions can be made. The level of reality, then, is determined by the events predicted. For example, horses are real on the 'sensory' level, because a prediction can be made and realized about them at that level ('You can see, touch, etc. a horse'). Unicorns may be said to exist on a different level, but not on the same level as horses, because of the nature of realizable predictions about unicorns ('You will encounter them in literature,' etc.). The number π exists on a still different level. It is assumed in this article that each true proposition is reducible by a series of predictions to a prediction involving structure relations only. For example, 'You can touch a horse' involves the notion 'touch,' which again breaks down into predictions concerning nerve impulses traveling along certain channels, and this in turn involves physio-chemical changes, changes of energy states on submicroscopic levels, etc., down to considerations of structure only. Structural relations are considered here as the most fundamental (general) known reality.

Quantitative definition: An establishment of an evaluation in which a scale of order exists. Examples of terms quantitatively definable are relative humidity, elasticity, infant mortality, rank in the military hierarchy, etc. An attempt is made in this article to establish a quantitative definition of civilization.

Religion: Behavior based on the postulation of 'existence' (level of existence usually not specified) of beings to whom wish reactions are attributed which are reflected in the phenomena of the external world. This behavior is very broad in its scope, ranging from semantic disturbances of magic and taboos to extensive and more or less consistent postulations of systems of ethics. A cosmology is often included in the fields of experience influenced by religion.

Science: All systems of inquiry characterized by investigations of observable phenomena, attempts at clear differentiation of existence levels, attempts at reduction of assumptions, verification by experiment on the sensory level, and heavy reliance on the criterion of predictability.

Semantic disturbance: Semantic reaction of zero or negative survival value, *e.g.*, magic, numerology, chauvinism, prudery.

Semantic reaction: Reactions induced by conditioning, whether to features of the natural environment or to signs, sign-situations, symbols, or symbol-systems. Semantic reactions may be of a low degree of conditionality (*i.e.*, the same stimulus always, or almost always, producing the same response), or of a high degree of conditionality (*i.e.*, the response to the stimulus being conditional upon many other factors, such as internal state of the organism, time, place, context, etc.). Language is an elaborate system of symbols, each involving semantic reac-

tions. As such it may have tremendous survival value, e.g., the reaction to the sounds 'There's a bear!' may prepare one for, or enable one to avoid, the actual encounter with the bear. Semantic reactions of zero or negative survival value are reactions to symbols or signs evaluated without reference to reality, e.g., superstition, racial prejudice, etc.

Survival value: It is at present almost impossible to measure quantitatively the survival value of various modes of behavior except in very simple cases. It is hoped that methods may be developed by which the survival value (relative) of semantic reactions can be experimentally or statstically determined. Of course the survival value for the race as well as for the individual is to be considered.

Structure: In this article the term is used simply as multi-dimensional order. All propositions of mathematics involve structure only.

Taboo: A semantic reaction inhibiting certain behavior. Also the enforcement of such inhibitions by prohibition, e.g., the prohibition of appearance on a motion picture screen of a girl clothed in a tight fitting woolen upper garment, etc.

True proposition: Defined in this article.

Verbalization of behavior: Utterances which transmit a rough knowledge of an inner state of one individual to another, e.g., 'I am hungry,' 'This female is mine.' Animal sounds are also primitive verbalizations of behavior if they induce uniform response in other individuals, e.g., cries of fear, anger, etc.

The men most disdainful of theory get from it, without suspecting it, their daily bread; deprived of this food, progress would quickly cease, and we should soon congeal into the immobility of old China.　　　H. POINCARÉ, *The Foundations of Science*

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If a distinction is to be made between men and monkeys, it is largely measurable by the quantity of the subconscious which a higher order of being makes conscious. That man really lives who brings the greatest fraction of his daily experience into the realm of the conscious.　　　MARTIN H. FISCHER,
'Spinal Cord Education.' *Ill. Med. Jour.* Dec., 1928.

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The current accounts of perception are the stronghold of modern metaphysical difficulties. They have their origin in the same misunderstanding which led to the incubus of the substance-quality categories. The Greeks looked at a stone, and perceived that it was grey. The Greeks were ignorant of modern physics; but modern philosophers discuss perception in terms of categories derived from the Greeks.　　　A. N. WHITEHEAD, *The Principle of Relativity with Applications to Physical Science*