COMMUNICATION THEORY AND METHODS OF FIXING BELIEF

JOHN R. KIRK *

B ONE AND BRAWN-WISE, man is so delicate a creature that in floods, fires, famines, hurricanes, earthquakes, and from the rigors of heat and cold, he would long ago have perished were it not for the artificial environments he constantly creates and continuously controls. What controls man? To what can be attributed his success in battling those natural forces which drove the dinosaur and myriad other species to early extinction and which today consign even the great apes—despite their apposable thumbs—to confining geographic areas and the ignominy of man-made zoos? Citation of man's great brain is common answer to both questions; it is a true answer, but a partial one.

Once the neurologist goes behind the scenes of the celebrated human cortex and compares the scaffolding there with the ganglion of, say, the moth, he notes decided differences. The chief difference, of course, is in absolute size. Of all the animals, the species *homo sapiens* has the largest nerve-network. Also important is the *relative* size of man's brain with respect to his body; the walnut-sized brain of the brontosaur made the latter a quite stupid animal, but in a cat the same brain might well bestow a wisdom on the feline in excess of that granted by legend. Finally, there is complexity of neural connection. In concert, these three factors fit man superbly for handling and storing superlative *amounts of information.*

The *amount of information* associated with a stimulus has to do with the total number of stimuli which can be responded to. Thus, in the simplest case of an automatic device that can respond only to two stimuli, "on" and "off," which occur independently and with equal frequency, the amount of information in each stimulus is just one "bit." Generally, the more complex the response repertoire of an organism or a machine, the more information is carried by the signals that stimulate it.

The *capacity* of a channel of communication, be it a wire, the air, or a certain band of radio frequencies, is strictly measured by the maximum amount of information that can be pumped through it in a unit of time; there is always such a maximum. Up to a point, the telegrapher can increase the amount of information conveyed per unit time simply by shortening the dots and dashes

---

* Dr. Kirk has taught symbolic logic, semantics, and the philosophy of science at The University of Texas and is currently on the staff of KTBC-TV in Austin.

and spaces in between. But, even with the use of automatic sending and recording equipment, there is a limit to this process. The dots and dashes cease to be discriminable, the capacity of the channel has been overloaded, and general confusion results. Given a sophisticated audience, a lecturer can convey vast amounts of information in a short time by the use of abstract and technical terms. The same lecture delivered to an audience of smaller *semantic capacity* may completely fail of its purpose. The audience may *not* be information-filled to the limit of its capacity, the excess information spilling harmlessly like water from an over-filled glass; rather, the audience will be confused and carry home *less* information than it *would* have if the lecturer had pitched his talk within hailing distance of the vernacular. The tailoring of a message with respect to the capacity of a channel so that the latter will be effectively exploited without overcrowding is termed *"coding."*

A bugaboo of communication is *noise,* a ghostly hand that claws at a message somewhere between source and destination, changing it into obvious nonsense or, what is worse, converting it into another meaningful but entirely misleading message. Channels are never without some noise—acoustic noise in an auditorium, electrical noise in a wire, electromagnetic noise (static) in the ether, semantic noise in the neural network of a human being trying to understand. And the only effective weapon against noise is some form of *redundance.* For safety's sake, tower operators at our airports, guiding pilots to safe landing, invoke a simple form of redundance—they repeat the same message over and over. The newsman, deciphering a garbled communiqué in the teletype, profits from the subtler redundance woven into the message by the rules of language. Redundance can go to waste, but clever coding will put redundance to work battling the noise. That redundance always lowers the amount of information conveyed by a set of stimuli is an inconvenience we are often happy to tolerate in order to escape the masking effects of noise.

Oddly enough, noise will *add* information to a message, but it will be *spurious information.* This brand of information can be recognized and corrected for only if it crops up as an obviously nonsensical message; a message lacking redundance, should it be altered by noise, would allow the resultant spuriousness to go undetected. The particular character of a message which distinguishes it from nonsense and from other messages is termed *"content of information."* One practical problem in all communication is the preservation of the same content of information from source to destination.

COMMUNICATION THEORY applies powerfully to all modes of communication whether by television, ordinary speech, or Amerindian smoke-signal, and whether it be between organisms (human beings), between machines, or between organism and machine. Normally, the semanticist and linguistician would narrow inquiry to speech and, depending upon their purposes of analysis, *choose as*

elementary stimuli the letters or words in written speech or, in oral speech, the syllables, phonemes, or even the sine-waves of Fourier analysis. What choice is made will have notable effects on the numerical value of the amount of information carried by a unit. But suppose we refuse such *choice* and consider the *natural* stimuli, those composing messages from the outside world and discriminated by our sense-receptors. Such messages are highly redundant, and it is this redundancy which corresponds with our psychological conviction that there exists an external world. "Pink elephant" messages will ordinarily lack the reiteration of those we ascribe to real objects; if and when they do not, we will ascribe reality to pink elephants.

Despite the redundancy the world thrusts on us, human beings are extraordinary capacitors of information. Man's nostrils make fewer discriminations than a dog's, and there are forms of life relatively more sensitive as regards touch or hearing or sight; yet, it can be safely affirmed that man extracts from his environment a total amount of information greater than that extracted by any other organism.[1] He does this via *learning*. Learning, like noise, increases the amount of information; but whereas noise introduces only spurious information, learning *may* do otherwise—indeed, it *may* weed out of storage spurious information placed there by noise or by prior learning. Learning *will* accomplish these happy results *if* there is something to be learned and the learning process is not halted. As a channel of communication man has staggering capacity. For this reason, man *can* carve out his environment with a fine chisel to make his world meet his wishes. Man *can*. Whether he *does* or *will* is a different and sobering question. Learning is often stymied, comes too late, or is of indifferent quality.

THE CONSCIOUSLY-ENTERTAINED product of learning is *belief*. Belief, behaviorally speaking, is a habit-pattern under the control of the cortex. It does not, as Peirce points out, incite us to immediate action but "puts us into such a condition that we shall behave in some certain way, when the occasion arises."[2] But whether the resultant behavior is appropriate with respect to our

---

[1] Either a great deal that is going on in the human brain and nervous system is correlated with events in the environment or a preponderance of these neural events is spontaneous (intrinsically undetermined) or reverberative. But in the latter case the human being in question would quickly be diagnosed as mad. Most, therefore, of the amount of information coded in normal cortical events must be considered as transferred from the environment. And since more goes on in the human brain than in any other, we conclude that the human being extracts a greater amount of information from his environment than does any other organism.

[2] In an article which has become classic (Cf. *Popular Science Monthly*, Vol. 12, November, 1877), Charles S. Peirce investigated and evaluated four avenues by which we acquire beliefs. That his conclusions are informally derivable from information theory gives additional support for each. See Charles Hartshorne and Paul Weiss (ed), *The Collected Works of Charles Peirce*, Vol. 5, Chapter IV.

goals depends sensitively on whether our belief contains genuine or spurious information. The methods we choose for fixing our belief—the communication channels we tap for filling our reservoir of beliefs—will critically influence the probability-weight, the truth-value, of the information thus acquired.

There are pre-conscious, even pre-learning, analogs of belief. Watch the activity surrounding a bright street lamp some summer night. In complex traffic-patterns come the moths. One by one, their wings singed, they fall. If they survive, again to engage in flight, their previous danger in no way inhibits their fatal phototropism. In short, their learning-behavior is negligible. On each side of their tiny bodies is a receptor, similar in operation to the photo-electric cell, which dispatches neural messages of control to the wing on its side; these messages are in such a code that the vigor of the wing's beat is a function of the receptor's illumination. So long as the receptors are equally lighted, the moth flies "straight and level;" if otherwise, the moth makes a spiral approach to the light-source. The moth, too, has a habit-pattern, but one which is rigid, inflexible.[3]

Our pervasive notion that human beings are "superior" and that moths are, in truth, "lowly," is not entirely a vestige of religion nor a token of our usual anthropocentrism. Human communications equipment, properly used, *could* maximize far beyond the capacities of other life-forms the conditions for sustained and even pleasant survival. Faced with sudden and capricious changes in his environment, man has *methods* at his disposal, if he will but use them, to combat such threats effectively. Many of the lower animals, by contrast, have been irrevocably defeated in the matter of species-survival by even such orderly and creeping vicissitudes as the advance of glaciers or evaporation of lakes. Moths display a good survival record because they are so prodigally proliferous that somewhere on earth's varied surface they are almost sure to find a convivial foothold. Other species seek refuge in the static environment of the deep sea.

[3] All stimuli are *cybernetic agents* (agents of control or communication)—*signals, signs,* and *symbols.* Any stimulus is a signal; a sign is a signal the response to which has been modified by learning; a symbol is a sign producible by its interpreter and substitutable for a synonymous sign. Signals include signs, and signs include symbols. Communication theory applies to all cybernetic agents whereas *semiotic,* the theory of signs, applies solely to *semiotic agents*—signs and symbols. Light, for the moth, is a *mere* signal with respect to which it indulges in what Korzybski has termed a *signal-reaction,* and students of general semantics have long been aware that this is often detrimental to survival. But signal-reactions are not always valueless—whether for moths or for human beings! Lepidoptera, as an order of insects, was abroad on earth long before man, and, relative to present data, it is not unlikely that following an atomic holocaust of sufficient severity the moths, not man, will inherit that earth. Neural development necessary for *sign-responses* and *symbol-responses,* involving as it does an absolute number of neurons (around ten billion) far greater than that available to "lowly" insects, constitutes expensive evolutionary investment; in the present epoch that investment may prove to have been excessive. Indeed, the distinctively *human* mastery of symbols threatens the survival of *all* life-forms.

But the mechanism of *cultural inheritance* (Dobzhansky) or *time-binding* (Korzybski) bestows on a human being—or, rather, on a human species—a greater range of strategies.

For the moth, very nearly all behavior-responses are fixed, made rigid, by *biological inheritance*. In man, a few hereditary traits—like eye-color—are similarly fixed, others—like skin-color—are relatively plastic, and plasticity is maximized in that neural activity we identify with thought, the *fixation of belief*. There is overwhelming evidence that in man's arsenal of strategies are those which would deal effectively with threats to survival which would overpower any other animal, and this can be summarized in the statement: Man has maximum survivability (i.e., survive-ability). To infer, however, that man will probably outsurvive contemporary competitors among other species would be a dangerous *non sequitur*. Though plasticity-of-response to environmental change is a practically necessary condition of survival in a world choked with contingencies, *sheer* plasticity will neither necessarily nor even practically insure that survival. *There is no necessary correlation between survivability and probability of survival.* Whether the survival-strategies available to man will be exploited or are destined, rather, to remain wistful possibilities, depends crucially on the efficiency of our learning, the methods by which we fix our beliefs, the manner in which we deal with the hazard of spurious information.

A S HUMAN INDIVIDUALS either we learn, or we are carefully coddled by other individuals who can learn, or we quickly die. The *rate* at which we learn governs the amount of information we absorb. The *method* of learning governs the signal-to-noise ratio and thus determines what proportion of the information will be genuine and what spurious. Fantastically, a large segment of society has adopted a method of learning, a method of fixing belief, which reduces it, as a social organism, to the level of a helpless imbecile or even the moth. This is the *method of tenacity*. It consists in clinging steadfastly to the *status quo* in beliefs. Its motto: "What was good enough for father is good enough for me!" Its battle cry: "Return to the eternal verities, the basic truths, the fundamental principles, the faith of our forefathers!" Its justification: "These are the beliefs which befit strength of character, integrity, peace of soul!" Its educational philosophy: "Teach only that which will not disturb. Publish for the sake of prestige, but, if your remarks are based on research, do so in a journal sufficiently obscure that no one will discover what you have found out. The aim of educational institutions is to teach students what their parents *would* teach had the latter the time and pedagogic skill." Its psychology: stolidity, armoring; quiet conservatism in normal times; in times of crisis, hysteria and sadomasochism.

By this method human individuals learn only what is *told* them by individuals or institutions. (A total schizophrenic learns only what he tells himself). This source of learning has been termed *"cognitive transfer,"* but both genuine

and spurious information are subject to such transfer. *On the assumption* that a large number of the beliefs circulating within the "social organism" are true or substantially so, a society which invokes this method may for a time fare well. Myths and superstitions can sometimes be held on to with little danger, while their rejection may mean loss of employment, ostracism, or burning at the stake. Nor will belief in heaven be disappointed (though this belief may induce quite irrational behavior prior to death). But in prolonged use, the method may easily lead to disaster. Old beliefs, even in the absence of noise, may lack cogency with respect to new situations (i.e., environmental changes may make even old truths irrelevant to new needs), and any new beliefs will be due to noise, hence false (spurious information). Too, the old truths are not immune to the ravages of noise; it is known well that old truths get contaminated via word-of-mouth transmissions and in the semantic change which, with due age, all written symbols undergo. Slowly, one by one, the old symbol-strings become either false or meaningless or (in extremely rare cases) accidentally true in some new interpretation. This is roughly the situation in the moth. The photo-receptor "tells" the wing that there is light. The "belief" the wing thus acquires is true. But this "true belief" is certainly irrelevant to the new danger which arises when the moth approaches a light-source hot enough to roast it. And the heat itself may so alter the channel of communication between receptor and wing that future messages become false or lapse into nonsense. The method of tenacity suffers from built-in *obliquity*: "It would be so nice if what has worked in the past will work in the future, therefore it probably will." In effect, this method reduces the value of our individual symbol-responses to that of a social signal-reaction; it by-passes whatever value our individual and distinctive learning capacity might otherwise have.

Finally, and fatally, this method affords no justification for the assumption that *any* beliefs will be true. In this lies the poignancy of the story Anatol Rapoport tells (in *Science and the Goals of Man,* p. 25) of a Moslem scholar painstakingly punctilious in his memorizing of the Koran. Guarding against noise is of no value if what is preserved is spurious information, and whether or not this is the case cannot be ascertained by the method of tenacity. Genuine information is *not* the sort of thing that *stores* well. Channels of communication, gorged with genuine information, are like leaky buckets. The only way to keep them full of information is to assure a proper *intake;* plugging the leaks serves, in this case, to hasten the decay of information from genuine to spurious.[4]

---

[4] "Plugging the leaks" is an apt description of billion-dollar secrecy measures taken in the name of "security" with respect to our basic research in nuclear physics (the narrowing of communication channels is a partial plugging of a leak). Similar considerations apply to loyalty oaths, etc. The *sense* of security that such measures yield is likely to be based on spurious information and thus out of all proportion to the *real* security, if any, thus implemented; and to the degree that policy-making is dictated by sense rather than reality, this real security is in fact diminished.

THE METHOD OF AUTHORITY relies on the pronouncements of State and Church, of parents and teachers, of priests and kings. Beliefs are fixed by decree and backed by power—by threats of violence or the promise of reward. It is a method of which we as individuals must all make use on first entering the world. Without it, it is doubtful whether we would ever learn language; the language we first understand is imperative in character and backed by power—be it tender or otherwise; words are our masters before they become our slaves. Ignorance, too, is a dark power hovering over us, and against the alternative of remaining ignorant we do well to consult authority—if by "authority" we mean "a source of knowledge."

Neither the existence nor the usefulness of authorities is denied here, but two embarrassing questions require answer: (1) By what method of fixing belief do we distinguish real authorities from pseudo-authorities? If we reply: "By authority," we fall into a vicious circle. (2) What method of fixing belief does the authority use? If he answers: "By authority," he, too, falls eventually into a vicious circle. And if the authority uses the method of tenacity and *we* invoke authority, we are, as a group, employing the method of tenacity.

The *method of reason,* too, reduces to tenacity. "Reason," as used by Peirce and most other philosophers, denotes deductive inference; this kind of inference cannot of itself produce genuinely new knowledge. The premises on which logico-mathematical manipulations operate to yield factual conclusions must be established by a method other than the method of reason.

IN THE METHOD OF EXPERIMENT, or *scientific method,* we discover controls of our beliefs outside ourselves and our institutions. Assiduously applied, it enables us to escape obliquity. And it is a democratic method, available to all members of mankind of no matter what age, gender, race, or previous condition of intellectual servitude. While by tenacity we are the slaves of the past (and entropy), while by authority we are the slaves of those who wield the power, and while by pure reason we become unknowing slaves of our own prejudices and obliquities, the method of science affords freedom from all these influences.

Scientizing can be either crude or sophisticated; it is by no means the monopoly of the professional. This is important. A relatively crude use of scientific method is sufficient to discriminate between pseudo-experts and genuine experts—the latter being those who use scientific method directly or who are linked to it via cognitive transfer; this method enables us to become expert in the detection of experts in fields of inquiry in which we are not expert. In rational policy-making with cognitive ends in view, we first detect the experts and place them in positions of authority; *we* then use the method of authority—gaining from these experts, by cognitive transfer, the beliefs *they* fixed by scientific method.

Are such beliefs true? Does scientific method enable us to weed out spurious

information, to counteract the effects of noise? The answer is not as congenial as we might like it to be. According to *scientific* evidence, it does, but we cannot—without obvious circularity (the problem of induction)—rely on this evidence for appraising the scientific method itself.

What we would *like,* of course, is a method which would *guarantee* a yield of true beliefs. Both communication theory and the theory of inductive inference agree that no such method exists. Very well, we may pitch our requirements more modestly—rest content with a method which will *probably* yield true beliefs. But this involves a *guarantee* of a probable yield of true beliefs. Again, there is no such method. At no point in this infinite regress is there either a guarantee or a probability of a probable yield of true beliefs.

And yet, as the late Hans Reichenbach was able to show, *we do have a guarantee* that *if* our goal be that of arriving at true beliefs, then it is a good idea to use scientific method. Reichenbach has proved what Peirce apparently believed without proof, namely: *if* there is some truth or other to be discovered, continued application of scientific method must at some time discover it.[5] It can not be proved that there are not better methods. Nor can we prove anything about another method without implicit use of scientific method as a tester of the candidate method. It is legitimate, however, to use scientific method as a tester of other methods; and, thus far, these other methods have been found wanting. For a growing number of philosophers this proof is entirely satisfying. And it is a fascinating story in itself.

[5] Hans Reichenbach, *The Theory of Probability,* Ch. 11.

Comparison of living things with machines may seem at first to be a crude, even rather childish procedure, and it certainly has limiations; but it has proved to be extraordinarily useful. Machines are the products of our brains and hands. We therefore understand them thoroughly and can speak conveniently about other things by comparing them with machines. The conception of living bodies as machines, having, as we say, "structures" and "functions," is at the basis of the whole modern development of biology and medicine.

J. Z. YOUNG, *Doubt and Certainty in Science.*