Education: An Enterprise In Language Learning

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Let me begin by introducing myself in order to put my qualifications and biases before you. My concern with the educational process has three roots: I am a father of five children; I am a professor in a great university; and my chosen profession is to do research on the brain-behavior frontier. These roots have nourished a concern that appears to be shared by all at this Conference. The time is ripe for a hard look at what we are doing to our children.

My immediate experience is with higher education: college, doctoral programs in psychology, medical school, and residency training in the medical specialties. I have found, as has been found so often in more formal analyses, that the ordinary approach to teaching turns enthusiasm into ennui and curiosity into conformity. I have the suspicion that attrition of this sort can also be found in grade and high schools.

My views on what can be done about education (Pribram, 1964) come from my research. To oversimplify somewhat, the brain turns out to be primarily an instrument for coding information. Properly coded, information can be stored in retrievable fashion and retrieval does not come hard. Proper coding is what education is all about, or ought to be.

By information I mean novelty, the factual content of what we teach. The trick is to transmit information from one generation to the next in such a fashion that the information remains useful to the individual and to society. Usefulness need not necessarily mean practical use, though contribution to social and cultural progress is one major result of good education. The usefulness of an education may equally well, however, take the form of esthetic enjoyment and ethical efficacy.

The coding of information is accomplished by the time-honored process of repetition. It is the form repetition takes that makes the difference between a good and a poor educational system. That we intuitively acknowledge this fact is shown by our arguments and efforts in choosing the best curriculum. That these arguments and efforts are often in vain shows that we have no criteria for judging what might be best.

The results of brain research suggest a way to establish such criteria. Let me emphasize once again that the brain is primarily an instrument for coding information (Pribram, 1969). The brain quickly

becomes habituated to any simply repeated sensory event. Habituation, however, is not a fatiguing of nerve cells leading to a raised threshold for excitation. On the contrary, habituation is the organization of a neural representation of the repetitiously experienced sensory event. Here is the classic experiment by which Eugene Sokolov (1960) at the University of Moscow demonstrated this fundamental fact.

Repeat a tone beep of a given intensity and duration. A subject exposed to the beeps will initially show physiological and behavioral indicators of orienting (GSR, heart and respiratory rate changes, EEG activation, cocking and turning of head, ears, and eyes). These orienting responses fade within three to five repetitions indicating that the subject has habituated. Sokolov's ingenuity lay in showing that orienting could be reestablished (dishabituation) by any change in the stimulus configuration—even by making it *less* loud or shorter. When shorter than expected, the orienting reaction takes place at the offset of the stimulus, therefore, during a period of unexpected silence.

The point is, that simple repetitions set up a representation in the brain that allows an organism to distinguish between the familiar and the novel. Ergo, information to be usefully processed must be simply repeated at least a few times in order that the pupil's brain can construct a representation of it.

But simple repetition will lead only to an ability to distinguish between the familiar and the novel. In order for information to be meaningful to the student, he must be able to do something with it. Training in the operations that make information meaningful again entails repetition but now the repetition must be organized. Organized repetitions of information constitutes coding or programming. Coding enriches; it gives meaning to what otherwise would be barren fact.

Three examples help illustrate the importance and power of coding. Take the stripped plot of most novels. This plot can be communicated very briefly and recognized as familiar if met again. But such communication would hold little interest and convey no meaning. The skill of the novelist consists of enriching the plot, weaving together several plots, evoking participation in his readers, and so forth. The skill in enacting a representation of the plot is a skill in coding; and when properly performed it becomes memorable.

A second example is the arabic numerical system. The concept zero and the concept of using its placement to provide a simple decimal code were inventions in coding that made mathematical communication infinitely more powerful and memorable. Can you imagine the operation of the U.S. Treasury if fiscal policy had to be implemented in the Roman numerical code? Try to work your own budget next month adding LXX to XIV!

The third example comes from my own experience with small,

general purpose computers. In order to initiate function, one must load into the computer memory 20 or so instructions that, together, are called the bootstrap program. These instructions must be toggled in by way of 12 switches on the front panel of the computer. Each switch can be in either an up or down position; thus the 20 instructions necessitate that 240 switch positions be toggled: U D U U U D U D D D U U, etc. The procedure gets to be pretty confusing, especially when any mistake, even of the eleventh position of the eighteenth instruction, means that the whole bootstrap must be repeated from scratch. Computer programmers quickly found a way out of the problem by dividing the switch array into triplets and assigning an arabic numeral to each combination of positions of three switches. Thus D D D = 0; D D U = 1; D U D = 2; U D D = 4; D U U = 3; U U D = 5, etc. Eight numerals (including zero) do the job and a combination of any four numerals describes an instruction (e.g., 4370). Our laboratory personnel very quickly mastered the ability not only to load the bootstrap without error but to remember most of the 20 instructions without having to refer to the printed program. The same information was transmitted in either form but the change in code from an up-down (binary) system to an eight-numeral (octal) system clearly increased the power and memorability of the communication.

This fantastic gain in power and memorability that comes from innovations in coding must be explicitly recognized by today's educational process. In essence, a classical education (the three R's) consisted of just this sort of training. The complexly programmed codes we call languages are the currency of powerful and memorable human communication. What has happened, recently, is that we have multiplied the number of generally-employed languages. In my father's time, one's parochial language plus the universal tongues of Latin, Greek, and mathematics were sufficient to communicate most of a man's and his neighbor's social and cultural heritage. Today, the various languages of physics, chemistry, biology, and psychology are easily as relevant to ready communication as are the classical languages used to pursue literary and political enterprises.

My suggestion is, therefore, that we return to the basic aims of classical education but that we enlarge the kit of communicative tools with which we equip the student. By returning to the aim of classical education I mean just that: We teach the language of chemistry, the language of ecology, the language of the human body so that our students can communicate about these topics. We are not in these early years attempting to make competent chemists or biologists any more than the classical educationist was trying to turn his pupils into mathematicians or authors. Languages are not just words, however, nor are they only systems of codes or programs by which individuals can communicate with each other. Languages are also systems of

codes by which internal communication—thought—becomes facilitated.

The results of brain-behavior research also tell us something about the way to go about educating the coding capacities, the linguistic abilities, of our pupils. The brain representation of sensory events is largely private. In order to communicate, this representation must be enacted, must be externalized in action. A two-step educational process is therefore necessary: (a) instructing, that is, structuring into the pupil a representation of the aims to be achieved, and (b) allowing the pupil opportunity for enactment so that the instruction becomes meaningful to him.

It is in the opportunities for enactment that the classical model of classroom education falls short. In the cultural framework in which classical learning took place, enactment was assumed to occur outside the school. Foreign languages were used in one's travels; mathematics in one's currency exchanges; and one, at least, became a spectator in the Roman Forum to participate in history, and in the theater to participate in literature. But how much better would it be were English courses infused with drama so that a laboratory exercise in enacting Shakespeare would accompany reading as literature! In the sciences, such laboratory enactments have become standard practice: why not in the humanities? But instruction in the sciences often falls short in the opposite direction because it fails to recognize that the first job is to teach the language, to portray the richness of the fields of inquiry, not to make a scientist of the pupil.

Herewith is a summary of the import of these results of brain research in terms of the four topics assigned to the conference.

1. *Socialization.* According to the research results described, two needs exist: (a) to establish an Image toward which the student can strive, and (b) for guided freedom to develop codes to enact his own version of that Image. Images need not be formed within the schoolroom; they can be established by visits to enterprises that are seizingly beautiful or enthusiastically pursued. Audio-visual displays (the TV program, Sesame Street, is, of course, a pioneer) provide excellent adjuncts. But most important, students must be made to feel by his community that some goals, some enterprises and encounters are worth pursuing, that the reward of pursuit is greater awareness, self-fulfillment, and social integration.

The guided freedom to develop personal skills to enact Images in the student's own fashion can only be accomplished in the flexible environment of a non-graded school system and all that it entails in changes in the student's school environment. Here, teacher-supervised computer-assisted instruction can make its mark. The price of computers and their peripherals has plummeted to such an extent that there remains little excuse for not giving each pupil access to a console for

at least a few hours a day. In the not-so-distant future, such consoles will be available at home and the drudgery of homework will be a thing of the past. The reason why computer-controlled instruction is so much more interesting than working through ordinary assignments, is the immediate feedback, the communication between console and pupil. It is not the equivalent of a private tutor but it is a step in this direction.

2. *Curriculum Development.* The research results described suggest that curricula be developed around the concept that each subject-matter constitutes a language-system. Thus an overview of the advantages of knowing a particular language must first be provided. It's good to know math because ——; it's good to study geography because —— etc. Then the elementary vocabulary of the language must be mastered. And finally the grammar of that language, its rules of organization that make it a coherent body of knowledge.

3. *Teaching.* We once asked medical students at Yale what they wanted most from their professors. The opinion expressed was almost unanimous: Show us the excitement, bring us the enthusiasm that make us want to learn, the rest we can manage from the library. At the grade-school level (and again later, e.g., during medical residency or postdoctoral training) this attitude is not enough. The teacher must also be able to guide the students' explorations and attempts to build coding skills. He can do this by example, by well-chosen and *well-timed* demonstrations of how it can be done, by gauging the amount and character of the repetition required by an individual pupil, and so forth. The teacher's own style of encoding will certainly be emulated and so he must be at least somewhat aware of how he goes about communicating.

4. *Guidance.* As indicated by the research results described, a great deal has recently been learned about the process of communication. I have focused on communication by languages whose content conveys the accumulated cultural heritage of man. There is another set of languages, however, those used in conveying interpersonal transactions. There is a body language, a language used in the games people play, and in the overt (e.g., legal) and hidden contracts that bind social intercourse. Knowledge about these languages and about the personality structures that are conveyed by them ought to be common knowledge. My friend and colleague George Miller, in his presidential address to the American Psychological Association, suggested that we "give psychology away to the people." There is no better place to do this than in grade and high schools and not only to pupils but to teachers and parents as well. Because this enterprise is new, a beginning might best be made in PTA meetings and student curricula developed within these meetings. As it now stands, PTA, in my experience at least, has been an almost empty and superficial exercise in

politeness, acquaintanceship, and cooky exchange. Why not make PTA the medium for enhancing public awareness of what psychology has to offer and for engaging in real encounters? And why not teach the psychology of social transactions to the teenagers who are most avid to find out just what is happening in their social lives? Again, let us teach this subject matter in terms of the fascinating languages that man has developed, not in terms of prescriptions for how life ought to be lived or material that must be memorized. Let the student encode in his own fashion the enactments that he pursues with the languages he has mastered.

I believe that we can do better by our children than we have. It is a new world they encounter, a world of social proximity, affluence, negative income tax, and other new dimensions. Since mid-century, an incredibly sumptuous harvest of knowledge has been gathered in the brain and the behavioral sciences that is relevant to this new world. In the ordinary course of events, it would take another quarter of a century for this knowledge to become effective, that is, institutionalized. In today's rapidly-paced, changing social climate, we cannot wait. The challenge before us is, Can we in this conference formulate a program with teeth in it that will hasten the institutionalization of psychological knowledge within the educational establishment? If we don't, our students will turn elsewhere. The Free Universities, muddled as they may seem to be, are forerunners of what can be accomplished once word gets around. The time to act is now. What can *we* do?

References

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