A HUMANISTIC EVALUATION OF PROGRAMMED INSTRUCTION

A Thesis Written in Partial Fulfilment
of the Requirements for the Degree of
Master of Arts

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CHAPTER I

INTRODUCTION

The "industrial revolution in education" which Sidney L. Pressey predicted in 1932[1] has become a near reality in recent years largely due to the leadership and direction given to the movement by B.F. Skinner of Harvard University.[2] Although the periodical literature has contained widely varied reactions to teaching machines and programmed instruction, the majority of books written to date on the subject express an apparent bias in favour of the movement. There is, for this reason, a need for a critical evaluation to be made, if not with a bias against the movement, at least with a more humanistic and less behavioristic concept of pedagogy than is apparent in most of the books which have been written thus far. It is the purpose of the present thesis to present such an evaluation, based chiefly upon the experimental results and professional opinions published during the past five years.

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[1]Sidney L. Pressey, "A Third and Fourth Contribution toward the Coming Industrial Revolution in Education," School and Society, XXXVI (November 19, 1932), 672.

[2]B.F. Skinner, "Why We Need Teaching Machines," Harvard Educational Review, XXXI (Fall, 1961), 377-98.

It is hoped that this paper will lead to a better understanding of what programmed instruction can and cannot do in the education of human beings.

The same definition of programmed instruction as is prevalent in the auto-instructional field has been adopted. That definition looks upon the medium, not merely as an audio-visual aid, but as a sequence of stimulus - response items designed with the primary purpose, not of reviewing, not of testing, but of teaching. The definition does not specify whether this material is presented to the student by a machine, a stack of cards, a slide projector or a textbook. It does, however, exclude educational motion picture films or television unless the characteristic stimulus-response item is presented specifically via such media. Because the majority of the programs and devices on the market or in use throughout North America are of the linear or Skinnerian type, this paper focuses attention accordingly, although the branching program technique developed by Norman A. Crowder has special importance in some of the issues raised.[3] The rather large, expensive simulators in widespread use in military training

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[3]Norman A. Crowder, "Automatic Tutoring by Intrinsic Programming," in Teaching Machines and Programmed Learning, A.A. Lumsdaine and Robert Glaser (Eds.), (Washington: National Education Association, 1960), pp. 286-98.

are not considered in this discussion, although the "computer-based" machines, currently being developed with the goal of making vast sources of programmed information available to large numbers of students working individually and simultaneously, fall within the definition adopted and therefore within the scope of the evaluation.

No attempt has been made to summarize the history of the programmed learning movement or to describe the technology of either machines or programming except where such topics are contributory to the critical evaluation of programming rationale. Such summaries and descriptions have been provided more than adequately by such authors as Stolurow,[4] Deterline[5] and Green.[6]

The essence of this paper is the contention that the psychological theory underlying programmed learning has made a number of capricious assumptions about the nature of man and the processes through which he learns,— assumptions which violate humanistic principles which have withstood the test of human experience. The procedures

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[4]Lawrence M. Stolurow, Teaching by Machine (Washington: United States Government Printing Office, 1961).

[5]William A. Deterline, An Introduction to Programmed Instruction (Englewood Cliffs: Prentice-Hall, Inc., 1962).

[6]Edward J. Green, The Learning Process and Programmed Instruction (New York: Holt, Rinehart and Winston, Inc., 1962).

which arise out of these assumptions would appear to militate against educational aims based on traditional concepts of human thought, human freedom, and human values. That the dangers to be expected from the imprudent use of these procedures are even more ominous than those already associated with more conventional media of mass communication is evidenced by the subtlety with which the procedures set out to control the thoughts and motives of their subjects. These dangers, therefore, merit the special awareness of educators of all ranks. It will be the task of teachers to erect whatever safeguards may be necessary to ensure that the use of automation in education in no way tends in the direction of enslaving the soul of mankind.

The evaluation of programming rationale is attempted first on a strictly experimental basis. This is followed up by a theoretical evaluation conducted in the light of humanistic principles of learning and humanistic educational objectives. The term "humanistic" is employed here in the sense of having "an attitude of mind, system of thought, which concentrates specially upon human interests and the mind of man, rather than upon the external world of nature."[7] It is an attitude

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[7]Henry Cecil Wyld, (Ed), The Universal Dictionary of the English Language (London: Selfridge and Co. Ltd., 1936) p. 568.

which is opposed to the view that man can be best for solely known by a study of phenomena which are not characteristically human, - such as a study of animal behavior. The humanism of the present writer is not that of any particular school of psychology. In fact, his attitude might be called "functionalistic" at those times when he ignores the malignant sectarianism of psychological schools and utilizes with a liberal eclecticism what appear to be significant and respectable data, regardless of their source. This assumes that underlying all controversy there is one and only one truth, and that no psychological school has a monoply on that. The humanistic viewpoint admits sources of knowledge long since labelled "unscientific" by the behaviorist school of psychology. These sources include both expert opinion — in the fields of human education and human psychology — and introspection. This latter source of knowledge has fallen into such serious disrepute in recent years that special justification for its use is appropriate at this point, especially for the benefit of the behaviorist reader.

First of all, introspection is experimental. The data are observed closely and experiments are reproducible. The only constraints which make a given experiment different from those of conventional science is that each experimenter is restricted to the observation of one subject and is required to observe that subject from the inside. The constraint of having to look at a phenomenon from the inside is no more cumbrous than that of having to look at it from the outside. Thomas Gilbert, in fact, would lead one to believe that having to observe it from the outside is so unproductive as to be almost futile:

> The science of human learning in the 50 years since the death of Ebbinghaus has provided us a net value amounting to very little; indeed, it may have saddled us with a methodological bias so hampering to our progress as to make the few valuable results hardly worth the price. In short, ... this science has been largely irrelevant to both educational engineering and theories of learning.[8]

Far from discarding introspective observations, metaphysical philosophy has always considered them as primary sources. The very strength of the metaphysical approach, in fact, is that it has never denied itself the use of man's reflective powers, his awareness of his own knowledge, his consciousness of his own consciousness. Tielhard de Chardin upholds this as one of the faculties which clearly distinguish human and sub-human mentality:

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[8]Thomas F. Gilbert, "On the Relevance of Laboratory Investigation of Learning to Self-Instructional Programming," Lumsdaine and Glaser, op.cit., p. 475.

> Admittedly the animal knows. But it cannot know that it knows: that is quite certain. If it could, it would long ago have multiplied its inventions and developed a system of internal construction that could not have escaped our observation... Because we are reflective we are not only different but quite other. It is not a matter of change of degree, but a change of nature.[9]

We need not be concerned at this point with the argument as to whether man's reflective powers are shared to any degree with animals. The important thing is that man _is_ reflective and this is the mental faculty which enables the vast majority of his higher thought processes to occur. The liberal use of this faculty is, however, of particular importance in a study which compares human and infrahuman learning.

The use of introspective data makes possible the recognition of thought processes—not to speak of certain classes of human motives — to which the behavioral scientist must of necessity pretend to be blind. In addition to perception, _apperception_ can be considered, as can those deductive and inductive aspects of learning which neither involve any contemporary perception nor of necessity result in any observable behavioral change. Hilgard has chosen to include such abstract deduction and induction within his

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[9]Pierre Teilhard de Chardin, _The Phenomenon of Man_ (New York: Harper and Brothers, 1959), pp. 164-65.

definition of learning:

> Where the solution of problems is relatively mechanical (as in addition and subtraction), the problem may be thought of as merely the exercise or utilization of a learned bit of behavior. When, however, there is greater novelty, more putting of things into relationship, as in reasoning or inventiveness, the process is interesting in its own light, and is not to be described simply as the running off of old habits.[10]

In addition to allowing the consideration of higher mental processes and higher human values, the subjective approach taken permits consideration of such external factors as teacher enthusiasm as something quite other than the annoying contaminant which it represents to the experimental psychologist. As these "external" factors are, to the teacher, partly internal, their contagious qualities usually defy external explanation.

It is recognized, of course, that introspective observations have value only insofar as a number of people are able to re-experience the phenomena which are described. One knows what is meant by the word love, only if one has experienced it; the dictionary is of little help. What substitutes for objectivity in such data is the universality of human experience. This

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[10] Ernest R. Hilgard, Theories of Learning (2d ed.; New York: Appleton-Century-Crofts, Inc., 1956), pp. 5-6.

universality can be illustrated by reference to the words a language uses to denote higher mental processes, If these processes were not universally observable words such as "understanding", "knowing", "imagining", "reasoning", or "thinking" would not have a recognized existence in the language.

The behaviorist reader perhaps remains unswayed from his position that "the verbal approach . . . is a dangerous will-o'-the-wisp among the quagmires of subjectivity."[11] He may, however, continue two chapters further without fear of being led into temptation with regard to his laws of parsimony, objectivity, and experimental rigour. Chapter II presents a strictly behavioristic description of Skinnerian principles of learning, with emphasis on infrahuman learning, and indicates how these principles have been applied in the formulation of Skinner's programming postulates. Chapter III retains the experimental approach but restricts experimentation to humans in an effort to test objectively the validity of these postulates. It is not until Chapter IV that subjective criteria are invoked.

Chapter IV conducts a critical inquiry into the processes of human learning in an effort to discover which,

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[11] Raymond B. Cattell, "Personality and Motivation Based on Structural Measurement," in Psychology of Personality, J.L. McCary (Ed.), (New York: Grove Press, Inc., 1956), p. 69.

if any, of these processes are identical with those which are known experimentally to occur in infrahuman learning. This inquiry succeeds in differentiating human learning into two distinct forms or classes. These classes demonstrate a correspondence in the motivational realm with volition and determinism, in the psychical realm with conscious and unconscious mentality, and in the cognitive realm with two somewhat less distinct kinds of learning outcome. Out of this classification there emerges a theoretical definition of the capabilities of Skinnerian programs.

Chapter V examines the outcomes which may be anticipated as a result of the use of automation in education. It investigates, first of all, the philosophical impact which full-scale use of automation may have on the ideals, beliefs, and values which are upheld in a free society, and recommends appropriate precautions to be taken in the implementation of programming technology. It then makes a detailed study of the possibility that some of the weeds in today's educational garden may spring up luxuriantly in programming's fertile soil. An attempt is made to indicate the direction in which educational aims should be oriented if the merits of programmed instruction are to be wisely exploited.

Chapter VI draws from the findings of this study some practical inferences for the administration of programmed instruction in educational institutions, including the university. It cites some of the important achievements of the programming concept and speculates upon the developments to be expected in the future.

CHAPTER II

PRINCIPLES OF OPERANT CONDITIONING AND THEIR APPLICATION IN PROGRAMMED INSTRUCTION

Prior to undertaking an experimental or theoretical evaluation of the psychological theory underlying programmed instruction, it is appropriate to summarize briefly the essential principles of that theory and to indicate the manner in which they have been applied in the development of a programming rationale. As "operant conditioning" occupies a central position in the theory it will be the principle focus in the account of the theory given here. This account has been abstracted mainly from a teaching machine program entitled "The Analysis of Behavior," devised by Holland and Skinner, a revised version of which is available in textbook form.[1]

"Operant" conditioning differs from classical or Pavlovian conditioning in a number of ways. Perhaps the most significant of these is that the temporal relationship of the stimulus to the response is reversed. The controlling stimulus follows, rather than precedes, the emission of a response.

Skinner has chosen to retain the words "stimulus"

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[1]James G. Holland and B.F. Skinner, The Analysis of Behavior (New York: McGraw-Hill, 1961).

and "response", even though they seem paradoxical in their reverse sequence, in order to standardize his terminology with that used in classical conditioning. The paradox is largely resolved when it is seen that the control which the stimulus exercises over the response occurs through an increased probability of the recurrence of the response rather than through the direct causality of Pavlov's system.

As the controlling stimulus in operant conditioning must be satisfying, either directly or through the withdrawal of an annoying stimulus, it can be seen that the process is intimately connected with Thorndike's "law of effect". It makes, however, certain refinements of this law. For example, it recognizes the emotional states which frequently accompany punishment and which constitute the chief reason why rewards and punishments are not exact opposites from a behavioral standpoint. Because punishment and negative reinforcers are not applied in the rationale of programmed instruction, only the positive motivating influence of operant behavior need be considered here.

In the process of instrumental learning, behavior is "shaped" through "differential reinforcement", i.e. responses which approximate a step in the direction of the desired behavior are reinforced while other responses are not. Reinforced responses, according to Skinnerian principles, are more likely to be repeated while responses which are not reinforced undergo a natural extinction. A continuous "repertoire" of behavior is developed or, as Skinner would say, "shaped up" through a series of successive small approximations, culminating ultimately in proficiency in the desired terminal behavior. The entire process can be best understood by conducting a practical experiment similar to those out of which these principles have been deduced. The only "apparatus" needed is a hungry animal and a supply of food.

To illustrate: One is strolling through the park equipped with a bag of popcorn and wishes to condition one of the swans to stretch its neck high in the air and emit a loud call. The desired repertoire can be conditioned in the space of fifteen or twenty minutes. As hungry animals usually emit a wide variety of seemingly random behavior, there is little problem in initiating the conditioning process.

One begins by "rewarding" <u>any</u> movements of the head or neck.[2] When neck movements are occurring at a convenient rate one commences differential reinforcement in order to "teach" discriminations. <u>Elevating</u> head move-

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[2] Skinner would prefer that we say "reinforcing" rather than "rewarding".

ments alone are reinforced, until the desired height of neck-stretching has been attained. One must now commence the "verbal" portion of the repertoire by reinforcing any utterances made by the swan. The present writer has found that utterances will occur if one merely withholds reinforcement a few times after admirable demonstrations of neck-stretching have been provided. The remainder of the procedure merely involves differential reinforcement of the noises made until the desired intensity of sound has been achieved.

As long as reinforcement is continued, the behavior is maintained "in strength" until, of course, the animal's hunger becomes satiated. The syncronization of the two elements of the conditioned task presents no problem in the particular example chosen. It is possible that the two elements could be shaped up simultaneously instead of separately, but there is danger of confusing an animal if one attempts to condition more than one response at a time.

Operant behavior can be held under more precise and temporally regulated control by the use of "eliciting stimuli". These are stimuli which are "paired" with the emitted response in a more-or-less Pavlovian manner. While this pairing can be achieved in a number of ways, an example might be the ringing of a bell or the burning of a coloured light at those time at which the desired responses of an animal will be reinforced or rewarded with food. Such a signal serves to define for the animal the "occasion" of reinforcement. The animal eventually makes the desired discrimination and performs only at those times when it will receive reinforcements for correct responses, i.e. when the bell rings or the light burns.

Reinforcement schedules form a significant aspect of operant conditioning. It has been observed, for example, that extinction occurs much less rapidly following withdrawal of reinforcement which has been intermittent than following continuous reinforcement. That this principle appears applicable to the human is best demonstrated by citing the perseverity induced by the operation of a slot machine. Slot machines provide reinforcement at best intermittently.

Analogies between animal and human behavior, similar to the one suggested here in connection with slot machines, are made in a very casual and unrestrained way in Skinner's writings. His frequent use of the word "organism" to describe a class including both human and sub-human species demonstrates little recognition of the discontinuities in the evolutionary hierarchy and seems at times to imply the non-existence of those discontinuities. The transition from the subject of training two pigeons to play ping-pong to the subject of the evolution of competition patterns in the "human organism" is made with the same ease with which the cooperative efforts of animals in a co-ordinated task are likened to the precision of skilful human dancers.[3] Skinner states, in connection with his experiments:

> In all this work, the species of organism has made surprisingly little difference. It is true that the organisms studied have all been vertibrates, but they still cover a wide range. Comparable results have been obtained with pigeons, rats, dogs, monkeys, human children, and most recently . . . with human psychotic subjects.[4]

Far from justifying the application to humans of principles of animal learning, Skinner chooses, for the most part, to ignore the need for such a justification. Human examples are frequently interspersed indiscriminately with infrahuman examples in his discussions of operant conditioning.

The brief description of operant conditioning which has been given in this Chapter is sufficient to indicate how the basic elements or postulates of Skinner's programming rationale were formulated. These postulates will now be stated, along with brief comments concerning their origin. The wording of the postulates is largely

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[3] B.F. Skinner, "The Science of Learning and the Art of Teaching," in Lumsdaine and Glaser, op.cit., p. 101.

[4] Ibid. p. 103

taken from one of Skinner's articles[5] which is an accurate and succinct expression of the position he has advanced in his writings. The first eight postulates stipulate procedures to be employed in programmed learning while the last two specify the essential benefits to be realized.

1. "Some sort of teaching machine is needed." As Skinner has explained: "Contingencies of reinforcement which change the behavior of lower organisms often cannot be arranged by hand; rather elaborate apparatus is needed. The human organism requires even more subtile instrumentation."

2. "One frame is presented at a time, adjacent frames being out of sight." It has been noted that animals are frequently confused if an attempt is made to shape up two responses simultaneously. Presumably, humans will encounter the same difficulty. Eliciting stimuli, as well as reinforcing stimuli, must be presented one at a time.

3. "Each step must be so small that it can always be taken." This is in keeping with the successive small approximations used in the shaping of infrahuman repertoires.

4. "The machine must make sure that these steps are taken in a carefully prescribed order." This is a

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[5] B.F. Skinner, "Teaching Machines," in Lumsdaine and Glaser, op.cit., pp. 137-58.

corollary of the principle of differential reinforcement If learning is to proceed via a sequence of discriminations, these discriminations must follow progressively one from another.

5. "The student must compose his response rather than select if from a set of alternatives". To quote Skinner, "effective multiple-choice material must contain plausible wrong responses, which are out of place in the delicate process of shaping behavior because they strengthen unwanted forms."

6. Students must compare their responses immediately with printed material revealed by the machine. The printed answer is the reinforcer, the pellet of food. If the student's response is correct his being told so is a satisfying experience. If his response is incorrect the printed answer, while not necessarily an annoying or harassing stimulus, fails to give reinforcement and so leads to extinction of the behavior emitted.

7. The student works on his own, at his own rate. Reinforcements given to groups of animals reinforce unwanted behaviors quite accidentally amongst those members of the group whose behavior, at the time reinforcement is given, happens to deviate from that desired. If operant conditioning follows the same laws for humans, then individual instruction is mandatory. An added advantage is allowance for individual differences in that brighter students complete the program in less time.

8. The machine acts in such a way as to prevent the student from cheating. Skinner explains: "When material is adequately programmed, adjacent steps are often so similar that one frame reveals the response to another. Only some sort of mechanical presentation will make successive frames independent of each other."

9. The machine induces sustained activity. Skinner states: "The machine, like the private tutor, reinforces the student for every correct response, using this immediate feedback not only to shape his behavior most efficiently but to maintain it in strength in a manner which the layman would describe as 'holding the student's interest'."

10."Machines ....are capital equipment to be used by teachers to save time and labor." Again in Skinner's words, "He [the teacher] may teach more students than heretofore — this is probably inevitable if the world-wide demand for education is to be satisfied— but he will do so in fewer hours and with fewer burdensome chores. In return for his greater productivity he can ask society to improve his economic condition."

Although the above postulates provide a general description of programmed instruction one can best "get the feel" of the methodology by attempting a short sequence of programmed material. Such a sequence, extract-ed from The Analysis of Behavior,[6] is provided in Appendix "A". This is an example of what has been called a "linear" of "Skinnerian" program. About 95 per cent of today's programs are of this type.[7]

It is apparent from the foregoing that the rationale of programmed instruction is a direct application to the classroom of principles derived from an experimental study of animal psychology. That these infrahuman principles are applicable to human beings constitutes the major premise of Skinner's arguments. That these principles are largely inapplicable to human beings is the major premise of the present thesis.

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[6]Holland and Skinner, op.cit., pp. 41-5.

[7]Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: Fund for the Advancement of Education, 1962), p.2.

CHAPTER III

EXPERIMENTAL EVALUATION OF SKINNER'S PROGRAMMING RATIONALE

The scientific method of assessing the validity of a postulate is to examine its ability to endure repeated experimentation. Because Skinner's postulates regarding programmed instruction have a scientific origin they must, if they are to gain recognition in any of the disciplines, submit to scientific verification. It is inappropriate, moreover, to attack them from a humanistic standpoint until they have had ample opportunity to be tested on their own ground.

They have had this opportunity. Stolurow was able to fill an average sized volume with reviews of research in this area as early as 1961.[1] Probably an equal or greater quantity of research has been conducted since that time. The present chapter summarizes, on the basis of the literature which is presently available, the current status of Skinner's postulates. Their ability to endure experimentation on human subjects up to the present time is taken as one measure of their validity.

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[1]Lawrence M. Stolurow, Teaching by Machine (Washington: United States Government Printing office, 1961).

On the strength of Skinner's stipulation that a teaching machine is needed, millions of dollars have been spent developing and manufacturing machines and printing programs to fit them. The present research position is that the machine is insignificantly better than a programmed textbook or a manilla folder with a "window" cut out to reveal items one at a time. Eigen *et al*. have found no difference in student mastery of material taken via a horizontally programmed text, a vertically programmed text,[2] and a teaching machine, though it is significant to note that both textbook versions required less time.[3] Feldhusen and Birt compared the Min-Max machine (Grolier Corp.) and the Teaching Machine 2002 (Foringer and Company) with the use of a manilla folder. They found no significant difference.[4] Hollins College, Roanoke, which performed the famous pioneer study in which two semesters of algebra were taught by machine in a single semester, has long since stowed its

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[2]The sample given in Appendix "A" is horizontally programmed. In a vertically programmed text, the format is similar but the student proceeds vertically down each page from one frame to the next much as in a conventional textbook.

[3]Lewis D. Eigen *et.al.* , "A Comparison of Three Modes of Presenting a Programmed Instruction Sequence," *Journal of Educational Research*, LV, (June-July, 1962), 453-60.

[4]John F. Feldhusen and Andrew Birt, "Study of Nine Methods of Presentation of Programmed Learning Material," *Journal of Educational Research*, LV, (June-July, 1962), 461-66.

machines away.[5,6] Skinner, of course, was amongst the first to concede that a textbook could be adapted to serve adequately in lieu of a machine. This is evidenced by his permitting The Analysis of Behavior to be published in textbook form in 1961.

The study made by Eigen et al. also tends to reject Skinner's statement that the frames must be presented one at a time, and that the student must be effectively prevented from cheating.[7] A vertically programmed text reveals several items at a time while even a horizontally programmed version offers no guarantee against "peeking ahead."

The necessity of a carefully ordered sequence has been challenged by Roe et al.[8] Achievement by students using a linear program in its prescribed sequence was compared with a group who used the same items in a scrambled order. Although the study failed to demonstrate the superiority of either method with the rather short program used, it is logical to expect that a follow-up study using a

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[5]George A. W. Boehm, "Can People be Taught like Pigeons?" Fortune, LXII, (October, 1960), 265.

[6]E.W. Rushton, "Programmed Learning in the Schools of Roanoke, Virginia," Ontario Journal of Educational Research, IV, (Spring, 1962), 122-38.

[7]Eigen et al., op.cit.

[8]K.V. Roe, H.W. Case, and A. Roe, "Scrambled versus Ordered Sequence in Autoinstructional Programs," Journal of Educational Psychology, LIII, (April, 1962), 101-104.

longer program would have different results because the longer the program, the greater the heterogeneity produced by scrambling.

The study, however, if it is valid for short programs challenges indirectly the hypothesis regarding step size. The students who used the random sequence made a higher percentage of errors — and therefore took, on the average, larger steps — but learned just as well. The error count is the most commonly used criterion for determining size of step. As such, it is a function not only of the program but also of the intelligence and background of the student. The literature which reports more direct investigations of step size gives conflicting results but in general supports the conclusion that an optimum step size exists somewhere between the extremes and probably depends on the type of subject matter programmed.

The issues arising out of Skinner's requirement that the student make a <u>constructed</u> response have been well explored.[9] The chief issue is that of overt verses covert responding. The evidence is overwhelming in favour of the covert response mode when one compares the number of studies

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[9]That Skinner requires the student to make an overt or <u>constructed</u> response is demonstrated implicitly by his use of the word "compose" and explicitly in the directions given to the student at the beginning of Appendix "A" of the present work.

which support it with the relatively few which show no difference or support overt responding. The investigations invariably find that covert responding reduces learning time. A study by Unruh, for example, showed that overt responders required 50% more time than those responding covertly.[10] The rigour of the controls exercised in some of the studies which support overt responding may be open to some question. In the study by Krumboltz and Weisman, for example, the criterion test consisted of fifty "completion" type test items similar to the type of linear program item employed.[11] It may be valid to inquire whether the students responding overtly would benefit from practice in answering this type of item more than would students responding covertly. Indeed, Michael and Maccoby have "analyzed the source of gain from active responding as primarily due to specific practice effects."[12] As regards Skinner's stipulation that the student must compose a response rather than select it from a list of alternatives, Hough's findings are typical of those of a

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[10]Waldemar R. Unruh, "An Investigation of Four Methods of Presenting Programmed Material" (M. Ed. thesis, University of Alberta), Canadian Education and Research Digest (Summary), III, (June, 1963), 138.

[11]John D. Krumboltz and Ronald G. Weisman, "Effect of Overt versus Covert Responding to Programmed Instruction on Immediate and Delayed Retention," Journal of Educational Psychology, LIII, (April, 1962), 89-92.

[12]Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: Fund for the Advancement of Education, 1962), p. 63.

number of researchers.[13] Hough reports no difference after comparing the "constructed-response" mode, the "selected-response" mode and a combination of selected and constructed.

There is some question as to whether the student needs to "respond" at all in the layman's sense of the word. Feldhusen and Birt found that students who used material which had the answers already typed into the blank spaces of the program (used in a manilla folder) demonstrated achievement insignificantly different from that of the two groups who used machines in the prescribed manner.[14] Goldbeck and Campbell are among a number of investigators who have obtained similar results.[15] They found that _reading_ the program was just as "effective" and, when learning time was taken into account, more than twice as "efficient" as the conventional response mode. These studies, however, are in disagreement with that reported by Unruh, whose covert and overt responders learned significantly more than students who read the program with blanks filled in and underlined.[16]

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[13]John B. Hough, "Analysis of the Efficiency and Effectiveness of Selected Aspects of Machine Instruction", _Journal of Educational Research_, LV (June-July, 1962), 467-71.

[14]Feldhusen and Birt, _op.cit._

[15]Robert A. Goldbeck and Vincent N. Campbell, "The Effects of Response Mode and Response Difficulty in Programmed Learning", _Journal of Educational Psychology_, LIII, (June, 1962), 110-18.

[16]Unruh, _loc.cit._

Skinner's requirement for response confirmation is related to this issue because if there is no response made there is nothing to confirm. However, assuming that the program requires a response, the value of confirmation can itself be tested. McDonald and Allen have compared five variations of program in two of which no "feedback" was given to the student.[17] These variations proved insignificantly inferior to those in which immediate feedback was provided. Feldhusen and Birt obtained similar results with two groups who used programs in manilla folders without response confirmation.[18] These groups achieved only slightly less well than the two groups previously cited who used machines in the conventional way. Krumboltz and Weisman found similarly that students receiving no confirmation gained insignificantly less than those receiving 33%, 67% and 100% confirmation.[19] Hough and Revsin, using college students as subjects, report a similar "no-difference" result.[20] The question remains open,

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[17] Frederick J. McDonald and Dwight W. Allen, "An Investigation of Presentation, Response, and Correction Factors in Programmed Instruction", Journal of Educational Research, LV, (June-July, 1962), 502-7.

[18] Feldhusen and Birt, op.cit.

[19] John D. Krumboltz and Ronald G. Weisman, "The Effect of Intermittent Confirmation in Programmed Instruction", Journal of Educational Psychology, LIII, (December, 1962), 250-53.

[20] John B. Hough and Bernard Revsin, "Programmed Instruction at the College Level: A study of Several Factors Influencing Learning". Phi Delta Kappan, XLIV (March, 1963), 286-91.

however, as the programs used in these studies were of rather short length. It is logical to presume that this null result is dependent upon the use of an almost "errorless" type of program, because in programs of greater step size confirmation is a vital part of the information being made available to the student.[21]

The temporal relationship in which the student is shown the correct answer has come under serious attack. Cook found that if the student is shown the carect answer <u>before</u> he makes his response, or is shown the correct answer if he has failed to respond within a very short time interval, performance in paired associate learning, such as associating objects with their names, is actually increased although insignificantly so.[22] For a serial learning task, such as recitation of the alphabet or the scale of numerals, performance is superior by a highly significant amount to that produced by the conventional use of the program.[23] Skinner recognized the importance of "prompting", either <u>formally</u> or

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[21]Information theory, for the sake of analogy, tells us that the quantity of information contained in a "yes-or-no" answer is significantly less than the usual "one bit" if the person receiving the answer has prior knowledge that one answer is more probable than the other.

[22]John Oliver Cook, "'Superstition' in the Skinnerian", <u>American Psychologist</u>, XVIII (August, 1963), 517.

[23]<u>Ibid</u>.

thematically - i.e. explicitly or implicitly - in producing an "errorless" program.[24] He did not, however, condone so formal a prompt as directly telling the student the desired answer before he has had an opportunity to respond on his own. The prompting versus confirmation issue is not entirely settled, but most of the studies made thus far favor prompting.[25] Stolurow, having summarized research in this area, has conjectured that the prompted student may learn material more rapidly but remember it less well.[26]

The requirement that a student work on his own and at his own rate was tested by Feldhusen and Birt.[27] They obtained the same results as an earlier study by Roe and others,[28] namely, that a paced program or programmed lecture produced insignificantly different outcomes than individualized use of the program. A paced program, however, such as might be given to a group via an automatic slide

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[24]For a detailed description of "formal" and "thematic" prompts, see Green, op.cit., pp. 151-54.

[25]Harry. F. Silberman, "Self-Teaching Devices and Programmed Materials; Comparisons with Conventional Instruction," Review of Educational Research, XXXII (April, 1962), 185-6.

[26]Lawrence M. Stolurow, "Implications of Current Research and Future Trends," Journal of Educational Research, LV (June, 1962), 519-27.

[27]Feldhusen and Birt, op.cit.

[28]Ibid., p.461.

projector with or without a taped sound commentary, sacrifices allowance for individual differences in favour of administrative considerations.

The assumption that programmed instruction saves the teacher's time and labour implies that the method must produce effectiveness comparable to, and efficiency superior to, teacher-given instruction. This hypothesis is supported by approximately half of the studies reported to date, on the basis of student scores on tests of strictly conceptual outcomes. That programmed instruction is decisively superior, however, cannot be concluded from the literature as a whole. Hough found that the lecture-discussion method and machine instruction were equally effective, but that machine instruction saved time.[29] Smith, on the other hand, found no significant difference in overall achievement or time required between programmed instruction and conventional classroom instruction.[30] The literature abounds with such comparative studies but gives largely inconclusive results. Silberman, in a survey of results published between 1958 and 1961, found

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[29] Hough, op.cit.

[30] Norman H. Smith, "Teaching of Elementary Statistics by the Conventional Classroom Method Versus the Method of Programmed Instruction," Journal of Educational Research, LV (June-July, 1962), 417-20.

that six studies reported programmed instruction superior, one study reported programmed instruction inferior, while five reported no significant differences.[31] What all such studies seem to lack is an average program and an average teacher to pit against it. Stolurow has expressed the hope that this type of study will be discontinued.[32] It has little significance until better definitions and measures of educational outcomes are available. As regards the question whether teaching machines, in the presentation of programmed material, save the teacher time and labour, the following statement by Stolurow may suggest an answer:

> The smaller machines need to be loaded and unloaded. They have to be set up for every new student, each period of the day. Every student has to be relocated in his program at the point where he left off. This means that after the program is inserted, the place must be found and the recording tape reset. The teacher who does this for 25 to 50 students every 35 to 50 minutes will find some way to escape from the situation.[33]

The status of Skinner's postulates may now be sum-

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[31]Silberman, loc.cit.

[32]Stolurow, "Implications of Current Research and Future Trends," op.cit., p. 520.

[33]Ibid., p.523.

med up with the help of the following table:[34]

1. A "teaching machine" is needed.	rejected
2. Frames must be presented one at a time.	tends to be rejected
3. Steps must be very small.	research inconclusive
4. The sequence must be carefully prescribed.	research inconclusive
5. Students must compose their responses.	rejected
6. Immediate "feedback" must be provided.	research inconclusive
7. Students must work individually.	rejected with qualifications
8. Students must be prevented from cheating.	tends to be rejected
9. Sustained activity is induced, through feedback.(See 6. above).	research inconclusive
10. The method saves time and labour.	research inconclusive but tends to be supported.

Five of the postulates appear, on the basis of the literature surveyed, to have been either rejected outright or cast into such doubt that serious qualifications must be attached to them. Four others, although subjected to some qualification,

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[34]The individual conclusions in this summation carry unequal weight due to the varied amount of research which has been conducted on each postulate. The conclusions should be assessed in the light of the quantity of research which has been available to the present writer and reported here.

await more conclusive research before final judgment can be passed. The remaining postulate, that concerning the efficacy of the method, tends to be upheld though is subject to considerable qualification. The only hypothesis which can be deemed on the basis of research to have been elevated to the status of accepted scientific fact is one which has been more implied than stated, namely that programmed instruction, whether used with a machine or not, is capable of producing significant amounts of learning. Even this fact lacks some relevance to education because of inadequate definitions and measures of educational outcomes. These outcomes will be the subject of a later chapter.

Of the issues which remain open, that which seems most intuitively plausible is the assumed ability of program feedback to sustain the activity of the student. If this motivation can be demonstrated experimentally, it may well gain scientific recognition as a prime factor in the success of Skinnerian programs. Unfortunately, the measurement of human motivation has always ranked amongst the most difficult of experimental tasks. Although "sustained activity" is an observable behavior, the goals, drives, sentiments and other motivating causes which underly it are most intangible from any objective approach.

It is virtually impossible to exercise efficient controls over all the variables which may be operative in a human motivational measurement situation. Gilbert for example describes a laboratory investigation into human avoidance conditioning in which successively more severe electrical shocks were applied to a subject via a hand-shock grid.[35] When asked why he did not remove his hand from the grid even when the current had reached its "searing" maximum the subject replied: "I thought you were studying how much guts I had!"

Human behavior obviously does not submit easily to laboratory investigation. For this reason another approach seems justified, — a theoretical approach — in which programming rationale may be analyzed in terms of strictly human learning principles. It is not sufficient to reject a procedure which works merely because the postulates on which it is based fail to stand up under scientific verification. If it works, it must do so for a reason. If this reason can be found and better understood it should be possible to perfect the procedure so that it will work even better. It seems likely that the reasons underlying the success of programmed instruction, in addition to involving cognitive considerations, are intimately connected with motivation. It seems even more likely that a study of these

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[35]Thomas F. Gilbert, "On the Relevance of Laboratory Investigation of Learning to Self-Instructional Programming," in Lumsdaine and Glaser, op.cit., p. 484.

cognitive and motivational aspects will require philosophic critique and criteria.

When educational philosophy inquires into the nature of human motivation, it is apt to ask more questions than the behavioral scientist is prepared to answer. The educational philosopher will endeavour to discover human purposes underlying human behavior. The behaviorist knows nothing of such things; "reinforcements", yes, but "purpose", no.[36] Furthermore the behaviorist typically claims that conditioning is the only kind of learning. Green, for example, states:

> Historically, writings on complex processes have dealt with the so-called 'cognitive' aspects of behavior. Implicit in these treatments has been the assumption that the organism shifts gears, so to speak, and that the essential nature of these so-called higher activities is different from the simpler behaviors of the organism. Our position is necessarily that no such discontinuity exists....in effect, we claim that the behavioral processes involved in the conditioning of a bar press in the rat are essentially the same as the processes underlying speech and thought in the human.[37]

Hilgard, on the other hand is opposed to such a narrow con-

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[36]Skinner has, however, leaned upon the popularity of the concept of purpose to justify his search for evidence of "reinforcement" in human affairs. In a recent article he finds it "reassuring" to recall that reinforcement's place "was once taken by the concept of purpose; no one is likely to object to a search for purpose in every human act." ["Operant Behavior," American Psychologist, XVIII (August, 1963), 515.]

[37]Green, op.cit., p.86.

cept of the learning process:

> There are probably a number of different kinds of learning.... It is quite probable that these different kinds of learning follow different laws, and it is foolhardy to allow our desire for parsimony to cause us to overlook persisting differences.[38]

This controversy is one of the first that must be resolved by any theoretical evaluation of a learning medium.

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[38]Ernest R. Hilgard, Theories of Learning (2nd ed.; New York: Appleton-Century-Crofts, Inc., 1956), p. 461.

CHAPTER IV

THEORETICAL EVALUATION: PART I (IN THE LIGHT OF HUMANISTIC PRINCIPLES OF COGNITION AND LEARNING)

This chapter endeavors to answer four questions:

1. Is <u>all</u> human learning conditioning?
2. Is <u>any</u> human learning conditioning?
3. Is <u>programmed</u> learning conditioning?
4. Can subject matter beyond the level of rote learning be successfully programmed?

As promoters of programmed materials characteristically answer all of these questions in the affirmative and some educators answer all of them in the negative, the questions form the basis of much of the seething controversy which has surrounded the topic of programmed instruction during recent years. The answering of these questions is essential to the intelligent use of programs in schools.

Herbert A. Thelen, Professor of Education and Director of the Teaching-Learning Laboratory, University of Chicago, evidently does not believe that all learning is conditioning. He has given recognition to at least two distinct kinds of learning in a recent article.[1] "Conditioning", he states,

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[1]Herbert A. Thelen, "Programmed Instruction: Insight versus Conditioning," Education, LXXXIII (March, 1963), 416-20.

"is the only process through which nonsense (or near nonsense) can be learned."[2] By "nonsense" he means not only the experimenter's usual nonsense syllables but also any factual data which has no inherent logic by which the student may justify its particular form. Under this definition much of the terminology of language is near nonsense, as most objects and ideas could have been assigned arbitrary names without detriment to the function of communication. Thelen therefore concludes that rote memory of the vocabulary aspect of language must be acquired chiefly via a conditioning process. He points out, however, that learning vocabulary is a relatively minor aspect of the total process of language mastery. The important aspects of language require insight, which involves the sudden reorganization of concepts to form a concept belonging to a larger class. The essential elements of the large concept must be present, but their unique rearrangement is complete and instantaneous in true insight. Insight is more characteristic of second and higher order abstractions than of abstractions made from physical sense data.

Human purpose, for Thelen, is an essential ingredient in insightful experience. In a previous article he stated: "The concept of activity is meaningless and empty unless it

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[2] *Ibid.*, p.416

is linked to the concept of purpose."[3] The relationships between concepts, rather than the concepts themselves are of greatest importance in insight. That Thelen's approach is very close to classical gestalt theory is event when he says:

> For learning not confined to nonsense syllables, the requirement is for seeing relationships within a pattern of elements; and this pattern must be visible as a whole. The pattern may be built up through a sequence of small operations, but it must accumulate and remain before the student.[4]

Thelen makes a good case for looking upon education more as inquiry than as acquisition.[5] This proposition has been supported by Brown in a recent article.[6] Brown states: "If we question the popular notion of knowledge as something to be acquired and possessed, . . . we permit ourselves the luxury of moving our search for more adequate teaching and learning down (or is it up?) to the level of fundamental beliefs."[7] Brown goes on to contrast the educational

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[3]Thelen, "Programmed Materials Today: Critique and Proposal," Elementary School Journal, LXIII (January, 1963), 192.

[4]*Ibid.*, p. 191.

[5]*Ibid.*, p. 195.

[6]Bob Burton Brown, "Acquisition versus Inquiry," Elementary School Journal, LXIV (October, 1963), 11-17.

[7]*Ibid.*, p. 11.

philosophies of teachers who subscribe chiefly to the acquisition theory with these of "inquiring" teachers. The argument bears a close resemblance to the insight versus conditioning dichotomy, with the "insight" side winning a clear victory. Brown concludes, however, that an appropriate balance between the two philosophies is optimum.[8]

A very similar dichotomy with regard to learning theory was expressed by Eugene Galanter (University of Pennsylvania), in a lecture given at the University of Chicago.[9] "There are two forms or mechanisms by which people learn." The first of these is the "stochastic" mechanism. It enables the individual to "extract from the contingencies between events the expectation that when one occurs the other will." Trial and error, rote learning, and conditioning, according to Galanter, are related to this mechanism. The second form, the "recursive" mechanism, involves the "construction of plans or methods for

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[8]Such dichotomies as insight versus conditioning and acquisition versus inquiry must be regarded as poles or extremes in the cognitive realm. There is probably considerable miscellany in between these extremes which embodies mixtures or elements of both. Such mixtures appear both in the process and in the cognitive outcomes of learning. Bodies of organized data, for example, may be acquired without the imposition of critical judgment on the truth or value of such data, but may involve such mental processes as classification and deduction.

[9]Eugene Galanter, (Lectures delivered at the University of Chicago, August 18, 19, 1959) cited by John Ginther in "Man, Values, and the Machine," Elementary School Journal, LX (January, 1960), 179.

figuring out the world."[10] This distinction, like those made by Thelen and Brown, provides a starting point in differentiating amongst learning processes in an effort to discover which, if any, can be validly identified with an invention based on Skinnerian principles. It also provides a basis for rebuttal of the behaviorist contention that all learning is the result of conditioning.

Introspective data are needed to finalize the argument that much of man's learning and behavior are unconditioned. The argument must first posit the freedom of man's will. Introspection reveals clearly that, however determined a man's actions may seem objectively,—subjectively they are free. Without recognizing this freedom a man cannot even speak of an act of judgment or a decision. This freedom, insofar as it is asserted and enjoyed by a man, is the antithesis of any contention that his (free) conscious actions are conditioned because conditioning implies determinism.

While it is granted that the causality of the "stochastic process," rather than being a "causal chain," is a "causal texture"—a chain with uncertainty at every link—[11]

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[10] Ibid. Although he does not justify the choice, perhaps Galanter chose the term "recursive" to avoid the lack of precision which always accompanies adaption of an already well-used word.

[11] Hilgard, op.cit., p. 389.

—it is nevertheless the same kind of causality as obtains in the world of modern physics, where the uncertain but possible events at each link are also expressed according to the mathematics of probability.[12] Man's mind could not be considered free in the context of a causality identical to that which applies in the physical world, (any more than it could in a world which upholds the theories of modern physics if man's nature were assumed to be entirely physical). If we upheld the principle of man's freedom, even subjectively, then we must conclude that an important part of his behavior and learning is unconditioned, and also — a corollary not essential to the present argument — that an important part of his nature is not physical. To argue more positively, the very fact of man's consciousness, his possession of his faculties at points of decision, his ability to weigh alternatives in terms of moral, social and aesthetic values, denies the necessary influence of conditioning stimuli in forcing his decision in one direction in preference to another.

All conscious acts, then, are potentially free and unconditioned. (This does not, of course, preclude a man's being "lazy" in the exercising of his freedom with the result that his "path-of-least-resistance" behavior appears externally

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[12] F. Waismann, "The Decline and Fall Causality," in Turning Points in Physics, (Amsterdam: North-Holland Publishing Company, 1959), pp. 84-154.

to be conditioned.) The converse of the above statement, namely, that all unconscious acts are potentially conditioned has not been proved. All that can be said at this point is that such unconscious acts are not of necessity free, and therefore <u>may</u> be conditioned.

Galanter, in stating that human learning is of two kinds, stochastic and recursive, implies that human learning which is not stochastic must be recursive. It may, then, be asserted that whatever learning man achieves by other than a stochastic or conditioning process,—as through insight, inquiry or other forms of free, conscious and purposive thought,—must be identifiable with Galanter's "recursive" learning.

Skinner himself, has come very close to acknowledging the existence of the recursive mechanism:

> The behavior of a person who has calculated his chances, compared alternatives, or considered the consequences of a move, is different from, and usually more effective than, the behavior of one who has merely been exposed to unanalyzed contingencies.[13]

Intrusions, such as the above, of behaviorists into the cognitive aspects of thinking and acting, are becoming increasingly common. They are analogous to the intrusion which the present work is about to make into the science of conditioning in an effort to examine from a rational viewpoint the objective laws

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[13] B.F. Skinner, "Operant Behavior," <u>American Psychologist</u>, XVIII (August, 1963), 512.

which it has derived,—in an effort, in fact, to discover whether any human learning is conditioning.

It would appear that what often looks like conditioning in man can be explained in very rational ways, usually in terms of some kind of purposive behavior. Hilgard suggests this with reference to simple conditioning when he says:

> Despite all the attention commonly given to simple conditioning in learning theory, the evidence for it is very fragmentary. There is no doubt that learning takes place under the arrangements of the conditioned response experiment, but the results may usually be given alternative explanations. . . It is undeniable that in many instances the learner will do what he last did in the presence of given stimuli because similar motives are operating, and what he did last time achieved the goal.[14]

When viewed in relation to subjective as well as objective data, operant conditioning, or what looks like operant conditioning of the human, takes on an entirely new meaning. To use a very practical example, let us suppose that a hungry man, who has no means of support, unexpectedly is invited to partake of a meal at one of the "soup kitchens" which are becoming common in some large cities. Behavioral science would say, perhaps correctly, that the probability of his returning to the same location at a later time is

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[14]Hilgard, op.cit., pp. 462-3.

increased. For the Skinnerian, the situation is exactly analogous with the hungry rat whose behavior is reinforced when it discovers food at the centre of a maze.[15] To say <u>why</u> man returned, or did not, would be a violation of Skinnerian discipline. On the other hand the situation as viewed by the layman unschooled in behavioral discipline is trivial. Either the man went back with the purpose of obtaining food to satisfy his hunger, or he did not go back because his pride would not let him, or because he did not want to identify himself with some of the people there, or because he had in the meantime discovered a less soul-destroying means of support, or for some other rational reason probably best obtained by asking the man why did not go back.

Another example is more within the scope of Skinnerian analysis. A woman sees a black cat cross the sidewalk in front of her. Shortly thereafter her purse is stolen in a department store. For a considerable time after these events she exercises extreme caution whenever a black cat crosses her path. The layman can suggest no rational analysis of the woman's behavior, nor can the woman herself, except perhaps to say that she has heard that black cats are "bad luck". The behavior is, on the other hand, very analogous to the "superstitious" behavior exhibited by the pigeon when fixed interval reinforce-

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15 Henry Gleitman, "Place-Learning," <u>Scientific American</u>, CCIX (October, 1963), 116-22.

ments result in accidental conditioning.[16]

A third example is pertinent to our discussion. A small child of age two years, in an adventure of probing an electrical outlet with a metal toy, receives a shock. The child thereafter avoids the outlets. This example has elements in common with both previous examples. Like the hungry man, the child has learned something useful from the results of an incidental behavioral act. It has learned something which is not only useful, but true by scientific standards. The child, however, has no concept of electricity, no understanding of the true causal relationship between the act and its consequences. Therefore, for the child, the situation is very similar to that of the superstitious woman. It has assumed a causal relationship between two events having proximity in time, without sufficient valid evidence to justify the implication of such a causal relationship. It may be concluded, then, that something very closely akin to superstition (i.e. conditioning) is an essential factor in certain kinds of learning especially for very young children. It might also be conjectured that excessive dependence upon this factor in a teaching procedure

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[16] Holland and Skinner, op. cit., frames 14-1 to 14-51. A food magazine delivers a pellet of food to each of several pigeons every 15 seconds. The birds soon associate the reinforcements with incidental behaviors. The experimenter returns to find one pigeon hopping from one foot to another, another bowing, another turning around and around, and so on, each bird repeating its own "ritual" between reinforcements.

may have as one of its outcomes the development of a habit of inventing causal relationships between events where insufficient evidence is available to demonstrate the truth or value of these relationships.

If one has something to teach which lacks rational causal relationships, the stochastic mechanism, to borrow Galanter's term, may be the best learning function to call upon in teaching it. An attempt will presently be made to demonstrate the truth of the converse of this statement, namely that if one has something to teach which has rational causal relationships, then the recursive mechanism, again using Galanter's term, is best.

It would seem then, that much human behavior which has the external appearance of conditioning can be rationalized at the conscious level in terms of purposive acts originating ultimately in the soul and will of free man. It must be allowed, however, that introspective techniques can say very little about what is going on at the unconscious level. Many human acts, especially those involving the kinesthetic sense, are efficiently regulated by unconscious mentality - not merely such reflexes as occur in the pupil of the eye, the knee tendon, or the process of breathing, but also components of such acquired skills as walking, dancing or driving an automobile. It may well be that the laws of operant behavior apply in a fairly causal and useful way to the mental processes which occur below the level of consciousness.

Many of the human idiosyncrasies cited by Skinner as examples of operant behavior, like the examples which Guthrie has cited to support his theory of "contiguous" conditioning,[17] are plausible evidence of "human conditioning" if one assumes that such "conditioning" is, in fact, unconscious,— i.e. that a man who is being "conditioned" is not aware that he is being conditioned. Such a man may unknowingly permit some aspects of his behavior to be controlled efficiently by the will of others. This <u>unconscious</u> character of conditioning is in keeping with our earlier conclusion that it is contradictory to call a <u>free</u> act a <u>conditioned</u> act.

It must be conceded that a process very similar to the conditioning which occurs in animals may occur on occasion in man. Conditioning processes seem especially demonstrable in very young children. This brings us to the question as to whether this conditioning process occurs in programmed learning and, if so, whether it accounts for the apparent success of programmed instruction with respect to immediate measurable outcomes. Might there not, in fact, be alternative explanations of this success?

A number of authors have suggested that the "Hawthorne" or novelty effect is sufficient to account for the majority of

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[17] For a detailed account of Guthrie's conditioning theory and human implications in child-rearing and pedagogy, see Hilgard, <u>op. cit.</u>, pp. 48-81.

the success programmed instruction has enjoyed to date. Ramsey, for example, states that "aside from the novelty effect, machines do not seem to produce any significant amount of learning more than is produced through more conventional media."[18] Certainly children are fond of gadgetry; and something new in classroom environment and technique is likely to stir enthusiasm for a while. Indeed, the relatively few experimental studies which have extended over two full semesters generally report less remarkable results in the second semester than in the first. Reed and Hayman report that "several teachers pointed out that, when the novelty of the situation wore off, many pupils suffered from boredom."[19] There seems, however, to be more to the success of programs than can be dismissed as Hawthorne effect.

There are a number of other human factors which probably contribute to program effectiveness. No analysis of the initial learning of new concepts, for example, can ignore perception.[20] Indeed, experiments with nonsense material

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[18]Curtis Paul Ramsey, "Curriculum Issues in Programmed Instruction," Education, LXXXIII (March, 1963), 413.

[19]Jerry E. Reed and John L. Hayman, "An Experiment Involving Use of English 2600, An Automated Instruction Text," Journal of Educational Research, LV (June-July, 1962), 478.

[20]Perception straddles the perimeter of the behaviorist's ken. More than sensation, it implies that the level of consciousness has been reached. Unless it produces an overt response, however, the behaviorist can never know that it has occurred. Although Skinner has studied perception, it does not form an expressed part of his programming rationale.

have demonstrated that perception alone, insofar as the learning process can be stopped at that stage, results in a rudimentary kind of learning whereby a small amount of recall can be summoned. It is also widely accepted that man has a field of <u>attention</u> at any given instant and that this field, be it called a set, an expectancy, or merely an alertness of a threshold low enough to be overcome by the intensity of the sense data at hand, is the chief determining factor in whether or not perception will occur.[21] Entwistle has demonstrated that merely "administering attensity," i.e. calling attention to the subject matter at hand, promotes learning no matter by what means attention is summoned.[22]

The Skinnerian program certainly demands well focussed attention. The sentence which appears in the program frame has little meaning until the omitted word or words are available; and the student is told not to proceed to the next frame until he has provided the missing part. Unlike the conventional textbook which permits daydreaming students to go through the motions of reading whole paragraphs or even chapters without grasping the meaning of a single sentence,

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[21] Clifford T. Morgan, <u>Introduction to Psychology</u>, (New York: McGraw-Hill, 1956), p. 163.

[22] Doris R. Entwisle, "Attensity: Factors of Specific Set in School Learning," <u>Harvard Educational Review</u>, XXXI (Winter, 1961), 84-101.

the program requires that an understanding of the meaning of each sentence be attempted and acknowledged by the student before he is permitted to proceed. Sensations must become percepts, perhaps even concepts, before the student can continue. Once the meaning of the sentence has been grasped, there is nothing to prevent the occurrence of insights based on that meaning, insights that occur in their usual human way, unheralded, as-a-flash, full-formed.

The attention-holding quality of programmed learning would seem to have special merit for the student whose attention tends to wander. It can, however, be very cumbersome to a student who has mastered the art of comprehension in silent reading. Perhaps this "spoon-feeding" of the "scatterbrain" and inflicting of a needless burden on the good student offers an explanation of the rather low or insignificant correlations which have been obtained between intelligence test scores and scores on achievement tests based on programmed instruction.[23] The method seems, in any case, to be effective in reducing the variability of the achievement within a given group. Whether or not this is a desired outcome will be left for

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[23]Douglas Porter, "Some Effects of Year-long Teaching Machine Instruction," in Automatic Teaching: The State of the Art, Eugene Galanter (ed.), (New York: John Wiley and Sons, 1959), pp. 85-90.

later discussion.

Most programmers would say that the crux of the learning mechanism is the "stamping in" (or stamping out) of the student's response provided by the confirming (or correcting) frame. This is the reinforcer or reward which represents the food to the hungry animal. It was noted in Chapter III that this contention has yet to be demonstrated conclusively experimentally.[24] It is submitted that the confirmation portion of the sequence has little actual "stamping-in" value if the student's response is correct— especially in the errorless program where the student probably knows he is correct—, but that it undoubtedly offers encouragement, a well known motivating technique whenever the objective is to sustain an activity—in this case, to entice the student to continue with the program. When the student's response is incorrect, telling him so and supplying him with the correct information has obvious tuitional

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[24] Hilgard (*Op.cit.*, p.36) cites two interesting experiments (by *Wallach and Henle*) in which confirmation produced no strengthening of the subject's response. The subject was told that he was participating in an experiment on extrasensory perception, and so to be "right" on one trial had no known implication for the following trial. There was no *intent* to learn the *right* response, and in fact the hearing of the word "right" did nothing to increase the frequency of repetition of the confirmed response. We might venture the conclusion that if confirmation has any psychological *stamping in* value, aside from the information which it conveys, then this value is entirely dependent upon an *intent* to learn.

value.[25] This tuitional value is not, however, in itself a reason to justify the procedure because the mis-information would not have occurred if the correct words had been supplied in lieu of the blanks.

Thelen, in his critique of programmed instruction, concedes that man has certain low-level mental processes in common with some sub-humans, but he brands "the conditioning principles on which it [programmed instruction] is said to be based" as "questionable in this application".[26] The notion of feedback is, for him, the "one viable idea" used in programs today. The viability of program feedback would seem to arise not only out of such rational factors as the "encouragement" which has been mentioned, but also out of a rather <u>hypnotic</u> feeling which overcomes one who is undergoing programmed instruction,—a feeling that he is being controlled and that his interest is being maintained by forces which tend to deny rational or conscious explanation.

On the issue of whether programmed learning is conditioning, the stand taken here is in close agreement with

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[25] A marksman can shoot at a target indefinitely without improving his score unless there is someone in the butt to mark his target or otherwise signal back to him where his bullets are landing.

[26] Thelen, "Programmed Materials Today: Critique and Proposal," <u>op.cit.</u>, p.190

that which Thelen has taken. The probability that program "feedback" tends to sustain activity, like the probability that programmed instruction, by focussing attention, systematizes perception to the end that cognitive insights are facilitated, is acknowledged. To this extent it is acknowledged that programmed learning employs processes which are analogous to conditioning. It is not acknowledged, however, that the motivation which is operative in sustaining activity is anything other than strictly extrinsic motivation.

The issue of extrinsic versus intrinsic motivation brings us to the final question which this chapter purports to answer, namely, whether subject matter involving more than mere habit or rote memorization can be programmed effectively — whether, for example, permanent interests, discovery, problem solving, creativity, and independent thinking can be taught by programs. While these processes are interrelated, they merit separate detailed consideration because of their importance in the curriculum. They will be considered in the sequence just mentioned. The chief issue in determining their "programmability", over and above the extrinsic versus intrinsic motivation issue already mentioned, will be that of dogmatic versus Socratic method.

The extrinsic nature of the motivation employed in programs would seem to present a major problem with regard to the development of permanent interests and the teaching of techniques of discovery.

Jerome S. Bruner has opposed excessive dependence upon extrinsic reinforcement because it tends to lead to rote and conforming behavior and to inhibit originality.[27] He argues that the intrinsic motivation provided by discovery greatly reduces the need for reinforcement external to the task at hand. Gagne and Bolles express a preference for intrinsic motivation in military training because of the role which it plays in the transfer situation.[28] In the field of education, this transfer value has been verified experimentally by Haslerud and Meyers.[29] Extrinsic motivation, however effective it may be in initial learning, generates no wave of interest in the subsequent application of what has been learned. Contrary to the various drive-reducing theories (which identify human motivational impetus with the satisfaction of the various human appetites), genuine intellectual interest in knowledge for its own sake appears, if anything,

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[27] Jerome S. Bruner, "The Act of Discovery," Harvard Educational Review, XXXI (Winter, 1961), 21-32.

[28] Robert M. Gagne and Robert C. Bolles, "A Review of Factors in Learning Efficiency," Automatic Teaching: The State of the Art, Eugene Galanter, (ed.), (New York: John Wiley and Sons, Inc., 1959), p. 27.

[29] George M. Haslerud and Shirley Meyers, "The Transfer Value of Given and Individually Derived Principles," in Selected Readings on the Learning Process, T. L. Harris and W. E. Schwahn (eds.), (New York: Oxford University Press, 1961), pp. 335-41.

to be drive-increasing. The thirst for understanding of the mysteries of nature does not become satiated by the achievement of such understanding. Each new insight satisfies the curiosity of the moment, but also forms the basis for the asking of further questions. It is the asking of these questions, more than the finding of their answers, which provides the motivation. It is chiefly by this process that permanent interests are developed.

As far as efficacy is concerned, teaching methods which employ the intrinsic motivation of discovery have proved under experimentation to be superior to methods using extrinsic motives. Kersh has shown that "guided discovery" is superior to "directed learning" for teaching rules used in summing arithmetic progressions and both are superior to rote learning.[30] The University of Illinois Committee on School Mathematics has stressed "initial self-discovery of generalizations by students, followed by precise, consistent, and unambiguous verbalization of modern concepts."[31] The method of providing examples whereby the student is required to discover the "rule" is in direct

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[30]Bert Y. Kersh, "The Motivating Effect of Learning by Directed Discovery," Journal of Educational Psychology, LIII (April, 1962), 68.

[31]David P. Ausubel and Donald Fitzgerald, "Meaningful Learning and Retention: Intrapersonal Cognitive Variables," Review of Educational Research, XXXI (December, 1961), 503-4.

contrast to the "ruleg" programming system developed by Homme and Glaser in which the rule is stated first followed by an example.[32] It is extremely doubtful whether programs can be developed which are capable of providing the guidance, evaluation of responses, or heuristic teacher-pupil interchange which is necessary to elicit efficient discovery by the student when the examples, instead of the rule, are given first.[33] The heuristic method, characterized by a large variety of partly right suggestions proffered by students and evaluated by the teacher (usually by asking other questions) is definitely beyond the scope of the inflexible linear program. The inflexibility of programs results in a rigid dogmatism which characterizes the auto-instructional materials in existence today.

It is the dogmatism of programs which gives rise to serious difficulties whenever an attempt is made to program subject matter which for any reason admits of more than one possible answer to a given question. Subject matter of this kind is encountered in such activities as problem solving,

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[32]Lloyd E. Homme and Robert Glaser, "Problems in Programming Verbal Learning Sequences," in Lumsdaine and Glaser, op.cit., pp. 486-96.

[33]Norman R.F. Maier, "Reasoning in Humans," in Harris and Schwahn, op.cit., pp. 31-41.

creative and imaginative thinking, and the use of judgment in deciding upon the truth and practical or aesthetic value of data which have been presented.

Robert F. Creegan, Professor of Philosophy, State University of New York, has challenged programmers to eliminate the dogmatism of programs.[34] He writes: "Despite all their efficiency in one type of learning, the birds [pigeons] never questioned what might exist outside the [Skinner] box.[35] He suggests that students may be denied the opportunity to develop their imagination if the questions they are asked acknowledge one, and only one, correct answer in a world where the most important questions have either several possible answers, or perhaps no answer.[36] Robert B. Nordberg, Department of Education, Marquette University, is another critic of

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[34] Robert F. Creegan, "Automated Education: Must it be Dogmatic?," School and Society, XC (Summer, 1962), 258.

[35] Ibid.

[36] Not to quote Creegan out of context, it must be noted that his anxiety is about the types of programs we may choose to use and not about the fact that we may use programs. He suggests that it may be possible to devise a program which teaches honest doubt.

dogmatic programs.[37] Nordberg aptly states: "If the pupil is so hopelessly unmechanized that he demands to know why this is the right answer, or isn't, the machine might paraphrase Chaucer:

> 'I know not how these things may be;
> I give the answer given to me.'"[38]

The dogmatism of programs is the precise reason why they are not, in spite of their claims, Socratic in method. Claims that programs are Socratic ignore the fact that truly Socratic questions are conditioned to a great extent upon the answers of the students. They also ignore the fact that Socrates was an inquirer into human virtue, into the state of his own soul and that of his pupil's soul.[39] Socrates certainly did not believe in the "errorless" program. Ralph Thomas has cited one of the many examples of Socratic irony in which Socrates deliberately attempts to "trap the student," i.e., elicit an incorrect response, thus leading to contradictions which enable the student to discover his own error.[40]

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[37] Robert B. Nordberg, "What Teaching Machines Can and Cannot Do," Catholic Educational Review, LIX (September, 1961), 361-7.

[38] Ibid. p. 363.

[39] Harry S. Broudy, "Socrates and the Teaching Machine," Phi Delta Kappan, XLIV (March, 1963), 243.

[40] Ralph E. Thomas, "Programmed Learning and the Socratic Dialogue: A Critical Review," American Psychologist, XVIII (August, 1963), 536-8.

It is granted that Crowder's branching programs are somewhat closer to a Socratic method than are linear programs, but they are so only to the extent that they can forecast accurately the various alternative responses which a student may make. Even then, normally only one of the alternatives given is considered correct. The choice by the student of any other alternative results in his being routed through a cycle of frames, designed to reorient his "erroneous" logic. He is then returned to the original frame for a second try. The only way the student can continue with the program is to select the alternative which the programmer wanted him to. The program is still dogmatic; the subject matter must be just as clear-cut as with the linear program.

Problem solving is an extremely important example of subject matter which is not clear-cut. In their attempts to teach problem solving, programs of necessity end up teaching a step-by-step procedural method which, when examined critically, amounts to little more than rote learning. The memorized procedure is useful for only one problem. The so-called other problems to which the procedure is applied are really the same problem with variations in the values of the parameters. Furthermore, only one of perhaps several correct solutions to this one problem can be considered.[41] The method has validity only for such things as long division or use of a slide rule, i.e., procedures which are being provided as tools rather than tasks which are being assigned for the benefit of insightful experience. For more complex problems, such sets of rules not only rob the problem of the greatest part of its intrinsic motivation, but also develop problem solving habits which make the student blind to more generalized problem solving approaches. Some of the best teachers of problem solving give students, at most, three rules:

1. Organize the known data (i.e., draw a diagram, etc.).
2. Identify the unknown data.
3. Try something.

No program which has been devised thus far can cope with the evaluation of the multitude of original, creative, and imaginative approaches which students will take in applying these simple rules to a challenging problem.

There is considerable evidence to support the contention that over dependence upon the stochastic mechanism in problem solving impedes successful use of the recursive mechanism. It has been suggested, for example, that the

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[41] The branching program can be adapted to allow perhaps two or three different correct solutions, but today's programs have done very little to date to make use of this facility.

immediate feedback of the teaching machine program may develop impatience in the student and that this impatience may result in the student's becoming frustrated and giving up too easily when he is confronted by a long or difficult problem requiring a recursive approach.[42] Indeed, Holland and Skinner have shown that, with animal learning at least, the higher the frequency of reinforcement, the more rapidly the occurrence of extinction when reinforcement is withdrawn.[43] Experiments with human subjects show similar adverse effects of the excessive use of "conditioned" learning. Krumboltz reports that "too much unassimilated feedback can impede the solution of a two-dimensional geometric game."[44] This is in line with Galanter's contention that auto-instruction is capable of inhibiting imagination and creativity:

> It appears that an A.I.D.[Automatic Instructional Device] can only teach associations, or rote materials, and therefore can never teach a child to be creative, and, in fact, may result in stultifying any creativity that he may have.[45]

While student reactions to programmed instruction cannot be classed as "expert opinion" they are at least

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[42] John Ginther, "Man, Values, and the Machine," <u>Elementary School Journal</u>, LX (January, 1960), 179.

[43] James G. Holland and B.F. Skinner, <u>The Analysis of Behavior</u> (New York: McGraw-Hill, 1961), frame 18-2.

[44] John D. Krumboltz, "Meaningful Learning and Retention: Practice and Reinforcement Variables," <u>Review of Educational Research</u>, XXXI (December, 1961), 540.

[45] E. Galanter, "Two Models of a Student," <u>Teachers College Record</u>, LXII (December, 1960), 194.

experienced opinion, and reactions at the graduate level in university may be classed as "quasi-expert". Roth presents a most interesting spectrum of such reactions based on the critiques written by twenty-six graduate students, after completion of Holland and Skinner's "The Analysis of Behavior"[46] Five students liked the method both at the beginning of the program and at the end. The following is typical of the reaction of the seventeen students who, although initially interested, developed a dislike for the program;

> The end result is an overly receptive and manipulated conglomeration of protoplasm . . . . It is a detriment to creativity, critical thinking, and problem solving.[47]

It is generally accepted that imagination is the prime source out of which creativity and inventive problem-solving are made to flow; that the ability of man to visualize novel situations in the "mind's eye" facilitates the formulation of plans whereby new inventions can come into being.[48] Imagination when trained and used productively undoubtedly saves endless amounts of time and energy which would be re-

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[46]Robert Howard Roth, "Student Reactions to Programmed Learning," Phi Delta Kappan. XLIV (March, 1963), 279.

[47]Ibid.

[48]R.W. Gerard, "What is Imagination," Harris and Schwahn, op.cit., pp. 81-89.

quired in human enterprises if useful innovations had to be arrived at through trial and error. Imaginative power, to use an almost trivial example, enables a person who is assembling a jig-saw puzzle to try pieces mentally, and quickly reject them without the necessity of having to pick them up and try them physically. The human intellect is able to produce and direct this imaginative power at will because, according to the classical tradition, the intellect is an efficient and final cause in relation to other conscious mental faculties.[49] Man's imaginative power can make available to his consciousness such data as it may require, displayed in an organization appropriate to the problem at hand, to enable reasoning and learning to occur even in the physical absence of sense data relevant to the problem. For a teaching technique to stifle imagination—and it would appear programmed instruction does—is a very serious matter.[50]

The creative use of the imagination is but one of the higher mental faculties which characterize man's cognitive and reasoning powers. Judgment, for example, is an equally vital faculty. That judgment can be considered as more or less distinct from conceptualization is evidenced by the fact that a neurotic person may suffer no loss of I.Q. despite his loss

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[49] H.I. Labelle, The Agent Intellect According to Joseph Marechal and the Classical Tradition (Doctoral Thesis; Rome: Pontificia Universitas Gregoriana, 1960), p. 75.

[50] That programmed instruction stifles imagination and creativity is supported by arguments on pages 59, 62, 63 and 64 of the present work.

of ability to make sound decisions.[51] No cognitive learning process is complete, however, until the point of judgment has been reached. The truth and the value of the data must be assessed before any real addition has been made to the mind's intellectual content. The auto-instructional program in no way invites such judgments: if anything, it discourages them. This is demonstrated whenever attempts are made to program ambiguous or controversial subject matter. If a student chooses to use his own judgment in assessing the truth or value of his answer, failure to obtain confirmation can have very damaging consequences as well as negative motivating influences. The student may well be placed in such a position that he must either affirm his own judgment — thus losing confidence in (perhaps even terminating his learning from) the program — or worse, affirm the program's judgment, thereby discounting his own right to think for himself, merely so that he can continue with the program. An emotional reaction is to be expected in either case. Reed and Hayman report that "when pupils know instinctively that their answers are correct, but do not get reinforcement from the printed answer, they are confused and many are angry."[52] This clearly restricts the type of subject matter which can be programmed to that about which no controversy can exist.

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[51]Robert Nordberg, "Man's Rationality - A Psychological View," Catholic Educational Review, LV (February, 1957), 75.

[52]Reed and Hayman, op.cit., p. 478.

When material of a controversial nature is programmed the situation is entirely different from that in which a textbook, or even a teacher, presents opinions about controversial topics. A student can read or hear controversial statements without jeopardizing his right to think for himself. In the program, the student is required to participate in the presentation of the material without having any final say in the matter. He must speak his lines; no ad libitum is allowed. Even the most cautious student can feel himself being swept along, encouraged at every decision point, like a man who finds himself submitting to the skilful tactics of an experienced life insurance salesman. After an exposure to the indoctrination or "behavior-shaping" of the first 45 "sets" of The Analysis of Behavior, for example, the student finds himself confronted with the following frame:[53]

The term voluntary is a misleading description of operant behavior because operants * * * controlled through relevant variables as completely as respondents.	are

The student typically finds the frame easy, answers it readily, and moves on quickly to the next frame with little if

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[53] Holland and Skinner, op.cit., frame 46-29. Skinner uses the term "respondent" to denote a Pavlovian response in the same way that he uses the term "operant" to denote a Skinnerian response.

any thought about the implications of the deterministic principle to which he has subscribed. Thelen has observed that "there is no control over student purposes or motives... His posture is to be extraordinarily docile, and he is not expected to participate in goal-setting."[54] The stochastic mechanism of programs would seem then to be such a subtle process that it takes place largely unawares. It is not reflective or recursive; it does not question or challenge; it acquires without inquiring. Critical judgment does not participate in this type of learning.

In summary of this chapter, it may be concluded that only a very small amount of human learning results from conditioning and, by the same token, only a very small amount of programmed learning is "conditioning". The apparent success of programs may be attributed mainly to their ability to prohibit daydreaming while material is being read, and to a rather uncanny, or at least unconscious, ability to sustain activity. Programmed instruction has been found empirically to be highly successful in the stochastic learning process whereby knowledge of a type which may be acquired through rote, and skills of a type which may be acquired through drill, may be learned. For learning which involves concept formation or eveninsights (if they can be called such in the absence of critical judgments), the method has demonstrated a moderate

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[54] Thelen, "Programmed Materials Today: Critique and Proposal," op.cit., p.190.

success but one which is wholly unrelated to the psychology which has given rise to the procedures used. When programs attempt learning functions above the strictly conceptual level they frequently give rise to adverse "side effects" with regard to the use of imagination and judgment.

Many promoters of auto-instruction freely admit the limitations of programs with regard to the development of facility in the use of higher mental faculties.[55] Educators must, however, be on guard against the over-optimistic and probably sincere reformer who would like to program everything.[56] Silberman, an industrial programmer, claims that "any domain of instruction, including creativity, is fair game for programming."[57] The view that has been substantiated here is closer to that expressed by Nordberg when he writes:

> Teaching machines .. can be of use in teaching cut-and-dried, completely unambiguous subject matter, such as spelling or simple computation, and only when directed and actively supervised by a teacher and subjected to frequent review and criticism.[58]

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[55]Kenneth E. Anderson and Allan Jack Edwards, "Educational Process and Programmed Instruction," Journal of Educational Research, LV (August, 1962), 540.

[56]R.E. Komoski, "Programmed Instruction - A Prologue to What?" Phi Delta Kappan, XLIV (March, 1963), 293.

[57]Harry F. Silberman, "What are the Limits of Programmed Instruction?" Phi Delta Kappan, XLIV (March, 1963), 293.

[58]Nordberg, "What Teaching Machines Can and Cannot Do," op.cit., p. 367.

Pressey, the prophet of teaching machines, has shown great concern about the present day course of the revolution which he predicted. His charges, moreover, make a unique summation of the present thesis up to this point:[59]

> All this [Skinner's linear programming theory] has seemed plausible theoretically, and hopes have been high for extraordinary educational advances. Instead, evidence has been accumulating that the above hypotheses on which the programming was being based, were, for human learning of meaningful matter, not so! . . .
> . . . .
> Most important matter to be learned has structure, which the programming destroys except the serial order, and most important learning is integrative and judgmental, so requires a looking about in what is being studied; for all such purposes a teaching machine seems about as hampering as a scanning device which required that one look at a picture only one square inch at a time, in a set order. . . .
> . . . .
> Children gradually develop a number system, also cognitive schema as of space, causality; and they do this not by so crude a process as the accretion of bit learnings stuck on by reinforcements. . . . No less a charge is made than that the whole trend of American research and theory as regards learning has been based on a false premise--that the important features of human learning are to be found in animals.

At the same time, educators are faced by the fact that programmed instruction <u>works</u>, or at any rate gets students through examinations. Can one accept automated instruction but reject a large portion of the theory behind it? The findings of the next chapter will have some bearing on this question.

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[59]Sidney L. Pressey, "Teaching Machine (and Learning Theory) Crisis," Journal of Applied Psychology, XLVIII (February, 1963), 1-6.

CHAPTER V

THEORETICAL EVALUATION: PART II (IN THE LIGHT OF HUMANISTIC EDUCATIONAL AIMS)

This chapter endeavors to answer two questions:

1. Are there any undesirable educational outcomes, not produced by conventional education, that are apt to result from full-scale use of programmed instruction?

2. Are there any shortcomings of conventional educational objectives and outcomes that are apt to be perpetuated or accentuated by programmed instruction?

As regards the first of these questions this study must not fail to consider philosophical principles which are inherent in the behavioral scientist's approach and which may easily be imbibed by the impressionable minds of youth via the high efficiency indoctrination of programmed instruction. It must also inquire whether or not the danger exists of this system of instruction being put to some diabolical use.

It is easy to take a very pragmatic approach to programmed learning, — to disregard the strictures of the preceding chapter and to take, as the criterion of the truth of the underlying psychology, its practical value as tested by immediate measurable outcomes. This would all be very well if the psychology involved were not so closely bound up with a philosophy, a philosophy which the majority of professional educators find distasteful, if not untenable, This philosophy is deterministic, agnostic and materialistic, and aspires towards a rigid control over the thoughts and behavior of man. This rather serious charge will be demonstrated in due course. The immediate question is whether the methodology of operant conditioning can be borrowed without accepting also the determinism, agnosticism, materialism and cybernetic aspirations which go hand in hand with it today.

George L. Geis would lead us to believe that at least the determinism and cyberneticism must be purchased in the same package with programming rationale.[1] Geis has stated:

> To understand programming I am convinced one must understand the bias of determinism. For the programmer has committed himself to the active control of human behavior. He is an animal trainer using humans as subjects. The important point to recognize is that among educators this is a new idea. One major contribution of the programming movement to education is what it does in changing the attitude of the teacher. Up to now the emphasis has been the effect of programs on students. We might look at the effects of programs on the teacher and on the programmer for not all or even most programmers hold a deterministic view at least early in the game and certainly I do not think most educators do.[2]

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[1]George L. Geis, "An Attitude: Determinism, "(Lecture delivered to prospective programmers, A.M. 11 July, 1961), <u>System Training: Programmed Learning</u> (Toronto: Canadian National Telecommunications, 1961), pp. 9-1 to 9-11.

[2]<u>Ibid.</u>, p.9-5.

Geis has made no attempt to disguise his object of inculcating the deterministic viewpoint in the programmer, the teacher, and the student. He makes the precise nature of this determinism very clear when he says:

> Each new scientific event reduced man's role as a noble creature. He was finally told that he was but a continuation, no, merely, an off-shoot, of an evolutionary line.
> . . . .
> . . . At any rate the last vestige of prestige remaining today is free will. Man's planet is just one of many; man himself is a glorified ape.
> But he is dramatically different from the other apes for he has volition. It is this last bias that the behavioral sciences are attempting to overcome.[3]

Geis is not merely teaching a determinism for use in the physics laboratory, where it doesn't work particularly well anyway:[4] he is advocating abolition of the notion of the human will. Such an attitude certainly is unacceptable to educators like John Travers of the School of Education of Boston College, who writes:

> . . . The notion of the will is intimately bound to learning theory, and any attempt to overlook its importance or ignore it completely does irreparable damage to such a theory of learning.[5]

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[3]Ibid., pp. 9-2, 9-3.

[4]F. Waismann, "The Decline and Fall of Causality," in Turning Points in Physics, (Amsterdam: North-Holland Publishing Company, 1959), pp. 84-154.

[5]John F. Travers, "Learning Theory: Animal or Human?" Catholic Educational Review, LIX (April, 1961), 236. Travers' statement is in keeping with our earlier findings that the notion of the will is essential in defining the human learning processes which are not "conditioning" processes.

Travers also points out the materialistic philosophy of most behavioral scientists when he says:

> Theories of conditioning, Behaviorism, Connectionism, and even Gestaltism studiously avoid the use of such terms as 'soul', 'spiritual', or 'immaterial' in their attempt to explain learning.[6]

The agnosticism of the behaviorist position is inherent in its very ground rules, but it tends to go beyond the point of being merely a scientific discipline. E.C. Tolman certainly went beyond this point when he wrote:

> If the universe has characters other than discriminanda - manipulanda and means-ends relationships, relative to human beings or sub-human beings, these characters will never be known.[7]

Although not all behaviorists would go quite that far, nevertheless, the agnosticism which accompanies the procedures of behaviorism tends to make it eternally sterile in the field of human values.

Even if one admits the possibility that the behaviorist approach might eventually produce a <u>model of man</u> which is capable of love, a concept of beauty, a respect for truth and an appreciation of the good,it will probably not do so in this century or even the next. In the meantime, Thorndike's neurological models of man and Wiener's cybernetic

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[6] *Ibid.*, p. 228.

[7] E.C. Tolman, *Purposive Behavior in Animals and Men*, (New York: Century Company, 1932), p. 429.

computer models are not providing a particularly satisfying answer to any of the real problems faced by education. Ginther has suggested that teaching machines are an outcome of such "automatic models" of man.[8] He points up the futility of the neurological model by citing Thorndike's notions of intellect and character:

> Any neurone will, when stimulated, transmit the stimulus, other things being equal, to the neurone with which it is by inborn organization most closely connected. The basis of intellect and character is this fund of unlearned tendencies, this original arrangement of neurones in the brain.[9]

The cybernetic model has little more to offer, except perhaps that analogies between feedback and knowledge of results and between negative entropy and quantity of information have provided a few "laws"[10] which the communication arts had already derived empirically.[11] Nordberg views such mechanistic

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[8] Ginther, "Man, Values, and the Machine" *op.cit.*, p. 186.

[9] *Ibid.*

[10] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society*, (Boston: Houghton Mifflin Co., 1950).

[11] Daniel Fogarty, *Roots for a New Rhetoric* (New York: Teachers College, Columbia University, 1959).

models of man with great concern. He writes:

> In any but a mechanistic outlook, then, it is contradictory to speak of 'teaching machines'. We might note that every tyranny the world has ever known . . . has enthusiastically adopted this mechanistic theory of learning and all that goes with it.[12]

One must not allow an exaggerated fear of tyranny to cause an unfair prejudgment of the ubiquitous teaching machine. Most good inventions can be put to evil uses. At the same time, the Utopia Skinner describes in "Walden Two"[13] has a number of frightening features in common with Huxley's "Brave New World,"[14] and Orwell's "1984".[15] Certainly the teaching machine has all the qualifications to serve well the ends of any would-be Hitler or Stalin. If one wants to breed a race of obedient sheep, how could one better start than by adopting bestial psychological principles? If it is desired to convert society into an efficient machine, how could one better begin than by teaching a deterministic materialism? Fortunately, in a cybernetic model of a society, the feedback principle makes it difficult to say just what is controlling

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[12] R.B. Nordberg, "What Teaching Machines Can and Cannot Do", Catholic Educational Review, LIX (September, 1961), 362.

[13] B.F. Skinner, Walden Two (New York: Macmillan, 1948).

[14] Aldous Huxley, Brave New World (London: Chatto and Windus, 1932; Reprinted 1960).

[15] George Orwell, 1984 (New York: Harcourt, Brace and Co., Inc., 1949; Reprinted: New American Library of World Literature, 1963).

what. The Soviet government has had to undergo considerable change in order to control the Soviet people. Furthermore, the examples of tyranny which abound in the world today tend to make educators, if anything, over-cautious and over-suspicious of technological innovations.[16] For this reason it seems unlikely that programmed instruction will become the plague of a democratic society,—any more than it will become the panacea which it was originally predicted to be.

Aside from any fear of tyranny, however, the educator must be wary of the fact that the behaviorist school of psychology is inseparably associated with a philosophy which is characterized by a strictly materialistic concept of human values. He must also be aware that a significant proportion of the persons who have influence in the instructional programming industry subscribe to this behaviorist discipline. Ginther has shown an awareness of this fact, and he is convinced that these persons "will wield more and more influence upon education in the future."[17] Ginther adds:

> What many of us want to know is how much men answer the critics who assert that ultimate or eternal values, or just some kind of values, cannot be inferred from automatic models of man and thus must be

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[16]Nordberg is an example of an educator who is, perhaps, over-cautious.

[17]Ginther, "Man, Values, and the Machine," op. cit., p. 189.

> absent from education based on theories derived from the study of such models.[18]

That a philosophy which is void of human values can be transmitted from the programmer to the student in spite of the teacher's supervision is evidenced by the cunning with which programs accomplish their indoctrination. This cunning, along with the copious nature of programs, makes it difficult for the teacher to check them thoroughly,— even if one assumes that the teacher will be immune to indoctrination. It appears that in programs, as well as in teaching, attitudes are "more often caught than taught."

If the behaviorist approach is unable to provide sound guidance to education, where can educators turn for the direction which they need? Andrew F. Skinner has pointed out recently that educational philosophy during most of this century has been a shrinking field.[19] He writes:

> . . . the trend has been away altogether from speculation in the realm of metaphysics and towards reliance upon the more practically restrictive 'principle of verification' ... which states that speculation about meaning beyond sense experience is to be regarded as a waste of time since the conclusions cannot be verified. Philosophy in consequence seemed to have withdrawn from speculation about the nature of man, society, and eternal

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[18]Ibid.

[19]Andrew F. Skinner, "Philosophy of Education in Canada: Some Impressions and Comparative Comments," <u>Canadian Education and Research Digest</u>, III (December, 1963), 251-61.

> verities, and hence away from any claim to speak authoritatively on fundamental questions relating to purpose and values or, in this respect, to give directive assistance in education.[20]

Nevertheless, education must return to a more metaphysical approach if it is to put the soul and the will back into its model of man.

The implications of such a move for the field of programmed instruction are twofold. First, any feature of programmed instruction which denies the existence of man's soul or will must be removed. This means that most of the underlying psychology must be rejected and replaced by psychology of a strictly human origin. The second implication has to do with the means by which this can be accomplished and also the permanent safeguards which are necessary to defend the medium against contaminating influences. If programmed instruction is to be protected from false ideologies, the leadership in its development must be assumed by competent educators.

Although no one can guarantee that educators will be free from false ideologies, at least they are — under existing circumstances — not in business for themselves. They hold as a rule no hope of monetary gain through the promotion of this or that type of instructional material. Although

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[20] Ibid., pp. 255-6.

their educational philosophies may not always be puristic, at least they are widely diverse. This diversity in educational philosophy, moreover, has been championed by Andrew Skinner as the reason for its security against wholesale contamination:

> "Pluralism," to be regarded as a source of strength rather than weakness, operates in a democracy, and the emergence of any one particular philosophy is not to be expected.[21]

The real argument, however, is that educators, because they deal with <u>human</u> beings in <u>human</u> ways and are concerned with <u>human</u> objectives, offer the best available assurance against the intrusion into education of the methods and objectives of animal psychology. It must, then, be educators alone who decide on the proximate and ultimate educational goals to be achieved, who select the programming rationale to be employed, who construct and evaluate the programs, and who administer their use in schools. Educators have already taken some steps towards this end. Many of them have, in fact, rejected entirely the assumed role of "conditioning" in programming and have concentrated upon "arranging contingencies" (to use Skinner's expression) so that what occurs is <u>insight</u> in its purest and most human form.

In the autumn of 1961 the Canadian Teachers' Federation conducted a seminar in Ottawa on the subject of program-

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[21]Andrew F. Skinner, "Philosophy of Education in Canada," <u>op.cit.</u>, p. 253.

med learning and its future in Canada.[22] Among the more valuable ideas which came out of this seminar were those concerning the impact which the programming concept may have on educational aims and, conversely, the need for wholesome educational aims to govern the programming concept.

Among the distinguished speakers at the seminar was P.K. Komoski, President of the Centre for Programmed Instruction, Inc., New York City. Komoski stressed on a number of occasions the necessity, not merely to be on guard against undesirable outcomes which may result from programmed instruction, but to define clearly for the guidance of programmers the precise educational outcomes which are desired. To use Komoski's words:

> There is no question that programmed instruction could be used to breed a generation of blank-fillers and word-manipulators unless the proper people in education take the proper stand and say this is not the behavior that we specify as the behavior of an educated person.....If educators look at programming as something which is going to help them accomplish what they define, then we are on the right track. But it can be misused, it is being misused and I am sure it will be misused. The question as to what degree it will be misused depends on the educators themselves.[23]

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[22]Gladys Rutherford (ed.), Programmed Learning and its Future in Canada, A Report of A Seminar held by the Canadian Teachers' Federation, (Ottawa: November 22-24, 1961).

[23]P.K. Komoski, (Question and Answer Session), Ibid., pp. 45-6.

It is incumbent upon this study, then, in addition to pointing out dangerous consequences of educational automation, to suggest some desirable goals towards which to orient programmed instruction. Conventional educational practice has a number of shortcomings, some traditional and some of fairly recent origin, which have been adopted by program writers and will continue to be adopted until something better is provided. These shortcomings centre around three basic features of North American education:

1. Preoccupation with rote learning.
2. Inadequate character training.
3. "Over-partitioned" education resulting in mediocrity, conformity, and inadequate development of wholesome interpersonal relationships.

The changes in emphasis which these features indicate for education and the prospects which programs offer in these areas are considered, in the above sequence, in the remainder of this chapter.

The tendency of programs to deal excessively with rote learning was demonstrated in Chapter IV. Conventional education appears to be little better in this regard. Traditional subjective examinations characteristically encourage the parrotry of lists of facts, duly memorized but often not well understood, while today's objective tests rarely place any higher premium on understanding. As Lobaugh and McKinley have observed, evaluation of education in terms of a race for space tends to measure success in terms of test results and thus is liable to increase engrossment in facts.[24] Facts are important, but their importance rests solely upon the principles to which they can be related.

John McNeil, Associate Director of Teacher Training at the University of California, in comparing the didactic of Comenius with that of auto-instruction, has shown great concern about the exploding mass of facts available to the teacher and the learner. He suggests that a liberal education is now possible only by concentrating upon the major features and fundamentals of the principle disciplines, rather than on facts.[25] Thelen is another educator who has questioned the validity of excessive factual learning. His indictment is made in connection with some of the difficulties which have already been observed in the present work.

> The issue is whether increasing the verbal repertoire is a legitimate educational objective; whether conditioned learning of a very large number of fragments of information can in any way contribute to the development of character, ability to think critically, ability to apply principles, development of interests, and so on.[26]

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[24] Dean Lobaugh and Donald R. McKinley, "Teacher or Machine?" Clearing House, XXXVI (December, 1961), 209.

[25] John D. McNeil, "Great Didactic and Automated Teaching," Education, LXXXI (May, 1961), 569.

[26] Thelen, "Programmed Instruction: Insight Versus Conditioning," op.cit., p. 418.

Nordberg has expressed similar misgivings about the current preponderance of factual learning in schools and the tendency of programs to perpetuate this preponderance:

> The danger is that the preoccupation with trivia which has been the curse of schools since schools began will be increased incalculably by mechanical contrivances.[27]

The ability to memorize facts ranks amongst the lowest of human mental faculties. Should it not, then, rank amongst the lowest of educational objectives? Certainly, "knowledge of specifics" forms a relatively small portion of Benjamin S. Bloom's "Cognitive Domain."[28] Forms of critical thinking are given much greater emphasis. The findings of Chapter IV of the present work indicate that faculties such as creative imagination and judgment are much firmer foundations upon which to build educational aims than are the faculties of recognition or recollection.

It is not sufficient to delay the development of higher mental faculties until the university level of education. The high percentage of the population which does not reach university must learn to challenge statements and sources of information too. In addition to being able to

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[27]Nordberg, "What Teaching Machines Can and Cannot Do," op.cit., p. 365.

[28]Benjamin S. Bloom, Taxonomy of Educational Objectives; PartI: Cognitive Domain (New York: Longmans, Green and Co., Inc., 1959).

acquire facts people must be able to make logical deductions from them and to base sound judgments upon them. If programs are to hold any hope of furthering these goals, they must first recognize that man is primarily a recursive, rather than a stochastic learner and provide, insofar as they can, learning experiences which are insightful rather than conditioned. As Thelen has stated:

> There is little doubt that most competent opinion by people who have no vested interest in particular materials or in the sacred traditions of public schools is that we should maximize insight learning and minimize conditioned learning as much as possible.[29]

A more urgent concern, perhaps, than excessive factual learning itself, is that it tends to crowd out of the curriculum activities oriented towards such goals as character training. What are the likely effects of programmed instruction in this area? Although it is not suggested that programmers should undertake specifically the development of personality or character, at the present time these goals are completely ignored by programmers and sometimes downright abused. Jesse Day of Ohio University might like to reconsider his statement:

> Since the student learns the correct answer by cheating, then cheating can

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[29] Thelen, "Programmed Instruction: Insight Versus Conditioning," op.cit., p.419.

> legitimately be considered one way of learning. And if the student learns the material correctly, who cares how?[30]

Ruth Davies (University of Pittsburg) cites an appalling example of an entire classroom of youngsters who seemed to be in agreement on the principle of "judging right and wrong on the basis of 'what's in it for me?'"[31] It must be agreed that such sickness of the soul is the fault, not only of the school, but of home, church, and the community at large. Nevertheless the school exercises considerable influence in this area; and therefore it is incumbent on educators to see that the influence is in the direction of improving character rather than undermining it.

Sir Richard Livingstone is one of the relatively few educational leaders who has been bold enough to place the development of a sense of values and the training of character above all other educational tasks.[32] Such goals can only be achieved through teacher interaction with students and with the use of a psychology and a philosophy which exalts social, moral, and aesthetic values above the level of material ones. From this it is obvious that

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[30]Jesse H. Day, "Teaching Machines," Journal of Chemical Education, XXXVI (December, 1959), 594.

[31]Ruth Davies, "The Library — First National Bank of Communication," Visucom, II No. 4, p. 3.

[32]Richard Livingstone, Some Tasks for Education (Toronto: Oxford University Press, 1946), pp. 25-50.

the question which some unthinking people have asked, as to whether teachers can be replaced by machines, is so ridiculous as not to merit any consideration whatever.

Strength of character is generally thought to be related to courage and unswerving perseverance, traits perhaps best learned through the performance of challenging tasks under adverse conditions, and often through errors and failures. Advocates of the "errorless" program, on the other hand, are particularly concerned with protecting the pupil's delicate psyche from the anxiety which accompanies such errors and failures.[33] While granting that low achievers frequently need special encouragement, it is submitted that few persons will ever accomplish anything worthy of note unless they meet up with tasks which challenge every ounce of their aptitude and energy. If a student is protected from failure at every point in his schooling, how can he possibly develop the courage and perseverance to face the inevitable failures of life? Some of life's most valuable lessons are learned through one's mistakes. Such mistakes are far better made in school than in later life.[34] It may be noted that Crowder's

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[33]Day, loc.cit.

[34]Scott B. Parry, "To Err is Human ... and Sometimes Desirable," Phi Delta Kappan, XLIV (March, 1963), 258-60.

"intrinsic" branching program does not subscribe to the errorless philosophy, and yet it has proved just as effective as the linear program.[35]

Another failure of education, which might be related to character training, is that it has not successfully taught people what might be called self-appropriation, the ability to temper their judgments with whatever knowledge they have of their own personal biases. If people read in the newspapers that a man was arrested and charged with a crime of some kind, they tend immediately to try, convict, and if it were possible, sentence him without hearing any of the evidence. Twelve such individuals will later sit in judgment of this man. Whisperings of scandal from one neighbour about another are believed with equal gullibility. It is probaby fair to inqure whether linear programs, in which the assimilation of data without the use of critical judgment is reinforced upwards of ninety per cent of the time, will do anything to correct this educational shortcoming.

A traditional shortcoming of education is its failure to allow adequately for differences in student ability. Programs have promised to correct this situation, because the student with greater ability should complete a program in

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[35]Norman A. Crowder, "On the Differences Between Linear and Intrinsic Programing," Phi Delta Kappan, XLIV (March, 1963), 250-54.

less time and thus be able to work on extra-curricular programs or other enrichment materials. That individual differences are only half allowed for, however, is evidenced by the greater homogeneity of achievement in programmed learning than is obtained by conventional methods.[36] The "errorless" program, unless graded in difficulty to suit students of different ability levels, would seem to suffer from the same weakness which Anderson and Edwards have predicated of much of today's teaching:

> The conclusion seems justified that the emphasis on the process of striving for limited goals, homogeneity of achievement, and getting all pupils over the passing mark tends to encourage teachers to set limited goals for instruction which results in temporary factual learning.[37]

Programs, like teachers, are prone to encourage conformity in their efforts to meet a minimum standard, rigidifying not only the instructional level but the content as well. Ramsey suggests that "the dangers of freezing staid and prosaic content into the high efficiency system of programmed instruction may simply allow us to perpetuate mediocrity"—and teach it better.[38] Allowance for individual differences, then,

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[36]Hough and Revsin, <u>op.cit.</u>, p.287.

[37]Anderson and Edwards, <u>loc.cit.</u>

[38]Ramsey, <u>op.cit.</u>, p.415.

must be made on the basis of worthiness of the challenge as well as on the basis of time to complete. It must be realized that individualized instruction is but one of several methods of coping with individual differences and is not in fact a necessary procedure in this regard.

In a few of todays modern schools, we are beginning to see the disappearance of some of the physical and administrative structures which have always partitioned educational activity.[39] Grade levels and even classroom walls are undergoing pressure from many quarters to be removed or changed radically. These "revolutionary" modern schools have demonstrated dramatically that enrichment activities and challenges proportional to student ability can be provided without sacrifice of cooperative and other interpersonal relationships. Contrasted with this trend is the learning which "one attempts in a booth alone with a machine and enmeshing programmed material."[40]

In deciding which of these extremes is closer to the optimum, it may be useful to take note of Mead's comments regarding the importance of the group in the development of the individual:

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[39] John E. Helfrich, "A Laboratory for Total Communication," Visucom, II No. 3., 2-8.

[40] Ginther, "More on Teaching Machines," op.cit., p.239.

> The process out of which the self arises is a social process which implies interaction of individuals in the group, implies the pre-existence of the group. It implies also certain coöperative activities in which the different members of the group are involved. It implies, further, that out of this process there may develop a more elaborate organization than that out of which the self has arisen, and that the selves may be organs, the essential parts at least, of this more elaborate social organization within which these selves arise and exist.[41]

If the group is important in the development of the individual, it is equally true to say that the individual plays a vital role in the development of the social structures and social order which constitute the "group". The importance of this social order cannot be overemphasized because it enables stable communities to replace anarchy in our society. If education is to teach human virtues which will "transfer" effectively to life in this social context, should not the school be a miniature model of society, or at least of an ideal community? It is well known that transfer depends on similarities between what is learned and the task to which it is to be applied.[42] Group learning seems to be indicated.

The "ideal community" envisioned is one in which people look upon education as a process which goes on throughout their entire life. The traditional concept of education

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[41]George H. Mead, Mind, Self, and Society (Chicago: University of Chicago Press, 1934), p. 164.

[42]Gagne and Bolles, op.cit., p.34.

might be diagrammed as follows:

Education (Preparation for life)	Life

——Time——>

The concept envisioned for the education of the future looks more like the following:

Education
Life

——Time——>

Two important principles apply. First, schooling is not just preparation for life, but life itself. Second, in addition to learning specific knowledge, a child must learn how to go about getting knowledge the rest of his life. Only in looking upon education as a continuing process can man hope to keep pace with scientific and technological advances in a space age, and at the same time attain the social, cultural and moral stature to wisely control the knowledge which he has. The automation which will make his life less arduous will also provide him with the time to continue intellectual growth throughout his lifetime. It may be that programmed instruction will make an important contribution to his task of adult education. The question of the moment is whether automating his early education will in any way contribute to his ability to seek and find knowledge on his own. He may be preparing for a life in a world of automation but it is to be hoped that it will not be a <u>programmed</u> life.

If libraries contained only programmed textbooks, auto-instruction might well be the best means of learning how to use them. Such an eventuality is extremely improbable however because, as Pressey has pointed out, "for skimming for main ideas, for review, — for any use except that initial go-through — the programmed book is almost impossible and the teaching machine roll entirely so."[45] The libraries of tomorrow will contain books in a format little different from that which they now have. The idea of feeding the library's fund of knowledge into some monstrous digital computer has been suggested, perhaps not very seriously, by Ramo,[46] but quite seriously by some others. The computer would immediately cough up any desired data in response to simple commands by either one student or a hundred students. An amusing rebuttal of this suggestion has been provided by Herman F. Smith in his satire: "The Case of Johnie Lernslo."[47] Johnie, a hopeless child who liked to associate with other boys and girls, was unable to learn from the large computer-based teaching machine and finally was sent back to the old-fashioned little

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[45]Pressey, "Teaching Machine (and Learning Theory) Crisis," op.cit., p. 1.

[46]Simon Ramo, "A New Technique of Education," in Lumsdaine and Glaser, op.cit., pp. 367-81.

[47]Herman F. Smith, "The Case of Johnie Lernslo," Education, LXXXIII (March, 1963), 433-5.

red schoolhouse.

The impression may have been given thus far that auto-instruction is incapable of achieving any worthwhile educational aims whatever. This has not been the intention. The intention has been rather to support the caution advocated by Gerald Nason at the C.T.F. Seminar via the cliché: "Let us make haste slowly."[48] Once the programming movement has been completely divorced from the field of animal psychology and is placed safely in the hands of persons with only educational interests in mind, the way will be open to exploit cautiously whatever effectiveness the method is capable of demonstrating.

The programs of the future may demonstrate greater capabilities than those which are apparent in the programs of today. As Thelen has suggested, principles derived from human experimentation may enable educators to devise program items which stimulate man's higher intellectual faculties:

> The source of the required items is to be thoughtful teaching experience, not studies of infrahuman learning. The items are to challenge the higher mental processes of all students, not to reduce all learning to what can be accomplished with the lowest level mental processes that human beings have in common with rats, apes, pigeons.[49]

The greatest promise of programmed instruction would appear

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[48]Gerald Nason, "Summary and Observations," Programmed Learning and its Future in Canada, op.cit., p. 95.

[49]Thelen, "Programmed Learning Today: Critique and Proposal," op.cit., p.194.

to lie in those areas where individual instruction is both necessary and desirable; as in special instruction for slow learners, home study both for regular students and for students whose health prevents their attending regular classes, and adult education.

As regards the activities of regular classes, this chapter supports the conclusion that it is educational aims more than educational activities which need to be individualized. What may be perfectly adequate goals for one student often imprison the aspirations of another. This is dramatically illustrated by the following two diametrically opposed graduate-student reactions to programmed instruction. The first student wrote:

> With this program I had successive goals which were reached in a pleasant, painless and efficient manner. My interest was maintained at a fairly high level...My personal satisfaction was in learning the terminology and increasing the depth of my knowledge of the subject in an efficient manner, with a minimum of anxiety. In two words, it was an 'enjoyable experience'.[50]

The reactions of the second student can serve as an efficient summary of the ideas advanced in this chapter:

> It is difficult to conceive that critical, creative and independent thinking would result from this type of instruction. It is horrifyingly conceivable to me that an individual educated solely by this means would lose his individuality. His mind would be shaped and his thinking controlled ....Programmed learning in a classroom

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[50]Roth, "Student Reactions to Programed Learning," op.cit., p. 279.

> limits the learner's experience with his classmates. Group interaction and self-expression are limited. I see little or no opportunity for personality development. I see no opportunity to share frustrating or positively rewarding experiences with other humans. I see no opportunity for a student to learn to understand others, to feel with others, to work with others.... Again I submit, stereotyped puppets may result.[51]

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[51] Ibid., pp. 279-80.

CHAPTER VI

ADMINISTRATIVE IMPLICATIONS

The implications of this study, while of vital interest to teachers, will be considered mainly from the standpoint of educational administration. Although the more important inferences arise out of psychological and philosophical considerations, a few implications of a strictly practical origin are included in this chapter.

First of all, the machines, or at least the small inexpensive models, are on their way out. This was predicted by Stolurow in 1962.[1] As Cook has observed, "the design of teaching machines not only reflects certain theoretical principles about behavior; it also exhibits a number of irrelevant features of the Skinner box, —features that had to be incorporated into it because of the very limited symbol - manipulating capacity of rats and pigeons."[2] The fact that the small machines belong to a dying race does not mean that educators will cease to be under sales pressure in the immediate future. Industry desires to recover the

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[1]Stolurow, "Implications of Current Research and Future Trends," op.cit., p. 523.

[2]John Oliver Cook, "'Superstition' in the Skinnerian," American Psychologist, XVIII (August, 1963), 516.

investment which it has made, and some companies are already engaged in a frantic effort to do so.[3]

Stolurow has expressed the opinion that the large computer-based machines will be with us for some time.[4] As they are still for the most part in the developmental stage, it would be premature to pass judgment on them now. It must be borne in mind, however, that as with any highly complex electronic system initial costs are high, and one must not overlook the expense of establishing and maintaining an organization to be concerned solely with preventive and corrective maintenance. The cost of programs is a major item which must be added to that of machines and their operation. Costs, of course, are usually quoted by the manufacturer on a "per student-machine-hour" basis. While it is a simple matter for the administrator to multiply by numbers of students and hours, it is a safer procedure to work out the cost problem frontwards instead of backwards, thereby allowing for such items as interest on capital outlay and hours during which machines will sit idle, items which manufacturers at times neglect to

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[3] Lawrence M. Stolurow, "Let's be Informed on Programmed Instruction," Phi Delta Kappan, XLIV (March, 1963), 255-7.

[4] Stolurow, "Implications of Current Research.....," loc.cit.

consider. As Edwards has stated, automated instruction shows no promise of reducing education costs.[5] Nor should boards of education plan to find money for programmed materials in their present allotment for salaries.[6] If pupils work on programs one hour a day—and few educators feel they should work more than this — they will still need a teacher to supervise them.

The medium sized, medium priced (circa $1000) machines designed for individual tutoring will probably persist for a considerable number of years, especially in exceptional applications where the use of a human teacher is not feasible. Those which use Crowder's "intrinsic" programming technique have been found more effective then"scrambled" books containing identical programs, almost as effective as teacher-given instruction, and more efficient than either on the basis of learning achieved per time consumed.[7] Their development will probably be in the direction of integrating sound commentary with combinations of still and motion picture film. They are

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[5]Reginald Edwards, "Teaching Machines and Programmed Instruction," Canadian Education and Research Digest, III (December, 1963), 262-78.

[6]Ginther, "Man, Values, and the Machine," op.cit., p. 185.

[7]D. Wallis and R.P.Wicks, A Comparative Study of Teaching Machines and Classroom Instruction in a Naval Training Establishment, A Report of an Experiment Conducted at H.M.S. SAINT VINCENT, (Gosport, Hampshire: Senior Psychologist's Division, Manpower Department, Admiralty, 1962), pp. 7-9. This difference from the linear program (for which machines are no better than books) may perhaps be due to the speed with which the machine finds the next frame,—compared with "thumbing" through a "scrambled" book.

prone to suffer mechanical breakdowns with a frequency roughly proportional to their complexity. Like most instructional automata, they will undoubtedly be proven to have greater training value than educating value.

The programmed text, in one form or another, is undoubtedly a "fixture" rather than a "fad".[8] The more the programmed textbook concept is refined, however, with the incorporation of diagrams, pictures and special descriptive panels, the more it resembles the conventional textbook or work-book, except that it still is almost useless as a reference book, and the teacher still cannot tell how far a pupil has progressed by looking at the page number he is working on, either with the horizontal linear or scrambled book format.[9] Pressey has ventured the opinion that the "best will be found closer to texts than to programs."[10] It is possible that the net result could have been obtained more quickly by devoting equivalent funds and effort to the improvement of conventional textbooks. Indeed, several studies report that the students learn just as well from narrative paragraphs

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[8] Stolurow, "Implications of Current Research....," loc.cit.

[9] Ibid., p. 524.

[10] Pressey, "Teaching Machine (and Learning Theory) Crisis," op.cit., p.2.

derived from linear programs as from the linear programs themselves.[11]

McNeil has pointed out the need for greater unification of effort in the programming field by observing that the short programs which characterize today's market do not fit together end to end.[12] This unification can best be obtained by placing the conceptualization of programs entirely within the hands of professional educators. As has already been observed, such a move would result in cognition's replacing conditioning as the basis of programs, thus enabling them to aspire to the development of learning functions above the stochastic level. An important added advantage would be the removal of many of the ideological dangers which attach so naturally to any large-scale educational application of principles of infrahuman learning. If educators accept a method, can they reject its psychological basis? The humanistic answer, in the instance of programmed instruction, is that they must do so.

Administrators, particularly at the university level, must be on guard against phenomenal claims regarding instances in which freshmen or sophomores have reached examination

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[11]John F. Feldhusen, "Taps for Teaching Machines," Phi Delta Kappan, XLIV (March, 1963), 267.

[12]McNeil, "Great Didactic and Automated Teaching," op.cit., p.567.

criteria in certain courses via programmed instruction in as little as two months.[13] The higher the level of education, the more trivial is the role of rote learning. This is not to ignore in any way the fact that greater efficiency than is presently apparent is possible in the university system. Independent study plans at universities have demonstrated marked reduction of time in class without automated programs.[14] With automated programs, E.E.Ellert reports that 75 to 87 per cent of students taking German at Colorado State University scored 100 per cent in examinations.[15] This result can only be described as "phenomenal".[16] The achievements of programmed learning, however, demonstrate not so much what the university has been failing to accomplish as what its examinations have been failing to measure.

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[13] Pressey, "Teaching Machine (and Learning Theory) Crisis," op.cit., p.4

[14] Ibid.

[15] "Programing Instruction in German," (Editorial) Phi Delta Kappan, XLIV (March, 1962), 249.

[16] Whether the addition of the statement that only 29 to 42 per cent of students in a conventional class scored 100 per cent adds anything to one's wonder at this phenomenon depends on whether one holds conventional views about the discriminating power of examinations or has applied the "errorless" philosophy in the field of educational measurement!

Schramm has conducted an efficient survey of the salutary achievements of programmed instruction.[17] He points out the wide range of levels at which it has been used — from preschool to graduate professional school, and from slow learners to superior students. He cites examples of its successful use in teaching rote learning, paired associate learning, the application of formulas, the construction of deductive proofs, the formation of generalized concepts, and a multitude of language skills. These types of learning have been taught over a wide range of the curriculum including mathematics, natural science, English Grammer, spelling, and foreign language.

The objectivity of the physical sciences would seem to give them special adaptability to programming. This study has observed, however, the particular difficulty which the program encounters whenever there is more than one way to solve a problem. That programming seems to have demonstrated great potential in the objective aspects of languages and other subjects which can be verbalized is a matter of considerable note. Programs which incorporate visual aids have extended

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[17] Schramm, op.cit., pp. 45-51.

this potential beyond the strictly verbal medium.[18]

In summary, it may be concluded that whatever can be <u>objectified</u> can be programmed, and probably successfully as gauged by <u>objective</u> outcomes. There is, however, no way to objectify for public scrutiny any student's subjectivity. This must remain the "ghost which differentiates the human 'machine' from all other machines."[19] The inner side of life, with its purpose, imagination, and judgment; its values, principles, and ideals; its conscience, steadfastness, and love; will undoubtedly remain always accessible only to another human being who shares it through the medium of physical presence.[20]

The most important contribution which programmed learning has made to education to date is that it has reminded educators to think of <u>teaching</u> and <u>learning</u> as different aspects of the same miracle. It has stimulated both objective and subjective research into the wonder and mystery of this miracle. It has assisted in demonstrating

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[18] Grosvenor C. Rust, "Programmed Instruction for Transfer to the Real Life Situation," <u>Phil Delta Kappan</u>, XLIV (March, 1963), 273-7.

[19] Broudy, <u>op.cit.</u> p. 244.

[20] The distinction might be likened to that which Martin Buber makes between his two "primary" words: his "I-Thou" and his "I-it." <u>I and Thou</u> (New York: Charles Scribner's Sons, 1958), p. 3.

the difference between at least two distinct kinds of learning process, which can be equated with Galanter's stochastic and recursive mechanisms. A study of these mechanisms has provided evidence that—just as infrahuman learning is primarily, if not totally, stochastic—human learning is primarily recursive.[21] Programmed instruction has demonstrated that it is capable of teaching via the stochastic mechanism and, in so doing, it has served to direct the teacher towards making better use of recursive activities in teaching the utilization of higher mental faculties.

The science of conditioning, having little place for values in its materialistic determinism, has served to direct the teacher towards the very highest goals of education, those of developing character and personality through the teaching of noble human values. Teaching machines, by demonstrating the sterility of overly partitioned education, have perhaps brought home to the teacher more strongly than ever the importance of using discussions and other group learning activities in which the environment is conducive to

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[21] This might be suspected on other grounds. It offers, for example, a very plausible explanation of the fact that a chimpanzee, which is nurtured from birth in an environment identical to that of a human child, performs learning tasks apparently superior to those of the child during the first few months,—i.e. before the child has acquired the language and other symbols which are the tools of recursive thought. (Morgan, op.cit., p.41

the wholesome interpersonal relationships which are the cement which holds social structures together. In short, thus far programming has done very little except good in the field of education.

The contributions which programming will make in the future, or the hazards which it may impose, are beyond the scope of accurate prediction. They will depend upon the ingenuity, wisdom and caution of teachers. It is the position of this thesis that as long as programmed instruction remains lodged on a foundation of conditioning it will be incapable of fostering insightful or other recursive learning experiences in any but an incidental way. Once freed from these rudiments, and rooted in the firmer soil of strictly human experience, knowledge, and experimentation, it may adequately fill roles far beyond those which can properly be undertaken by today's programming media. The present caution which is being exercised by educational administrators in exploiting programmed instruction inspires confidence that if it is found to have a prime role in education, they will find a way to place it in that role without impairing the teacher's devotion, imagination, and enthusiasm,—factors which, after all, are the chief determinants of the success of any of the tools which the teacher uses.

APPENDIX "A": EXTRACT FROM "AN ANALYSIS OF BEHAVIOR"

How to Use the Book

The material was designed for use in a teaching machine. The teaching machine presents each item automatically. The student writes his response on a strip of paper revealed through a window in the machine. He then operates the machine to make his written response inaccessible, though visible, and to uncover the correct response for comparison.

Where machines are not available, a programmed textbook such as this may be used. The correct response to each item appears on the following page, along with the next item in the sequence. Read each item, write your response on a separate sheet of paper, and then turn the page to see whether your answer is correct. If it is incorrect, mark an "x" beside it. Then read and answer the next question, and turn the page again to check your answer.

Writing out the answer is essential. It is also essential to write it *before* looking at the correct answer. When the student, though well-intentioned, glances ahead without first putting down an answer of his own, he commits himself to only a vague and poorly formulated guess. This is not effective and in the long run makes the total task more difficult.

It is important to do each item in its proper turn. The sequence has been carefully designed, and occasional apparent repetitions or redundancies are there for good reason. Do not skip. If you have undue difficulty with a set, repeat it before going on to the next. A good rule is to repeat any set in which you answer more than 10 per cent of the items incorrectly. Avoid careless answers. If you begin to make mistakes because you are tired or not looking at the material carefully, take a break. If you are not able to work on the material for a period of several days, it may be advisable to review the last set completed.

The review sets will help you to find your weaknesses. When you miss an item in a review set, jot down the set number given in the answer space and review that set after you have completed the review set.

Conventions

Observe the following conventions:

1. The number of words needed to complete an item is indicated by the number of blanks. Thus "__" indicates a one-word response, whereas "__ __" indicates a two-word response. When asterisks (* * *) are used in place of blanks, fill in as many words as you think necessary to respond to the item.

2. The abbreviation TT calls for a technical term. When it is used, a nontechnical word is incorrect.

3. There are often several reasonably equivalent responses, and it would be a waste of time to list them all. This is particularly true when the response is nontechnical. Use reasonable judgment in deciding whether your response is synonymous with the printed form. Score it correct if it is.

JAMES G. HOLLAND
B. F. SKINNER

Set 7

PART II Operant Conditioning: Elementary Concepts

Introduction to Operant Conditioning

Estimated time: 8 minutes

Turn to next page and begin

when (if, after) 7-4	Reinforcement and behavior occur in the temporal order: (1) ____, (2) ____. 7-5
deprived of food (hungry) 7-9	If an animal's response is not followed by reinforcement, similar responses will occur ____ frequently in the future. 7-10
natural (non-deliberate) 7-14	Food is not reinforcing unless the animal has first been * * * food for some time. 7-15
reinforce 7-19	In laboratory research, various devices are used to reinforce responses. Heat can be used to ____ the responses of a cold animal. 7-20
response (behavior) 7-24	The response of pressing a bar must be emitted at least once in order to be ____. 7-25
less frequent (become extinguished) 7-29	*No* eliciting stimuli are observed for bar pressing, flicking leaves in the park, etc. Therefore, responses of this type * * * classified as reflex behavior. 7-30

	Performing animals are sometimes trained with "rewards." The behavior of a hungry animal can be "rewarded" with ____. 7-1
(1) behavior (2) reinforcement 7-5	Food given to a hungry animal does not reinforce a particular response unless it is given almost immediately ____ the response. 7-6
less (in-) 7-10	To make sure an animal will perform, the trainer provides ____ for the response frequently. 7-11
deprived of (without, hungry for) 7-15	Reinforcing a response produces an increase in the ____ that the response will occur again. 7-16
reinforce 7-20	An electrically operated food magazine which presents food can be used to reinforce a(n) ____ of an organism deprived of food. 7-21
reinforced 7-25	Since no eliciting stimuli are observed for such responses as flicking leaves or bar pressing, we *cannot* say that these responses are ____ by stimuli, as are the responses in reflexes. 7-26
are not (cannot be, will not be) 7-30	**End of Set**

food 7-1	A technical term for "reward" is reinforcement. To "reward" an organism with food is to ____ it with food. 7-2
after 7-6	Unlike a stimulus in a reflex, a reinforcing stimulus * * * act to elicit the response it reinforces. 7-7
reinforcement(s) 7-11	A hungry pigeon in the park flicks dead leaves about with quick movements of its beak. This behavior is ____ whenever it uncovers bits of food. 7-12
probability (likelihood, chances) 7-16	We do not observe "probability" directly. We say that a response has become more probable if it is observed to occur more ____ under controlled conditions. 7-17
response 7-21	If the cold (or food-deprived) organism turns on an electrically operated heat lamp (or food magazine), the response of turning on will be ____. 7-22
elicited 7-26	Responses such as bar pressing, flicking leaves, etc., are said to be *emitted* rather than *elicited* since there * * * (are or are no?) observed eliciting stimuli. 7-27

reinforce 7-2	*Technically* speaking, a thirsty organism can be ____ with water. 7-3
does not (will not) 7-7	A reinforcement does not elicit a response; it simply makes it more ____ that an animal will respond in the same way again. 7-8
reinforced 7-12	A pigeon is occasionally reinforced for flicking leaves about because of the common natural arrangement of leaves over ____. 7-13
frequently (often) 7-17	When a response has been reinforced, it will be emitted ____ frequently in the future. 7-18
reinforced 7-22	The response of turning on the electrically operated heat lamp or food magazine will be emitted more ____ in the future if the organism is cold or hungry. 7-23
are no 7-27	If pressing the bar does not operate the food magazine, the response * * * reinforced. 7-28

reinforced (NOT: rewarded)	7-3	The trainer reinforces the animal by giving it food _____ it has performed correctly.	← To p. 41	7-4
probable (likely)	7-8	Food is probably not reinforcing if the animal is not * * *.	← To p. 41	7-9
food (seed, insects, reinforcers)	7-13	The reinforcement used by animal trainers is deliberately arranged, while the arrangement of leaves and food in the park is * * *.	← To p. 41	7-14
more	7-18	To get an animal to emit a response more frequently, we _____ the response.	← To p. 41	7-19
frequently (often)	7-23	In a typical apparatus, the depression of a horizontal bar automatically operates a food magazine. The apparatus selects "bar pressing" as the _____ to be reinforced.	← To p. 41	7-24
is not (will not be)	7-28	Reinforcement makes responses more frequent while failure to receive reinforcement makes responses * * *.	← To p. 41	7-29

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