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ABSTRACT

Research in instructional media needs to relate itself to research in other fields, e.g., human development, individual differences, and information processing, being nourished by other theories and in turn nourishing them. Thus it needs to deal with the functions of stimuli, laying the foundations of a prescriptive theory that concerns itself with the relationship between how things are presented and how they are learned. Research questions must be formulated in terms of the interaction between stimuli and cognitive functions. The hypothetical stimulus dimensions suggested here might lead to the formulation of theory-oriented research questions. The first dimension--the amount of information or response uncertainty--is superordinate to the others and should provide answers to the general question of how much motor, observational, perceptual, or conceptual activity is undertaken by the learner. The second--the explicitness of presenting information to be learned--ought to indicate how much specific mental activity takes place as a result of exposure to a certain kind of stimulus presentation by a particular learner. The other dimensions--the distance between the mode of presentation and the learner's level of mental development and the activation of specific operations as a function of stimulus structure--answer the question of what mental operations are called for by different kinds of stimuli and which are prerequisite to extracting information from them. [Not available in hard copy due to marginal legibility of original document.] (JS)

What Does It Do to Johnny?

A Cognitive-Functionalistic View of Research on Media

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June, 1969

A. A Theory of Stimulation

In the present paper I shall take the view that sound research in instructional media needs to fulfill at least three conditions.

(1) Research on media needs to generate a framework of valid questions to be asked. Questions which are interlocked with other questions and which are based on valid assumptions provide guidance and direction to research. A question is an ambiguous proposition (Langer. . . .). The way it is stated, the assumptions it implies, and the context in which it appears makes the answer have more or have less scientific import. Too many of the questions which were traditionally raised in the field of research on media were based on erroneous assumptions, or undefendable grounds, and hence led to invalid answers (Mielke, 1969).

(2) Research on media needs to be closely related to research in other areas like human development, individual differences, information processing, etc., and become part of them.

Unfortunately, most research in media as we know it is quite unrelated to any of the better established areas of research, as if implying that media research is a new field or a new discipline requiring an independent and unrelated place in the world of scientific inquiry.

(3) The third condition is that research be done in a theoretical framework. This point is complementary to the preceding one and means that our research conceptualizes rather than just tests new devices and novel modifications.

The ultimate goal of research is understanding. Without this we have a mere accumulation of devices and "significant differences" which add up to very little. This is the case because we don't know why something works and why something does not work.

Here, following Flexner (1925, p. 1; quoted by Cronbach, 1966, Stensil) we may distinguish between pure empiricism and scientific inquiry.

> . . ."the line between an empirical and a scientific observation is not always so clear. That quinine cures malaria, that sunlight cures rickets, that morphine quiets pain, that mercury cures syphilis--these observations, being correct, may as such be termed empirical or scientific at will. A real difference can be made out only at the next step. Empiricism does not penetrate more deeply, is not solicitous as to limitations -- in other words, gets no further. The very soundness of an observation challenges the scientist; he is not content with a fact; he asks why, and how far. The scientist is therefore at once modest and active --conscious of the narrow limitations of achievement, seeking to establish larger and surer combinations, while the empiricist, practising his rule of thumg, works disjointedly and tends to remain, in reference to any particular practice or observation, just where he is."

This statement appears to be very relevant to what is needed today, by way of change, in the field of media research.

It implies that we divorce ourselves from the immediate application, which was our major focus until recently, and concentrate instead on laying the foundations for a theory of stimulation. To echo Cronbach at this point, the only practical approach, for us, is to search for interrelated explanatory principles (1966).

Now, what is this theory of stimulation, I am talking about? Bruner (1961) who originated this terms, subsumes it under the wider label of a theory of instruction. This theory, as Bruner claims, needs to be prescriptive, rather than descriptive; it concerns itself with the relationship between how things are presented and how they are learned.

When we speak of a theory of stimulation we have in our minds the optimal arrangement of external stimuli, which can be controlled and managed. It can also provide explanations of the interactions between learner and stimuli. We thus search for some optimal matches between kinds of stimulation and educational outcomes. This, however, is more complicated than it seems. Previous attempts to prescribe such matches (e.g. Gagne, 1965) were not very successful because there were no psychological justifications to pair certain modes of presentation with certain educational outcomes. Two factors contributed to this deficiency: (a) to find psychological justifications for matching say, pictorial presentation with certain kinds of learning requires, by necessity, the analysis of mediating processes within the individual. (b) Once the analysis of mediational activity takes place, inter-individual and intra-individual differences need to be considered and the search for some universal simple rules of matching becomes impossible.

Since, however, a theory of stimulation can not be constructed without the search for specific stimulus-learner-task matches, there is a clear need to turn to contemporary psychological inquiries into cognition. However, to establish such a change, questions must be formulated in terms of the interaction between stimuli and cognitive functions.

B. A Cognitive-functionalistic View

Given that our research is theory-oriented, it does not only predict and control. It attempts, in addition, to explain. It is now common practice in nearly all branches of behavioral science to ask not only what goes with what, and under what conditions does x take place, but also why these phenomena occur. This, I think, is common to nearly all researchers: The The neoassociationistic school (e.g. Berlyne, 1960, 1965), the verbal-learning research (e.g. Mandler, 1967; Lennenber, 1969) the paired-association research (e.g. Bower, 1968), and, obviously, research in the Piagetian tradition. Once there is an attempt to explain, there is an inevitable need to enter the "Black box".

Attempts to study mental processes are as old as psychology itself. However, unlike attempts in the past, more recent ones are aided by advanced methodologies and tools of inquiry which enable the researcher to bring mediational activity under his control (Glanzer, 1967).

Contemporary researchers become more and more concerned with the <u>functions</u> of stimuli, conditions, instructions, etc. They do not ask "what is it", but rather: "What does it do to the subject?" "What is the psychological situation we create? " Asch (1969), to provide one example, writes: "Given the operations of relating, it follows that the nature of the psychological stimulus is the first problem in the study of learning and memory. It is necessary to distinguish between the external and psychological stimulus conditions. Activities of relating have their correlates in objective conditions, but they are not a copy of these conditions" (p. 97).

We become more and more aware of the fact that the physical stimulus, taken alone, accounts for a very small portion of the response domain. The same stimulus is differently perceived, decoded, processed etc. by individuals who differ on a number of relevant dimensions. Thus, the way they covertly handle the stimulus may have more influence on the way they overtly respond to it than the physical stimulus itself. We thus deal with a conception of human behavior which is best characterized as a three (instead of two) stage process:

S - r - R

where the stimulus (S) is responded to by covert processes (r) which in turn lead to the final response (R). Some interesting research procedures have been worked out in recent years to study mediating processes in a more direct way than was possible in the past.

My argument is as follows: if we do not know what a stimulus is expected to do to Johnny, why it should effect him and in what ways, we shouldn't be astonished to find insignificant results (both in the statistical and the theoretical sense). One can understand the psychological function of a stimulus only if it is analyzed in the same terms used to describe the mediating cognitive behavior. This point has been discussed in detail elsewhere (Salomon and Snow, 1968). Suffice it to say here that by dealing with stimuli and responses as belonging to the same nomological network, as Beiri (1962) recommends, one can account for more response variance with a reduced number of stimuli. Such an approach would be called cognitive because it makes reference to covert processes, i.e., to adaptive actions upon objects, or to the internalization of such actions. The approach is functional because it refers to the roles that stimuli and responses play in the interaction between learner and environment.

This seemd to be the emerging trend in educational psychological research today, and I think that research in media should link itself to it. The questions asked must come from those cognitive-functionalistic theories and lead to a new theory of stimulation which nourishes and is in turn nourished by these theories.

C. Media—from a cognitive functionalistic point of view

At this point, one would justifiably raise the question of what is media? We have opposing views ranging from McLuhan — The Medium is the message, to Carpenter (1968), who states that ". . .it is the content of the stimulus material (in psychological terms) and its very special value for the individual learner that is important and not the particular carrier of the information" (p. 236).

Scattered observations can be provided to support equally well both premises. Yet, I think, it is difficult to deny that extracting information from, say, maps calls for a different set of mental processes than extracting information from a photograph of the same terrain. It is not unreasonable to expect that the ways messages are shaped do require different strategies of approach on the side of the learner. Thus, stimuli which share the same essential shapes may call for arouse a common core of mediating responses. For instance, a graph, (actually all graphs) would require of all learners to transform spatial relations into temporal ones, or one spatial relation into another; motion pictures seem to require certain kinds of inferential thought, etc. Yet, it is unreasonable to claim that all stimuli which share some common structural elements tend to arouse, as a universal rule, the same information processing activities. Would such a clear correspondence exist, then there would remain no place for differences due to messages or due to individual aptitudes.

The conception of a medium must consequently be quite complex. We define a medium as the overlapping area of two circles; the stimulus-attributes circle, and the response circle. When various stimuli have common structural attributes which do not call for common cognitive responses, they cannot be said to constitute a medium. However, when such stimulus attributes call for a common core of mediators which is clearly different from the core of mediating responses called for by stimuli who share other attributes, then, and only then, can we speak of a "medium". If, for instance we found that as Pryluch (1969) suggests, films typically call for particular kinds of inference drawing, which require some degree of "film literacy," then we'd be able to speak of the medium of motion pictures.

~~Obviously, though, there will be many responses aroused~~ in addition to this common core. These cannot be attributed to the nature of film medium. Similarly, there will be unique stimulus attributes which do not arouse unique cognitive responses. Thus, the common stimulus shapes which do not ~~overlap~~ correlate with common responses are then conceived of as nonfunctional, and the responses which are not in the overlapping area can be attributed to the specific content and to individual differences.

However, there is a clear difference between the cognitive processes aroused by a stimulus, and their relevance to learning of a specific nature by a specific learner. This means that unique effects on learning will be observed only when the medium attributes under examination have a central function (Pryluck and Snow, 1967). In other words, when they are relevant to the learning of X by Y.

Here, then, we introduce two new factors which have little to do with media as the sole function of common shapes of messages: These are the learner and the task.

Once we introduce these factors the following occurs:

(a) We move away from the controversy of medium vs. message, since if a certain attribute is cognitively relevant only for certain people under certain task requirements, what sense does it make to deal with the medium alone?

(b) We concentrate on the triangle: learner, task-specific-processes, and stimulus.

(c) The stimulus which we study is viewed as doing something to the cognitive process of somebody under certain motivational and instructional conditions, regardless of whether it is considered a message, a medium ~~or a channel; whether it is a sign, sign vehicle or a signal.~~

It has been claimed in the past (Salomon and Snow, 1968) that the use of a certain stimulus attribute will have a learning effect only if it arouses or supplants mental processes which are relevant for a certain learner, to accomplish a certain task. Several studies (e.g. Festinger and Maccoby, 1964) can be taken as support for this contention. But this approach produces some very difficult questions:

(a) What is the difference between arousing and supplanting mental processes?

(b) When is either desirable?

(c) How does such inquiry support the construction of a theory of stimulation?

I will return to the two first questions a bit later. At present, I will deal with the third question only. It appears that even if research does ask the question -- "What does it do to Johnny and what is it good for" -- but deals with discrete attributes of stimuli, we are still far from laying any foundations for a theory of stimulation. Studying the cognitive functions of discrete attributes may offer some generalizable principles but these principles can not be interrelated. The degree of empiricism, to use Conant's term (1964), will not be reduced much.

To come closer to interrelated principles we need to raise a general question from which secondary, but interrelated questions can be deduced.

Second, and here I elaborate on a point I made earlier, we have to generate several general dimensions of stimuli in a way that relates them to cognitive dimensions. Thus, we move away from studying discrete functional attributes which can not be interrelated. The general stimulus dimensions are constructed to provide answers to the questions, not the other way around. We first ask: what do we want our learner to do? And then we ask, what general, and theoretically understood stimulus characteristics will serve us best? This view does not oppose other valuable routes to the study of media. For instance, the approach which begins with the study of a new medium's potentialities and moves, as a result, to ask "what can it be used for?" is certainly complimentary to the view advocated here.

D. Stimulus Dimensions for Research

I would like to suggest at this point examples of researchable questions which are rather general. The focus of those examplars is in what the learner does, or better: what we want him to do. To provide answers to these questions, stimuli can be analyzed along numerous dimensions which are interrelated in an hierarchical way.

The general question to be asked is as follows:

> How much mental activity, and of what kind, need our stimuli promote in a specific learner given a specific instructional objective?

This kind of a question is not really new and writers like Gagne (196?), Briggs ( ), Lumsdaine (1963), and others have implied it in one way or another. However, the stimulus dimensions used to provide an answer were mainly technical ones (e.g. color, movement), and thus, did not suggest any cognitive implications. Sometimes the studied attributes were functional but much too specific (e.g. overt or covert responding, degree of structure, rate of presentation, etc.), and hence did not lend themselves to interrelating observations. Given that state of affairs, no theory of stimulation could have possibly emerged.

The stimulus dimensions to be suggested here fulfill the following conditions:

(1) These dimensions deal simultaneously with stimuli and cognitive processes. Thus, the analysis of a stimulus immediately suggests its cognitive-functional ramifications.

(2) The dimensions are applicable to a very wide variety of stimuli with a wide variety of contents, and they seem to preserve themselves and their interrelations intact whatever the subject matter.

(3) Research along these dimensions, though it may become rather complex, can lead to a theory of stimulation, because underlying each dimension are numerous constructs and principles which can be interrelated.

The stimulus dimensions to be discussed in the second part of this paper are obviously examples of what can be done. They certainly do not exhaust all the functional potentialities of stimuli, nor do they necessarily capture some of the most complex interactions between stimulus attributes.

1. The first dimension is superodinate to the others. The other dimensions are thus subsumed under it in an hierarchial order. The construction of this dimension is based on the most fundamental function of stimuli: to inform, that is, to reduce uncertainty. I~~'d~~ would call it the information-uncertainty dimension. It should provide answers to the general question of how much motor, observational, perceptual or conceptual activity is undertaken by the learner. The provocation of intelligent activity is contingent upon the amount and intensity of uncertainty reducing or uncertainty increasing

stimuli (Berlyne, 1960, 1965). It is therfore fair to suggest that a stimulus dimension which analyzes stimuli along this dimension should supercede any other dimension.

2. The second order of stimulus dimensions ought to answer the general question which follows from the first one, namely: How much specific mental activity takes place as a result of exposure to a certain kind of stimulus presentation, by a particular learner. In more prescriptive terms it would be stated as: how do we construct the stimulus so that specific mental activities will be aroused and utilized in a certain learner. There may be numerous stimulus dimensions with which such a question could be answered. Two dimensions are suggested at this point, although it is possible that more than two can be constructed. These are: (a) the degree of explicitness with which mental activities are presented, and it concerns itself with what the learner has to provide as compared with what we do for him, overtly or covertly; (b) the psychological requirements of different modes of presentation in relation to the general developmental stage of the learner (in particular as inferred from Piaget's work).

In the first of these two dimensions we deal with questions of organization, simulation, discovery, aided recall or in short, with the devision of mental labor between stimulus and learner. In the second dimension we deal with questions of conceptual development as related to stimulation, thus with the sequencing of stimulus shapes to improve general mental development.

3. On an even lower level of generality, and subsumed under the former dimensions, are other dimensions which answer the question of what mental operations are called-for by different kinds of stimuli and which are prerequisite to extracting information from them. Here we handle questions of pictorial vs. verbal presentation, graphs vs. pictograms, programmed instruction vs. prose, etc.

~~Both~~ The proposed dimensions and the suggested hierarchial order in which they appear are to be taken as examples of what can, and possibly should be done. The ultimate test of these stimulus dimensions is their utility in guiding theory-oriented research in media and they may be retained as long as they fulfill that function.

1. <u>The amount of information or response uncertainty</u>

This dimension has received increasing attention in the ~~litature.~~ literature. Yet, in spite of a vast number of studies related to information-theory, "Filter" theory (Broadbent, 1968), etc. very little has been done in terms of interrelating observations. Let me try to conceptualize what this dimension means and to what it applies.

First, what is "information" and what is "response uncertainty"?

Amount of information has been defined and redefined in various ways since Shannon and Weaver's initial publication. Generally, information is conceived of as that which reduces chaos, entropy, lack of order, unpredictability, etc. That is information as perceived in information-theory terms. There are however some recent attempts to translate this conception into psychological terms (Broadbent, 1958; Berlyne, 1960, Garner, 1962) -- emphasizing mainly the subjective experience of uncertainty.

There is now much evidence to show, as Berlyne notes (1965, p. 8), that the effects on behavior of a stimulus-situation belonging to a certain class depend on what <u>other</u> kinds of stimulus situation might have been expected to occur instead, and how subjectively probable each of these stimuli was. In other words, a person enters a situation with a set of responses which are at the fore, or on "stand by". It is quite obvious that we do not bring to bear upon each stimulus that we encounter all our symbolic or motor responses. Some selection takes place prior to encountering the stimulus and we call this the person's "set", "predisposition", "expectation", etc. Very often we create these with advanced organizers, pretest questions, use of labels, or by relating the stimulus-to-come to previous stimuli.

The number of responses at the fore, the degree to which they disagree with each other, and their relative strength define our degree of subjective response uncertainty. The larger the number of responses which are brought to bear upon the stimulus situation, the larger the disagreement between them, and the more equal their relative strength -- the higher is our response uncertainty. Here, as ~~you~~ the reader will note, the number of responses on "stand by" defines, in a sense, the population of alternative events, and the relative strengths of these responses is analoguous to their relative probability, as conceived of in information-theory.

The stimulus itself, which we encounter, is informative, or contains information, to the extent that it changes this state of uncertainty. Note that I do not say that the stimulus reduces necessarily the uncertainty because it can increase it as well. How does the stimulus function?

(i) The stimulus can increase or decrease the number of responses at the fore.

(ii) It can change their relative strengths.

(iii) It can swamp them by arousing an entirely new response, previously not included in the set; or it can lead to the integrationof some responses, originally considered to be incongruent, by arousing a third response which reconciles the incongruity.

When we are in a hotel room in a strange city where ~~we have~~ there is no person we know and the phone rings, we may encounter quite a bit of response uncertainty. Who, on earth, could pay us a call? The ringing phone is informing us about something, but it does not reduce our uncertainty. It arouses it. Once we hear the operator telling us that it is a long distance call from our office, information has been transmitted again. This time, however, it reduced our uncertainty significantly. Thus, a stimulus can increase uncertainty by increasing the number of competing responses at the fore, by making an originally dominant response to become less dominant, etc. It is information since it changes our state of uncertainty, but this information is not the same as the information which decreases uncertainty. The latter is positive information while the former is negative information.

For a stimulus to be positive information some uncertainty must precede it; e.g. the person has a general, but not accurate idea of what will take place; he has a very vague notion; he knows exactly what will happen but then it turns out that the stimulus surprises him (it is not what he really expected); or -- he is completely unprepared for the stimulus. In all the above cases the stimulus will be regarded as containing positive information to the extent that it reduces the uncertainty. But if positive information is contingent upon the prior existence of uncertainty, then some stimulus must have contained negative information previously.

Stimuli that arouse, rather than reduce uncertainty have been thoroughly studied by Berlyne (1960, 1965). He theorized that stimuli which are novel, surprising, complex, ambiguous, etc. and which he termed as having "collative variables", induce a state of subjective response uncertainty. In the case of all these stimuli there is a discrepancy between incoming information and stored information. In terms of what I have tried to state earlier we'd say that there is a disagreement between what is encountered and the set of responses brought to the fore. The person needs to "collate" the incoming information with existing information, very often searching for additional information, reconstructing available information, etc.

Numerous phenomena which have been recently studied can be conceived of as illustrating cases of positive or negative information. Underlying the work of Broadbent, Bruner, Kagan, Ausubel, Rothkopf, and many others, you will find the existence of choice between response alternatives, or the external reduction of them. Take, for instance the case of the two-channel input. The major problem there is that of the informational relations between the various inputs. Does the second input add any information in the sense of reducing already aroused uncertainty? Or does it rather lead to occlusion, to overload, and thus becomes negative information? (Conway, 1968). Treisman (1969) in a very interesting article points to different strategies of attention. There also, the underlying theme is choice. It is choice between "analyzers", outputs, inputs, or tests. The same idea seems to underly other situations, e.g. difficulty of problem-situation as studied by Bruner ("cognitive stress"), or stimulus complexity as studied by Streufert et al. (1967).

The amount of uncertainty we induce or remove through our stimuli has some very important implications for learning. Let me summarize these briefly.

(a) The arousal of uncertainty, that is, the experienced conflict between alternative symbolic responses, complexes of responses etc. is motivating. It motivates the search for additional stimuli which promise to reduce uncertainty. On a motor or perceptual level this is exploratory behavior; when conceptual uncertainty is experienced it is epistemic exploratory behavior. Both imply curiosity. Search for additional information from external or internal sources, restructuring of information, injection of stored information and modifying it -- all these result from uncertainty. The specific nature of the activity the learner undertakes depends, however, on the specifics of the kind of uncertainty he experiences.

Here, for instance you have a typical observation:

Insert Figure 1

amount of information search increases as a function of aroused uncertainty. When too little uncertainty is experienced (one faces boredom) negative information is sought. The person searches for problems to solve, situations to cope with, etc. When experienced uncertainty exceeds a minimal level of comfort, positive information is sought so that uncertainty is lowered again. While, however, one can predict what kinds of information will be sought in the case of increased uncertainty, it is rather difficult to predict what information will be taken in in a state of boredom. After seeing the film "8½" people engaged in exchanging information about the main message of the film, and one could easily predict this. But what information are school children after when they see one of the much-to-common instructional films?

It is still an open question whether people attempt to reduce response uncertainty as a kind of drive reduction or not. It is not unreasonable to hypothesize that the process of uncertainty increasing and reducing is the source of gratification. People engage themselves in ludic behavior, thus exposing themselves to negative information (you wouldn't chose an inferior chess player as an opponent) only to derive satisfaction from the process of reducing this uncertainty.

In short, aroused uncertainty motivates curiosity, information intake and processing. Devices like doubt, contradiction, humor, surprise, ambiguity, etc. can lead to this increased curiosity. However, advanced organizers, pre-structured stimuli, arrows which point to what should be attended to, verbal directions, differential coloring, etc., -- reduce uncertainties.

(b) Uncertainty is not at its peak with maximum ignorance. As at least two studies show (Sieber and Lanzetta, 1966; Salomon, 1968) -- one needs first to study a stimulus, to perceive the ambiguity, complexity or novelty in it before he begins to generate alternative responses and become curious. Thus, using so-called familiar situations with some element of surprise, ambiguity or complexity in them ~~has been shown~~ is claimed to be more curiosity arousing than a completely novel situation (Charlesworth, 1969), because the learner can generate alternatives in the former case and not in the latter.

(c) The arousal of curiosity is not the only thing we're interested in. For one thing, surprise -- to take one example --disrupts ongoing cognitive operations and leads to more concentrated attention. This disruption has its positive merits in certain situations but may be disadvantageous in others. This may depend to a large extent on the task to be performed. The attention-catching elements in a stimulus may arouse task-irrelevant uncertainty in the learner. For example, the proof reader who is confronted with a shocking text, and searches for task-irrelevant information.

A Bergman film can arouse uncertainty as to its general meaning, thus induce thought processes related to this problem. At the same time it can reduce uncertainty as to the ways people dressed in the past in Sweden.

Would we want to arouse though processes concerned with dresses we~~'d~~ would prefer a more straight-forward film. One can hypothesize at this point that for effective learning to take place, the stimulus needs to arouse uncertainty about these ~~things that we'd like our learner to deal with.~~ It should reduce uncertainty about things which are irrelevant to the main issue to be dealt with. Fancy shooting techniques in a TV show may be quite exciting but they may interfere with learning when they arouse task-irrelevant uncertainty.

Archer (1962), to take one example, found that when the relevant information was also obvious, concepts were easier to discover. When however, the irrelevant information was obvious, the attainment of concepts became much more difficult. He suggested that when the learner's attention is drawn to irrelevant information (a source of irrelevant uncertainty) he attempts a solution involving wrong information, or the wrong mental processes. In another study (Salomon and Sieber, 1969) conceptual uncertainty was aroused. Ss were induced to think how to relate unorganized pieces of a filmed story. This induced process was highly relevant to the generation of hypotheses. It interferred with recalling details. On the other hand, providing a film in which the story easily suggested itself, aroused only a relevant kind of uncertainty. Namely, that which was associated with the recording of details (figure 2).

Insert Figure 2

(d) Our main purpose, though, is to lead to some durable cognitive changes. According to Piaget's conception of equilibrium between accommodation and assimilation, a cognitive change takes place when the learner faces a situation which calls for a modification of his existing cognitive network (Hunt, 1968). This sounds very much like the process of response integration which results from encountering a problematic situation, as discussed by Mandler (1967). Thus, learning takes place when the equilibrium is disrupted and when a change is required. Berlyne's notion of uncertainty and Piaget's formulation of equilibrium seem to be rather congruent. A stimulus is information when it changes the number, composition or relative strength of the responses brought to the fore. There is learning when the change is assimilated into the system for later use.

Thus, to cause a durable change in cognition, uncertainty needs to be aroused, or the equilibrium needs to be disrupted. How much uncertainty needs to be aroused? Although we know too little about it, learning will take place only within a rather narrow band between too much and too little uncertainty, or between too much and too little accommodation (Kessen, 1966). (e) It is quite resaonable to expect different media to have the capacity of arousing different kinds, not necessarily different amounts, of response uncertainty. Maps will arouse an entirely different class of conceptual or perceptual uncertainty than films, but written material presented by means of a computer can not be expected to arouse different kinds of uncertainty than, say, a programed text.

To summarize what I've said about this dimension:

(1) We can study our stimuli in terms of the amount of uncertainty they arouse, leave or reduce in certain learners. Procedures to measure the amount of response uncertainty aroused by particular stimulus variables have been studied (Attneave, 1959; Garner, 1962; and others) and although still a far cry from what is needed, they can be used by researchers.

(2) We can predict the amount of curiosity we arouse, its nature and consequences.

(3) We can subsume under this construct a rather large number of studied phenomena ranging from the study of multi-channel inputs, incidental learning (Bower, 1968), through the study of negative and positive instances in concept formation (e.g. Hovland, 1952), to the study of humor, ambiguity, stimulus complexity and surprise (e.g. Birch and Rabinowitz, 1951; Charlsworth, 1969).

2. The explicitness of presenting information to be learned

The dimension of "information" deals with the information values of stimuli and thus may potentially handle the general level of mental activity, attention, curiosity, interference or even cognitive change which will take place in a learner. Subsumed under this wide category of relations between stimulus and cognitive activity is the question of the specific mental processes to be aroused, supplanted, or handled in other ways. It is assumed that different kinds of cognitive activity have their correlates in modes of stimulus presentation and can be affected by them. Here, then, we have to deal with the nature of information to be learned rather than with its amount.

Information to be learned is composed of events, signs and their transformations. These, we believe, can be stored, integrated, generalised and used as symbolic stimuli and responses of two kinds: situational and transformational, or as Inhelder (1969) calls them: figurative and operative aspects of cognitive functions. Situational symbolic responses are internalised representations of objects and events, or of responses related to them. Transformational responses are internalized representations of activities which modify, manipulate and transform the objects and events (Berlyne, 1965; Piaget, 1964).

Both kinds of symbolic responses can be gradually generalized so that they become less and less associated with specific objects, events, or activities ("operations" according to Piaget). They can apparently generalize to such an extent that groups of such mediators constitute a "strategy", "program", "coding system" or "mode of attack" with which the organism approaches a particular kind of problem (Bruner, 1957). Such a highly generalized chain of mediators guides the arousal and activation of other, more specific mediators, but it continues apparently to follow the same rules which govern the others: it needs to be acquired, generalized, stored, aroused, etc. (Miller, Galanter and Pribram, 1960). Symbolic responses of both kinds and of various degrees of generalization and applicability are then what we'd call the information to be learned.

It is generally agreed that stimuli used in communication can represent the objects and transformations to be learned. Moreover, the signals used in the act of communication can be signs and symbols which may correspond, or even be replicas of the covert symbolic responses. This happens to be the implicit assumption behind most acts of instruction. Whether we show how something is done, how something changes, develops or transforms, or whether we derive explicitly a mathematical formula, we seem to imply that overtly conveyed signals can be stored, integrated in a given system of responses, and be activated on a later date.

I subsume deliberate presentations of signals and operations under the dimension of "explicitness" because their underlying common element is the explicit demonstration of what would otherwise need to be done covertly by the learner himself, such that a certain learning objective will be attained.

Some instructional media, particularly those which provide so-called contrived experiences, seem to be uniquely suited to demonstrate overtly certain operations and transformations which have to be learned. Imagine a film which shows in a speeded-up fashion how soil erodes. This is, no doubt, a simulation of a transformation of soil. The learner who does not observe the film, and still has to attain the same concept, will have to execute the same operation in a covert, symbolic way. What the presentation does for him is to supplant the process, i.e. to do it for him in front of his eyes. An explicit explanation of a certain argument simulates on an abstract level the thought processes which went into it. Similarly, the presentation of a picture of a volcano to remind the learner of what was learned a week earlier, simulates the end result of the process of recalling the image.

This, then, is what I'd call explicitness of information. ~~However,~~ and there may be several degrees of explicitness. Explicitness could range from the most detailed simulation of the relevant covert transformations, like in the case of showing how a side view of a mountain gradually becomes a view from above (Hovland et al., 1949), through short circuiting a process (i.e. "skipping over it" as in the case where one provides the end result of a transformation without showing the transformation itself), to an attempt to arouse the mediators by providing the problem stimulus only.

There are two major assumptions which guide the formulation of this dimension:

(a) Symbolic responses, both situational and transformational, share the same mode of development; they develop from prolonged daily contact with concrete objects which are manipulated. Once they are internalized, they can assimilate increasingly more complex responses without the necessary overt manipulation of objects. As the child grows up he does not need to manipulate everything new he is to learn.

(b) Symbolic stimuli have a dual purpose: they are used in overt communication to affect a receiver's behavior, and they are used in a representational capacity to guide one's own behavior. The latter are the ~~symbolic stimuli or responses used for~~ ~~elf-stimulation, self-regulation,~~ as internal information, etc. From these two assumptions a third one can be deduced, namely:

(c) Symbolic stimuli used by one source can be (i) adopted and stored by the receiver for later retrieval, (ii) they can, in addition, be adopted and used as internal stimuli to stimulate <u>other</u> internal responses, provided that they can be assimilated into the system. This implies at least a two step process of learning a new transformation from an external source: first the storing of the symbolic transformation, and then its use as an <u>internal stimulus</u> (Mandler, 1967).

To be now more explicit about the idea of explicitness let us assume that a certain phenomenon begins with an initial stimulus (S_o), goes through certain transformations (r_{TR}'s) and ends with a new situation (R_o). Now we could present only S_o, S_o, and R_o, S_o-r_{TR}, without the R_o, or all three of them. From the point of view of explicitness they go from least to most explicit respectively (see the ordinate in figure 3).

The most explicit presentation, in the present example, simulates overtly a certain process or operation. The second most explicit presentation, S_o-r_{TR}--, requires from the learner to apply the presented operation to the stimulus situation so that he'll come up with R_o. Berlyne (1965) calls this a "transformation applying" behavior. If "meaning" of an event means, among other things, the recollection of transformations which lead up to it (Bartlett, 1958), then we simulate in this case, also the process of providing meaning to the final response. The somewhat less explicit presentation, where short-circuiting of the process takes place (S_0--R_0), requires the learner to generate various relevant transformations and to choose one among them. Here, we induce "transformation selecting" behavior. If the question of meaning is brought up, it becomes evident that the learner has to provide it. Finally, the three different degrees of explicitness can function in an arousing capacity (i.e. arousing the necessary operations), in an increasing order: from simulation which does quite a bit *for* the learner, to the presentation of S_0 only, which leaves everything *to* the learner.

Note, that my description pertains to what is being done to the mental operations. But it is immediately clear that what is being done overtly to the mental processes determines only to a very limited extent what actually happens to the learner. Stimulus attributes alone, as we ~~all~~ will know, ~~cannot~~ account for, and explain, only a limited amount of the variations among individuals in terms of learning. For one thing, the utility of different degrees of explicitness may be a function of the availability and the accessibility of the relevant responses to the learner.

The question to ask now is how explicit does our stimulation need to be such that a certain new response will be acquired, internalized and utilized? We could hypothesize right away that when an entirely new transformation is to be learned, it would be necessary to *show* at least *some* of its components. But we know, for instance, that basic concepts and operations, of the kind that Piaget studies, are very unlikely to be learned by means of their overt presentation. The major reason is, ~~apparently,~~ as both theory and research indicate, that the most basic concepts and operations develop through a wide array of daily experiences rather than through direct teaching (Kohlberg, 1968). Thus, when it comes to the acquisition of *very* basic concepts the most we can do is to simulate the end results of transformations, thus -- the resultant situations (S---R_o) and try to arouse some of the processes which lead up to them. The rest should then be left to the learner. This implies, by the way, that a film which attempts to teach kids what "distance" is by means of simulating the process of measuring with rulers, is not very likely to achieve its goal. It has been shown, for instance that only the stimulation of subordinate constituent processes can enhance the attainment of a more elaborate, superordinate, concept, e.g. Sullivan (1967) succeeded to facilitate the generalization of conservation through the use of film with 6-8 year olds. What he did, though, was to simulate overtly some of the necessary underlying operations, but not to simulate the target concept itself.

On the other hand, less basic operations, more specific behaviors, can be learned through simulation. Bandura's work is only one illustration. Moreover, simulation can be expected to facilitate the generalization of an already available operation, as when we show how something known applies to a new situation; or it can be used to avoid unnecessary effort on the side of the learner; e.g., when we don't think that he has to try and recall something but rather use material which we recall for him. Thus, we short-circuit the process of recall for him.

When the acquisition of relatively new behavior is involved, it becomes clear that an extremely overt presentation, which leaves nearly no uncertainty (or no needs for accommodation) to the learner -- is less facilitating than a somewhat less explicit presentation. In most of the studies where problem solving strategies were taught, or where the discovery of a rule was involved, two major principles appeared: the first was that the learner has to use what he observes before he can integrate it. The second principle was that he can do it only if the underlying processes are aroused.

Thus, it isn't just perceiving the overtly presented operations which leads to their acquisition and later use in new situations. McGuire (1957, quoted by Flanders, 1968) argues that the recipient of the communication needs, among other things, to act upon it. In more specific terms, the subject needs to be able to accommodate his system to the new operation (and again, accessive accommodation will not be functional). The subject needs at least to repeat overtly or symbolically the represented act. More likely, he needs to transform the overtly presented signs so that they will fit his system. But it is quite evident that one does not utilize overtly presented signs as they are given. For instance, verbalization of what was observed (repeating an act in a symbolic, though overt fashion) was consistently found to facilitate learning (e.g. Flander, 1966).

All said, there seems to emerge one rather important rule: the explicit simulation of processes needs to be transformed by the learner before it can be assimilated.

As to the interaction between explicitness of presentation and the learner's mastery of relevant requisite processes, some predictions can be formulated. (see figure 3).

Insert Figure 3

Although the least explicit presentation conveys, by our previous definition, very little information, it may contain just enough for a learner who is familiar with the problem. If some extension of his knowledge is required, he'll do it without outside help. The more explicit presentations will carry for him, increasing amounts of redundancy (as in the case where you explain a familiar joke). On the other hand, the student who does not have available to him the necessary requisite responses, will be over-aroused, if not overwhelmed by the least explicit condition. One would not expect ~~him to learn the overtly presented operation, even if it is very explicitely~~ shown. This expectation is in line with what has been said earlier with reference to learning which takes place within the narrow band between too much and too little uncertainty. An example for the above can be found in a study by Sieber and Kameya (1968). Highly anxious Ss were found to perform less well than low anxiety Ss on a task which required memory of certain problem solving moves (as, say, in chess). However, when the highly anxious Ss were provided with so-called memory support, they performed as well as, and even ~~out-performed~~ better the low anxiety Ss. The memory supports they received was in the form of visual displays of previous moves, and it served to simulate overtly these operations which the Ss had to do covertly, and which they had difficulties with. Thus, the stimulus condition compensated for the defficiency by simulating the process. But this was too redundant for the low-anxiety Ss.

All stimuli simulate processes to some extent. However, there are kinds of stimuli, or media, which are better equipped to simulate and there are others which are better suited to short-circuit. A stimulus which shows static situations can simulate only the end results of transformations, i.e. to short-circuit processes. No doubt, by doing this it can arouse the application of the process. For instance, the illustration which is given above, simulates the end result of the process of relating some of the components I referred to. It could not simulate the processes themselves and a verbal description needs therefore to accompany it.

Uncertainty, as discussed earlier, can be both an entering state of the learner which influences the utility of different degrees of explicitness. It can also be an output: different degrees of explicitness lead to different amounts of increased or reduced uncertainty.

In summary, explicitness of representing mediational responses which are relevant to a certain act of learning may become a very powerful tool with which stimuli could be analysed and prescribed. The results of many experiments in media or stimulation can be interpreted in light of this dimension. For instance, one constantly finds that the pre-organisation of stimulus components (grouping of digits, spatial arrangement of dates, etc.) facilitates recall. This may be a result of the fact that well organised stimuli short-circuit the process of organizing the elements, a process which the learner would have to do on his own otherwise. Similarly, highlighting certain parts of the stimulus arrey facilitates learning of new material because it short-circuits for the learner (thus saves him the effort) the process of selecting the relevant from the irrelevant information. The desirability of, say, short-circuiting, as in the examples above, will depend of course on the function that the short-circuited process plays in learning. In some cases the process itself is to be used so that an opportunity for reinforcing it is created. In such a case "doing it for Johnny" is undesirable.

3. <u>Stimuli for mental development</u>

Information is conveyed to a learner not only to be acquired and retained, but also for purposes of development, that is, to improve the learner's cognitive processes.

development, if further development is sought (Bruner, 1960).

4. The activation of specific requisite operations as a function of stimulus structure.

The final dimension I wish to discuss is one example of the various dimensions which could be subsumed under the dimensions of explicitness of presenting information and under the developmental function of stimuli. Here we ask what kinds of mental operations are called for by different classes of stimuli and which are prerequisite to extracting information from them. This, of course, is most closely related to the specific nature of stimuli and is determined by it to a large extent. For instance, the works by Pryluck (1969) concerning the symbol system of films, that of Vernon (1962) concerning the nature of graphs, and my work, concerning maps and map-reading (1968), can be used as base lines for the analysis of stimuli along this dimension. That stimuli of different shapes do require certain mediators -- is not really a new idea. Take for instance the work of Paivio (1969), Bower (1968) and others, concerning mental imagery. They find that concrete nouns yield themselves more easily to pictorial imagery than less concrete nouns. In paired-association learning we have seen, following the work of Jenkins, Neale and Deno (1967), and Rowher et al. (1967), that encoding processes differ as a function of the concreteness or specificity of the stimulus. Runquist and Hutt (1961) report, that high school Ss learn verbal and quite abstract concepts more rapidly when the material is represented verbally than when it is represented pictorially. One would not be surprised to find that these high school students would learn more from the pictorial material if the task would be recognition.

and irreversible, but is necessary for the development of essential categories of primary generalizations. Perception begins to conflict with symbolic processes, or thought, at about the first years in school. The development of operations and concepts is enhanced, from this point on, as the learner relies less on perceptual evidence. The major agent in this shift is his active manipulation of concrete instances which surround him. The tremendeous importance of actual manipulation has been demonstrated in numerous studies and cannot be over estimated. These studies provide an empirical base to support the old claim about "learning by doing", as superior to "learning by observing".

I will not elaborate further on Piaget's work but rather discuss implications which are relevant to this presentation. Some of these were already discussed by Minkovich.

First, it follows from Piaget's voluminous work that the actual manipulation of concrete objects, rather than the passive perception of transformations, facilitates the development of thought processes. Second, it follows from his work that the disruption of equilibrium or if you wish, the arousal of conflict and uncertainty, underlies cognitive change (Hunt, 1969). And third, and this follows from recent work of Inhelder (1969), there is a need to distinguish, as we did earlier, between cognitive processes or transformations, and cognitive schemes, or situations.

The ability to imagine a transformation appears later than the ability to imagine the situations that preceded and followed the transformation (Piaget and Inhelder, 1962 quoted by Berlyne, 1965). The acquisition of certain kinds of operations follows a particular sequence, and the acquisition of accurate symbolic representations of certain situations in highly depended on the internalized operations. Finally, it is very possible that

. . ."concrete operational thought, or even sensorimotor thought does not disappear when formal thought arises, but continues to be used in concrete situations where it is adequate, or when efforts at solutions by formal thought have failed" (Kohlberg, 1968, p. 1021). Media, when used as a source of stimulation for the purpose of developing mental skills, need to be constructed in such a way that mode of presentation and development of learner will be congruent. The degree of congruence need not be complete since, as mentioned earlier, some uncertainty, or demand for accommodation on side of the learner is a necessary condition for learning to take place. How exactly can this congruence be studied? Minkowich, suggests numerous dimensions which would subsume the present one, and with whose aid the desirable degree of congruence between presentation and learner's development can be explored. Of these, two are very important to the present discussion: (a) the degree to which manipulation of the objects is invited, and (b) the nature of the object of motor, perceptual or mental manipulation (the "real" thing, a replica, a symbolic representation, etc.)

Let me provide an example of the kinds of discussions which follow from the present dimension. We may ask: how far are the psychological demands which are built into a certain mode of stimulation from the learner's level of development? Do we induce the right amount of accommodation when we use, say, maps with 6 year olds? Here, the examination of stimuli according to their degree of concreteness or abstractness seems to be suitable. Following the work of Piaget one can approach the answer in two interrelated ways. The first is concerned with the concreteness-abstractness of the <u>materials</u> or the objects which need to be available in symbolic form. I tend to view this not as just the semantic relation between referents "out-there" and their representations. Rather, I would deal with the relations between the abstractness of objects as representd in the learner's response system, and the abstractness of the objects we expose him to. It seems to be rather unimportant if the word "bottle" is, or is not an onomatopoeia, or whether the pictorial sign of "Railroad Crossing" is more of an icon than a similar verbal sign. The question is how far the represented object is from the way the learner represents it in his thinking. In other words, how many transformations (in the Chomsky sense, if you wish) need to be activated? You will agree with me that a drawing which is (semantically speaking) very abstract, or remote from its referent, is not remote at all if this is the level on which we operate on it and with it.

The second way of approach places the learner's activity on a continuum of decreasing dependency on actual manipu lation, thus ranging from overt manipulations to hypothetic-deductive thinking. The shifts along this continuum are not only from the overt to the covert, but are also accompanied by finer differences. One of them is the decreasing correspondence between stimulus-condition and overt responses. When more information is drawn from internal sources, when responses cease to depend on the immediate presence of the stimulus (that is, when the person deals with a stimulus situation which lingers behind), and mainly -- when perception gives way to operational thinking, there is less and less correspondence between stimulus and response. There is, on the other hand, increasing dependency of the final response on the covert processes.

Following these points, it is suggested that we devise stimuli which will represent objects on a specifiable level of concreteness, and demand processes on a desirable level of concretoness. For instance, we can simulate several processes with films. However, whatever we simulate in films is with very concrete objects and processes, This may be appropriate for a learner who functions on that level. But what about an adult? We quite obviously induce in him processes of abstraction. Are we interested in doing this? Or, take another example. Computers are capable today of producing moving images of three dimensional geometric figures. Such presentations could be expected to facilitate the development of spatial operations. Imagine, however, a child in the intuitive operational stage viewing the geometric figures transforming in space in front of him. This obviously is a nice simulation of the process which is otherwise done covertly. However, could the spatial operations of the child be expected to develop as a result of this exposure? The answer is negative. Although the objects are quite concrete, i.e. close to the level on which the child operates, the processes are too abstract. That is, they take place in front of the learner without him manipulating the objects. On the other hand, would the child be given a way to directly control the movements of the objects (something which is impossible even with the most advanced computers) - the desired development would have a better chance.

Bruner's theory of cognitive devlopment, with its very close ties to Piaget's work, suggests a similar way to handle this dimension of stimuli. Bruner discusses the decreasing dependency of children on external stimuli and their increasing dependency on internal, symbolic representation of events. This is accompanied by a gradual shift from the use of ikonic and enactive representations to symbolic ones. Growth, according to him and to Piaget, is also typified by increased complexity of organization of the internal representations of situations and transformations.

The implications for research in media are, as before, rather clear. In general, they point to the need for sequencing stimulation to match development, if further development is sought (Bruner, 1960).

4. The activation of specific requisite operations as a function of stimulus structure.

The final dimension I wish to discuss is one example of the various dimensions which could be subsumed under the dimensions of explicitness of presenting information and under the developmental function of stimuli. Here we ask what kinds of mental operations are called for by different classes of stimuli and which are prerequisite to extracting information from them. This, of course, is most closely related to the specific nature of stimuli and is determined by it to a large extent. For instance, the works by Pryluck (1969) concerning the symbol system of films, that of Vernon (1962) concerning the nature of graphs, and my work, concerning maps and map-reading (1968), can be used as base lines for the analysis of stimuli along this dimension. That stimuli of different shapes do require certain mediators -- is not really a new idea. Take for instance the work of Paivio (1969), Bower (1968) and others, concerning mental imagery. They find that concrete nouns yield themselves more easily to pictorial imagery than less concrete nouns. In paired-association learning we have seen, following the work of Jenkins, Neale and Deno (1967), and Rowher et al. (1967), that encoding processes differ as a function of the concreteness or specificity of the stimulus. Runquist and Hutt (1961) report, that high school Ss learn verbal and quite abstract concepts more rapidly when the material is represented verbally than when it is represented pictorially. One would not be surprised to find that these high school students would learn more from the pictorial material if the task would be recognition.

To these, one can add the large accumulation of findings which pertain to the importance of creating verbal mediators to the process of organizing materials ([illegible] 1967), recall, concept attainment (Kendler, 1963), problem solving (Gagne and Smith, 1962), etc.

The implication from these and similar studies is that the activation of certain kinds of mediators is a necessary condition for the learning from certain kinds of stimuli. Unless the mediators activated by a certain kind of stimulus are relevant to the learning process, there is no need to arouse them. For instance, the use of pictures may short-circuit the process of creating mental images. But the latter may interfere in certain learning tasks which require verbal links (Bower, 1968). Thus, the use of verbal strings may be more desirable. I will not elaborate much more on this dimension, mainly because we still know too little about the prerequisite response-classes called for by different media, or media combinations. It is however a promising way to examine the cognitive functions of media because if they really do call for different processes, then they can be brought to interact with individual differences to compensate for possible kinds of deficiencies. Dr. Snow discusses the latter point in his paper.

E. Some implications for research.

To recapitulate:

1. Research in media needs to relate itself to research in other fields.

2. It needs to be nourished by other theories and in turn, to nourish them.

3. It needs to deal with the functions of stimuli.

When one goes now to conduct a media study with these points in mind he obviously needs to know something about the following:

1. The nature of the processes which are to be learned.

2. The degree of mastery that his subjects have of that, or related (possibly, more general) aptitude measures.

3. The general level of mental activity of the subject relative to the material to be learned. Given this information, the E will have to decide how much uncertainty he wishes to arouse, how much independent activity and of what kinds he wants to allow, etc.

These prescriptions sound as if taken from a book entitled: "The Impossible Research Procedures. . ." Therefore, let me give an example.

Assume that we found that the more reflective teachers turn out more reflective students, and that the ability of "Self-examination" correlates with reflectiveness. It would seem desirable to increase the reflectiveness of low-reflectivity teachers. We choose to improve their self-examination-ability to meet this end. We hypothesize, by the way, that this ability underlies reflectivity and that improvement of the former facilitates the latter.

We thus decide to arouse processes which constitute the self examination ability, but how do we arouse them in subjects who are deficient in them? So we decide to simulate some of the components of the process so that they will be incorporated and used i.e. we tell the poor self-examiners how they actually perform. This may raouse quite a bit of conflict, hence uncertainty, as previous work of Nielsen (1962), ~~Salomon and McDonald (1968)~~ and others tends to suggest. Providing a verbal description which is expected to simulate the process of self-examination implies that people really examine themselves verbally, and this may be wrong! And if it is wrong then we may arouse more transformational activity than needed and defeat our purpose. Thus we devise an alternative way of simulation, namely, by using videotape recorder.

This may provide signals on a level closer to the one people actually examine themselves.

We set up an experiment. Teachers of all levels of self-examination-ability are included, and 3 treatments are given: visual concrete simulation, (self-viewing on VTR), verbal-abstract-simulation, and arousal. In the first condition Ss will see themselves on the VTR, in the second they listen to a verbal description of their behavior, and in the third they are told that they performed poorly -- and will be required to "examine themselves", thus, an arousal condition.

So, we compare 2 procedures of simulation differing with respect to their relation to the images one tends to use in such cases, and a third procedure which is supposed to arouse the relevant processes. Note that we know very well why we chose each of the stimuli. After administering these treatments we measure differences on a number of dimensions. Let's us take a look only at reflectivity -- the correlate of self-examination. We find that the VTR treatment is equally successful in improving the S's reflectivity as is the arousal condition and that both are better than verbal simulation. First, since there is improvement in reflectivity -- we support our hypothesis that the process of self-examination underlies reflectivity. We have nourished research in a field which also nourished us. There is also good reason to conclude that the verbal simulation required some irrelevant transformations, and that self-examination is facilitated by pictorial images. But then we examine the interactions between our treatments and self-examination aptitude measures which we took at the beginning.

Insert Figure 4

We find, as one would expect, that only the better self-examiners profitted from the arousal condition. Hence, it was arousing! For the poor self-examiners it was apparently too much negative information. However, the latter profitted best from the VTR presentation. It simulated something on the right level! For the good self-examiners it was too concrete, they perform perhaps on a verbal, rather than pictorial level and profit therefore from the abstract!

F. Summary: what does it do to Johnny?

The dimensions described here are a far cry from what would be needed, and very much experimental work needs to follow. The purpose was to provide a general sketch of some functional aspect of stimuli which are believed to complement each other and interact with each other. They derive most of their formulations from the core of more or less agreed upon constructs and empirical data, and are hoped to lead to the formulation of theory-oriented research questions. Much more could be said about each of the suggested stimulus dimensions, particularly in terms of the way they relate to each other. It is not unlikely that the reader felt in numerous points that there are clear overlapping regions between the dimensions, or that the organization of them leaves a lot to be desired. However, it was not my intention to describe an already existing theory of stimulation but rather to sketch, by way of suggesting hypothetical dimensions, how such a theory can be constructed. The point of departure I suggested here was to raise the general question of what does it to the learner? The ways stimuli affect learners can be analyzed from many different points of view. The idea, though, is to find a relatively small number of ways of analysis which deal simultaneously with the nature of stimuli and with their cognitive correlates. This, in turn, calls into play additional variables, mainly those which are related to the learner's cognitive world and with the task requirements. First, the general question of "What does it do to Johnny?" can be transformed from description to a prescription. Hence one asks: given that this and that is the desired educational outcome, what do I need to induce in the learner, arouse in him, show him, or let him do, given that these are his response capabilities? This, obviously, calls for a close cooperation between research in cognition and research in media.

Second, the general question is broken down into more detailed ones. The more detailed questions may guide the researcher in his search for empirical evidence which can be interrelated with other observations. Stimulus dimensions, with the help of which answers are sought, are nothing more than convenient ways to break down the world of stimulation into managable units. Thus, one does not ask how can films (in general) serve this or that function, but rather: what components of film, in terms of cognitive activation, can be used in the particular instance under investigation.

Finally, the close examination of unique media potentialities, although not an end by itself, becomes extremely important in this respect because it can suggest unique ways through which particular cognitive functions may be aroused, activated, acquired or developed. Here for instance, we find that the relationships between the digital and analogic channels of communication in films (Reusch and Kees, 19) and between the verbal, non-verbal and para-verbal modes (Pryluck and Snow, 1967) can lead to the discovery of yet unknown ways to stimulate thought.

The hypothetical organization of the stimulus functional dimensions discussed in this paper are represented in table 1.

Insert Table 1

It should be clear, though, that many other ways to organize them, are possible, that other dimensions can be added, and that some of the present dimensions may be replaced.

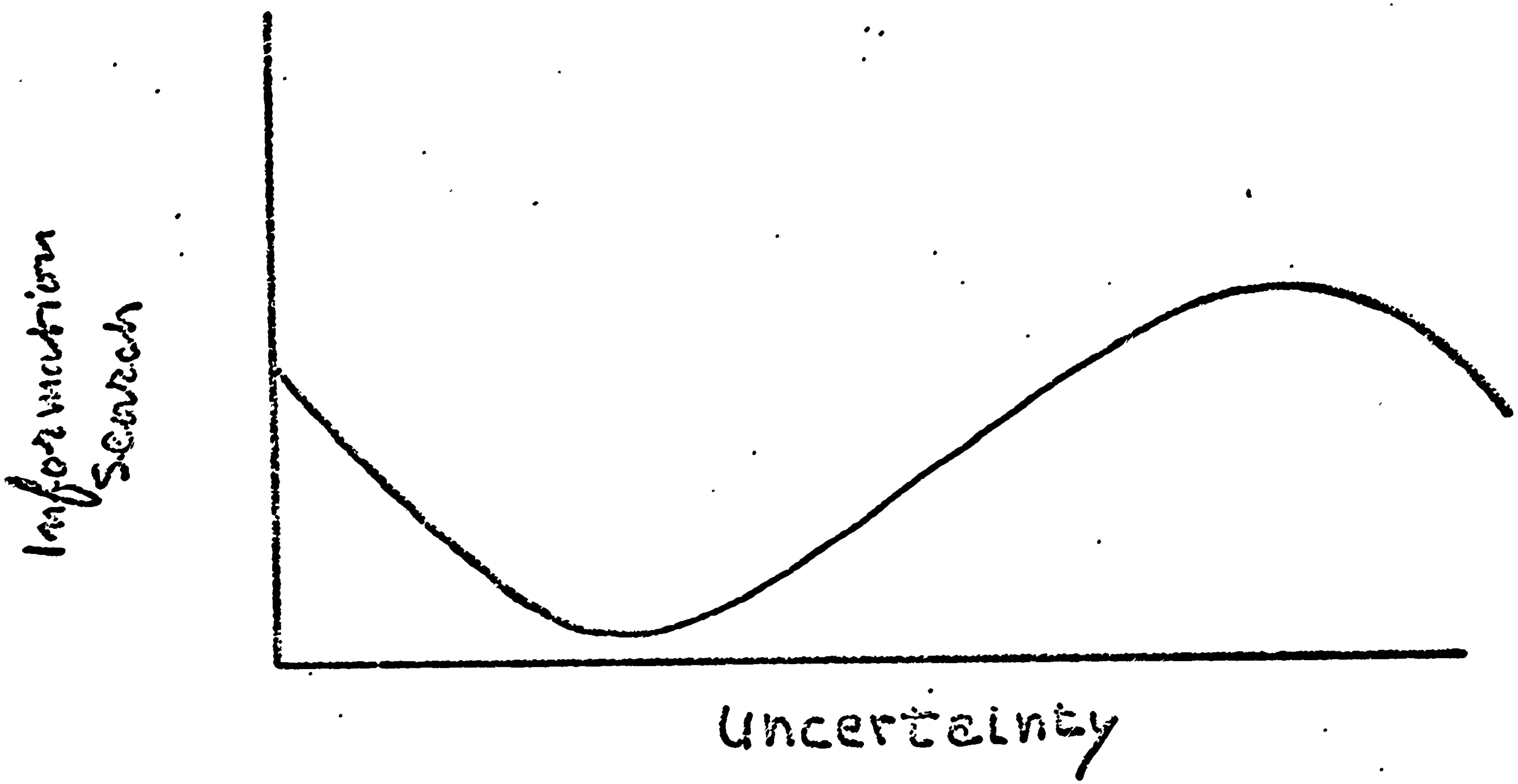

Figure 1 (After Sieber and Lanzetta, 1964)

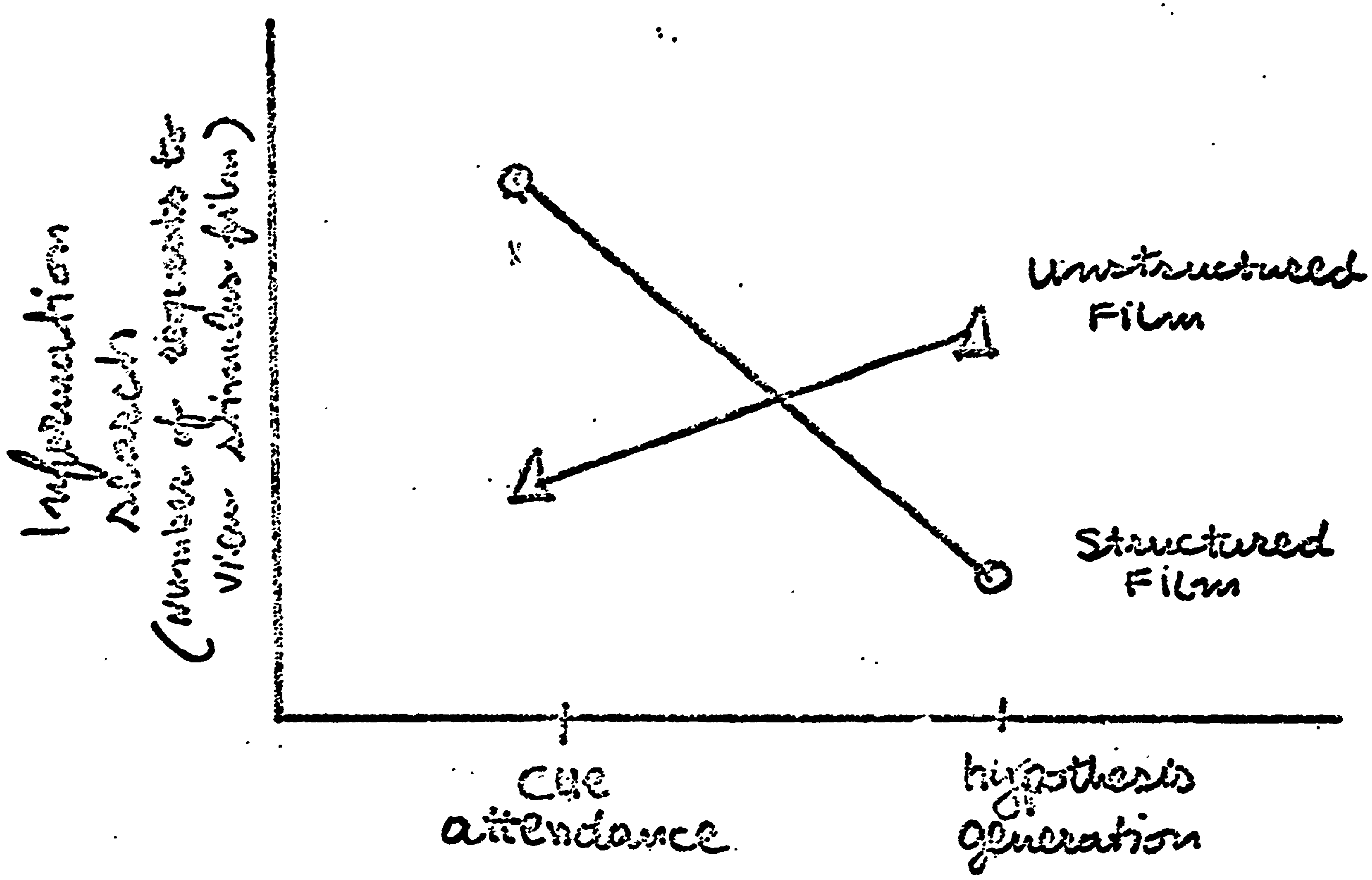

Figure 2

(Salomon and Sieber, 1969)

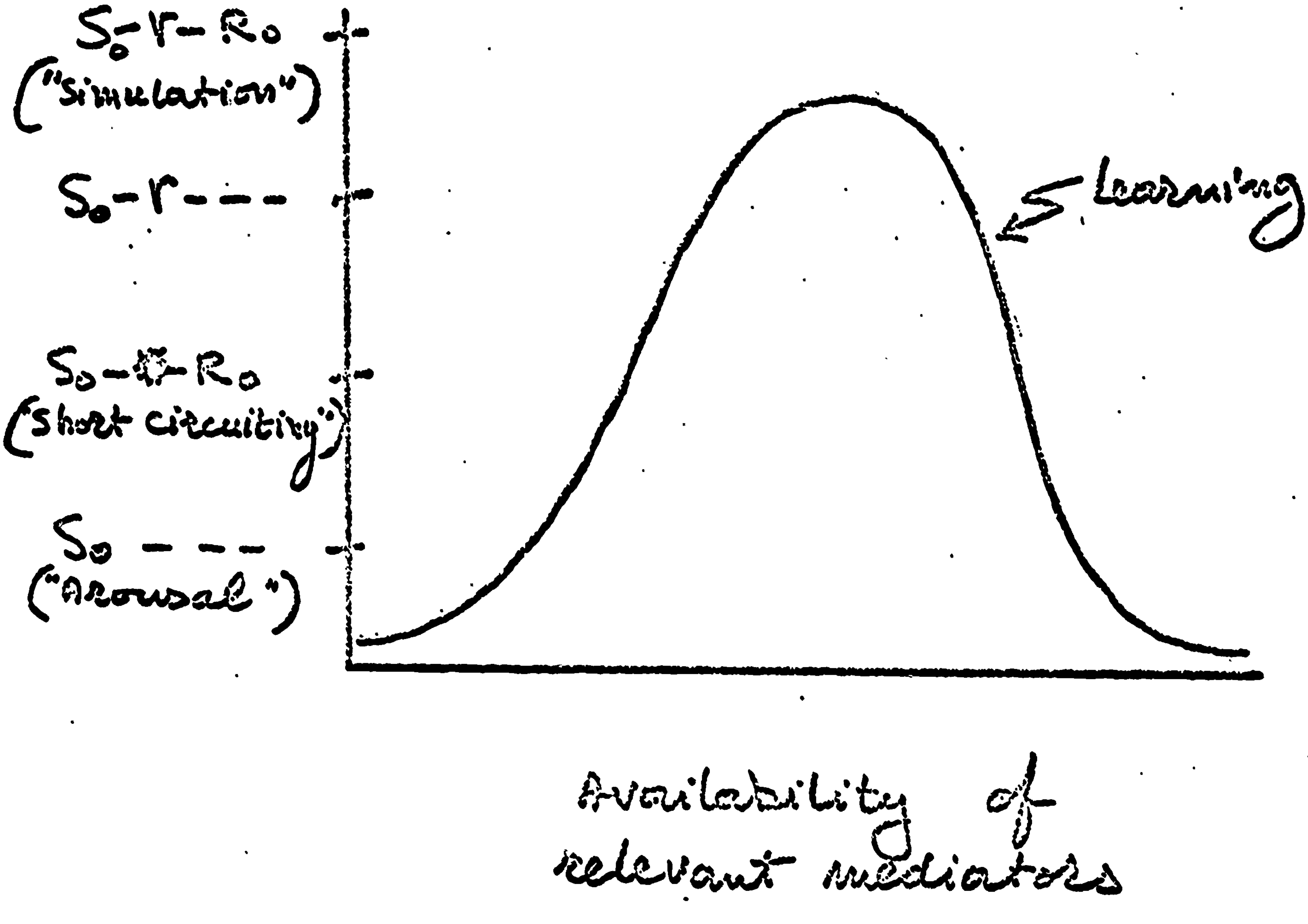
S_o-r-R_o
("simulation")
S_o-r---
S_o-r-R_o
("short circuiting")
S_o ---
("Arousal")
Learning
Availability of relevant mediators

Figure 3

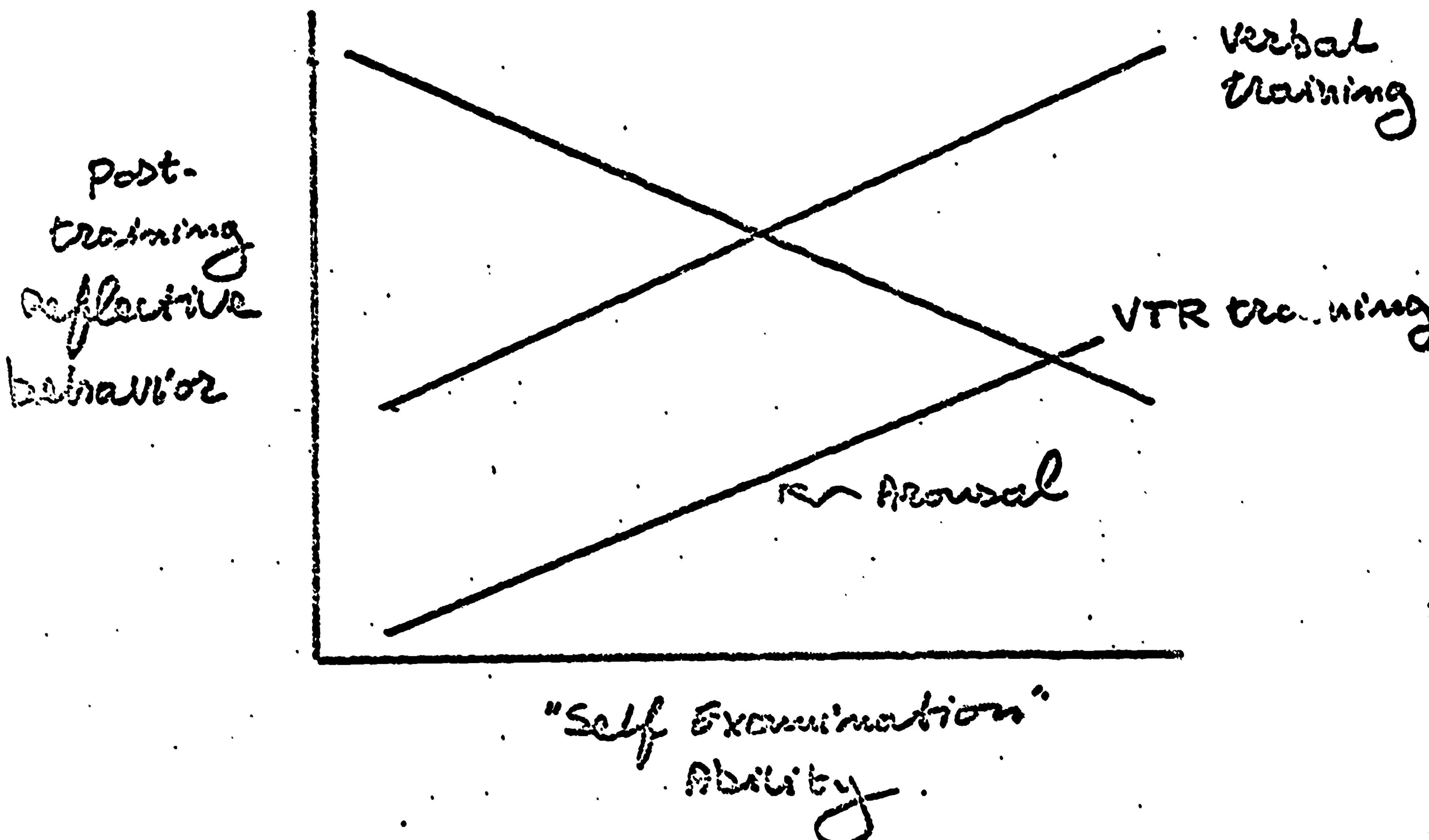
Post-training reflective behavior
Verbal training
VTR tra..ning
Arousal
"Self Examination" Ability

Figure 4

Table 1

The question	The functional attributes of stimuli
What should the general level of mental activity be?	The amount of positive and/or negative information transmitted by the stimulus (curiosity, attention, cognitive change, relevancy of information, surprise, novelty, etc.)
How much specific activity and of what kind is left to the learner?	The explicitness with which mediational responses are presented (the arousal, short circuiting or simulation of processes which are requisite to the learning to take place) The "distance" between the mode of presentation and the level of development at which the learner is (the amount of required accommodation, the relative "concreteness " of the materials and operations, the place of actual manipulation).
What specific processes do the different classes of stimulus require?	The specific operations which are called for by the unique structure of specific stimuli