DOCUMENT RESUME

ED 154 798 IR 005 888

AUTHOR Salomon, Gavriel
TITLE The "Languages" of Media and the Cultivation of Mental Skills.
PUB DATE Mar 78
NOTE 45p.; Paper presented to the Annual Meeting of the American Educational Research Association (Toronto, Canada, March 1978)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Art; *Cognitive Processes; *Cognitive Style; *Learning Modalities; *Learning Processes; *Media Research; *Mediation Theory; Modeling (Psychological); Psycholinguistics; Symbolic Language

ABSTRACT

The class of media characteristics, which is generic to them and which may be of potentially great relevance to learning, is the way in which media select, highlight, structure, and present information, i.e., their "languages" or symbol systems. How, if at all, and why do symbol systems, in general, differentially relate to cognition and learning? First, they address themselves to different aspects of the content conveyed through them. Second, they are processed by different cognitive systems or apparati; hence, given a particular learner and a particular task, some require more mental effort to process than others. Third, symbol systems vary as to the mental skills they require. Finally, media's symbol systems, which are internalizable and used as tools of thought, can cultivate mental skills. Three functions are attributed to codes that qualify them as skill-cultivators: activating skills, short-circuiting skills, and supplanting skills. If media's symbol systems can indeed affect, or be made to affect, the mastery of mental skills, then using and studying media as convenient delivery systems miss perhaps their greatest potentials and dangers. (VT)

THE "LANGUAGES" OF MEDIA AND THE CULTIVATION OF MENTAL SKILLS[2]

Gavriel Salomon

Introduction

For a couple of years now I have been disturbed by the discrepancy between common impressions of media's potentials and dangers, partly supported by mass communication research, and the cummulative poor yield of media research in education. There are of course obvious, even trivial findings, that show that when an educational program is propelled by a high-powered technology, say television, then--compared with a failing program or system--it makes an educational difference. This is trivial because it proves the obvious: Compare an eight cylinder car with a mule, the former will always be "better." But what happens when you compare one kind of a car with another, equally powerful one?

As far as research on media is concerned, the answer in Schramm's words is that while all media can teach very effectively "learning seems to be affected more by what is delivered than by the delivery system" (Schramm, 1977, p. 273). Similar conclusions are reached by Oettinger and Zapol (1971), Jamison, Suppes and Wells (1974), Olson (1974a) and Leifer (1976).

This, of course is a rather discouraging conclusion. While it is

2. The research reported here was supported by grants from the American Psychological Foundation and from the Spencer Foundation. The preparation of this paper and a book that expands on the topics covered here was made possible by a special grant from the Spencer Foundation.

THE "LANGUAGES" OF MEDIA AND THE CULTIVATION OF MENTAL SKILLS[2]

Gavriel Salomon

Introduction

For a couple of years now I have been disturbed by the discrepancy between common impressions of media's potentials and dangers, partly supported by mass communication research, and the cummulative poor yield of media research in education. There are of course obvious, even trivial findings, that show that when an educational program is propelled by a high-powered technology, say television, then--compared with a failing program or system--it makes an educational difference. This is trivial because it proves the obvious: Compare an eight cylinder car with a mule, the former will always be "better." But what happens when you compare one kind of a car with another, equally powerful one?

As far as research on media is concerned, the answer in Schramm's words is that while all media can teach very effectively "learning seems to be affected more by what is delivered than by the delivery system" (Schramm, 1977, p. 273). Similar conclusions are reached by Oettinger and Zapol (1971), Jamison, Suppes and Wells (1974), Olson (1974a) and Leifer (1976).

This, of course is a rather discouraging conclusion. While it is

2. The research reported here was supported by grants from the American Psychological Foundation and from the Spencer Foundation. The preparation of this paper and a book that expands on the topics covered here was made possible by a special grant from the Spencer Foundation.

true that rhetoric concerning media has outstripped observed effects, we may still feel that media potentially entail more than has met the researcher's eyes. Indeed, here and there you could have heard a few voices in the darkness that have repeatedly claimed that there's something wrong with our research assumptions and questions (e.g., Knowlton, 1964; Mielke, 1968; Salomon & Snow, 1968; Salomon, 1974a; Olson, 1974a,b).

One such claim is that media are not to be conceived of as invariant, discrete entities. While it is appropriate to deal with a medium as a total, invariant system from a sociological, economic or political point of view, it is inappropriate from educational-psychological ones. A medium per se does not interact as an invariant system with learners' aptitudes so that the learning of some is facilitated but not that of others. Neither does a whole medium, regardless of internal variations, make the acquisition of some kind of knowledge "better" than another. Rather, something within the mediated stimulus, possibly shared also by other media, and perhaps only a potentiality to be realized, makes the presented information more comprehensible or memorized by some learners in some tasks.

A second claim is that media have the potentiality of packaging, structuring and shaping information in different ways. These ways, however, have little direct relation to technology (although technology affords them). And assuming this is the possible—though often overlooked—case, media can hardly be considered as being only alternative routes to the same fixed ends.

If some media, under some conditions, have some unique characteristics, then also unique learning outcomes can be expected (Salomon, 1974a). First, they can serve different learners. Secondly, they may serve different learning tasks. But most importantly, they may serve different educational ends altogether. Olson (1974a) addressed himself to this point:

> "Perhaps the function of the new media is not primarily that of providing more effective means for conveying the kinds of information evolved in the last five hundred years of a book or literate culture, but rather that of using the new media as a means of exploring and representing our experience in ways that parallel those involved in that literate culture. In this sense, media are not to be considered exclusively as means to preset ends but rather as means for reconstruing those ends in the light of the media of expression and communication" (p. 8).

Considering media's potential characteristics as serving a diversity of new ends should force us to overlook their common outcomes, and focus instead on the different functions that such characteristics could serve.

The ever present "non-significant" difference in media research could lead us to dismiss media as insignificant delivery systems, which are but over-sized and expensive postal services. But findings from mass communication (e.g., Katz, et al. 1974; Comstock, et al. 1978) suggest that such an approach is unwarranted. Alternatively, we could try to identify the very essence of media, take a theoretical view at it, and study more systematically its unique psychological and educational import. My present paper is an attempt to outline such an approach.

The focus of interest in media

Technology, the very base of media, makes of course a large difference in learning, alas of trivial implications. It is true that television broadcasts do not permit on-the-spot interactions between learner and screen teacher. Indeed, to the extent that such interactions are necessary for a particular learner struggling with some domain of content, television will be less effective than a lively discussion. But then, what else is new?

And what does this teach us about the potential uniqueness of the medium?

Content is certainly of great importance in learning. But its relation to media is quite poor. If learning geometry is facilitated by graphic representations it is not because these can not be replaced by, say, verbal descriptions. They can, and hence the content of the two modes of presentation would, by and large, be similar. It is not the content that differentiates between the two. Similarly, the effects of aggressive television programs could not be attributed only to their contents or easy accessibility. We can be safe in assuming that holding everything constant and only replacing the present modes of presenting such programs with a narrator, would not result in the same learning outcomes.

My argument is that the class of media characteristics which is both generic to them and which may be of potentially great relevance to learning, is the way in which media select, highlight, structure and present information--in other words, their "languages" or symbol systems.

For the sake of brevity I will not dwell on the large question of what symbol systems are, on how the symbol systems of the media differentiate between them, nor on how they relate to the symbol systems of religion, myth or the subconscious. The interested reader may find some illuminating discussions in the writings of Cassirer, Susan Langer, Goodman, Eisner and others. It would be enough for the development of my case to understand symbol systems as sets of elements, such as words or musical notes, that are interrelated within each system by syntactical rules or conventions, and are used in specifiable ways in relation to fields of reference (Gardner, 1977). Thus, the table of chemical elements together with the laws of chemical combination, mathematics, visual art, music, language, film, etc.

are all symbol systems (Perkins & Leondar, 1977).

Some symbol systems, such as language or pictorial renderings are more elementary, or primary, than others. Most of the symbol systems we encounter--in maps, books, pocket calculators or television--have been derived from the more primary ones, thus they often share coding elements: consider film and painting, both sharing non-notational dense characteristics, or geographic maps and statistical Small Space Analyses.

Technology often plays a vital role in developing new symbol systems or--more often--new combinations and blends of "old" symbol systems. Film started out as photographed theater but as its technology developed, new modes of expression and communication could be developed. These entail coding elements ranging from the zooming camera to the "spatializing of time" (for a recent detailed analysis of film's languages" see Kjørup, 1977). Thus, while technology has, as we have argued, only trivial direct effects on learning, whatever important contribution it may have is through the symbol systems and their blends that it affords.

Before further developing my case let me point out that I do not wish to equate a medium with any symbol system (hence, the medium is <u>not</u> the message . . .), nor to ignore the simple fact that a medium entails more than modes of presentation. My point is that from among the many classes of attributes that characterize a medium, its symbol systems may be the most important (but also as yet the most ignored) one.

Implied here is the assumption that a medium has at its disposal numerous symbol systems but that some of them (or their combinations) are more generic to the medium than others. (Television could broadcast printed material but that would not constitute a proper use of what is available to it.) Any instance of medium use can entail more or can entail fewer coding elements that uniquely and generically characterize it. Hence the great variation within a medium. In what follows, however, I try to focus on the more unique coding elements of media which I treat as potentially available to them, rather than as invariant constantly-present ones. Thus, when Gombrich (1974) writes that through language one can inform of future, past or present conditional, but logically verifiable events, he speaks of the potential of language. Obviously, not all linguistic statements capitalize on this potentiality (see also Olson, 1977a on the difference between text and utterance).

Three premises underly the examination of communication media in terms of their symbol systems. First, media are cultural apparati for gathering, storing, and conveying information, feelings and experiences in representational forms. Representation, as distinguished from "raw" experience, is always coded within some symbol system, whether it is a verbal statement of fact or a work of visual art. Writes Susan Langer (1967):

> "As literal language owes its great intellectualizing power and its usefulness for communication to the relative simplicity of its logical structure, so the non-discursive structure of artistic presentation prevents art from ever being a symbolism which can be manipulated by general rules to make significant compositions, but at the same time is the secret of its great potentiality. Its elements are all created appearances which reflect the patterns of our organic and emotional tensions so ostensively that people are not even aware of speaking figuratively when they speak of "space tensions," the "tension" between two dance partners, or even between two unrelated events in a poetic work (p. 104).

Secondly, media's symbol systems are complexly related to cognition in ways which are not too clearly explicated. DeFleur and Ball-Rokeach (1975) conceive of communication as the "isomorphism between the internal responses (meanings) to a given set of symbols on the part of both sender and receiver" (p. 126). As Anatol Rapoport writes:

> "Symbolism is not something that happens <u>to</u> man (as conditioning happens to a dog). Symbolism is something man <u>does</u>. It embodies the entire gamut of man's mental life.. It is the mode of his mental life" (1965, p. 99).

Since cognition involves activities of knowing, organizing, transforming and using knowledge, and as these are accomplished through internal symbolic representations, the examination of the relations between symbol systems and cognition becomes inescapable. Finally, learning is a cognitive process. It is mediated by knowledge and experience that is already coded through the symbol systems of media. We learn as Stoddard has commented, not from what we are doing, but from thinking about what we're doing. Olson (1970) similarly, argues that a child does not internalize actions, as Piaget claims. Rather he internalizes the information (often already coded) that the actions yield. In this way, then, media's symbol systems, cognitive processes, and learning appear to be interrelated in important ways. The focus of this paper is on these interrelations and some of their potentialities.

While these premises may make great sense, we would still need to ask whether differences among symbol systems (whether generic to media or not) are correlated with differences of information processing and learning. Do symbol systems play a differential role in cognition and learning?

We could easily fall into the trap of translating an observable distinction into an assumed psychological difference. A similar issue was raised by Edward Sapir, and later on by Brown (1958) with reference to onomatopeic words, that is--words that are linguistically distinctive by their phonetic-symbolism (e.g., <u>bottle</u>, the <u>buzz</u> of the bee). Only after evidence was marshalled to show that such words have universal psychological correlates (they communicate meaning even to a person who doesn't know the specific language)--could the onomatopeic class of words be accepted as "making a difference."

There are a few recent lines of research in which some structural characteristics of a medium (usually television) are identified and their relationships to cognition and learning investigated (e.g., Atkin & Wood, 1976; Singer, Tower, Singer & Biggs, 1977; Tannenbaum & Zillman, 1975; Huston-Stein & Wright, 1977). Scattered research on other media also points to differences in comprehension and learning which can be attributed to the structural elements of media, such as maps (Salomon, 1968; Feldman, 1970), pictures (for summary see Pressley, 1977), or paintings (Gardner, 1972)

Thus, there is some empirical evidence to suggest that components of media symbol systems relate to cognition in a number of ways. Indeed, this is agreed upon, even taken for granted, by philosophers (e.g., Langer, 1942; Goodman, 1968), aestheticians (e.g., Gombrich, 1974), historians of technology and science (e.g., Ferguson, 1977) and art educators (e.g., Eisner, 1978).

But the assumption that the symbol systems of media play a significant role in cognition is not commonly agreed upon by cognitive psychologists. Some cognitive psychologists either ignore it (e.g., Neisser, 1976) or reject the notion altogether (e.g., Norman & Rumelhart, 1975). Similarly, research done within the Piagetian tradition, sidesteps the question of communication's symbol systems. As that line of research focuses on <u>universal</u> achievements, which are not related to any <u>specific</u> environmental situation and medium, other developments which may be more specifically culture-medium-, and technology-bound are left out (Feldman, 1978). Piagetian research deals with the development of only one mode of cognition--that which figures in logico-rational reasoning and the operations specified by Piaget bear upon the manipulation of <u>real</u> objects that lead to the internalization of the operations. Hence the manipulation of the cultural, symbolic environment is left out (Olson, 1973).

The case is somewhat different with recent developments in psycholinguistics. Much research on the cognitive aspects of language has been guided by the overall assumption that there is a lawful correspondence between the syntactic structure of language and cognitive processes. Syntactically different sentences are said to undergo certain transformational procedures in order to arrive at common deep structures where meaning is then given to them. Much empirical support was given to the hypotheses derived from this theory (e.g., Miller & McKean, 1974; Savin & Perchonock, 1965) to demonstrate the psychological reality of linguistic transformational rules. However, later empirical evidence and certain logical inconsistencies in the arguments no longer provide unequivocal support for this hypothesis. For instance, not all passive sentences require more processing time than active ones. As pointed out by Bower in reference to story comprehension (1977) and by others with respect to sentence comprehension (e.g., Winograd, 1972) semantic features, rather than syntactic, are major carriers of information. Hence there is little point in studying the syntactic, symbolic structures of language. Olson (1977a) argues that in effect there are large differences between oral speech ("utterance") and written language ("text"). Whereas meaning is to be found in the interaction between sentence and user in utterances, it can be found in the structure of the sentences themselves in texts. This distinction suggests that utterance and text are both structurally and psychologically somewhat different symbol systems. It also suggests a possible resolution of the conflict between the syntactic and semantic orientations in contemporary psycholinguistics.

There is another important relationship between language and cognition. It is the issue of language and thought. Grossly oversimplified, the issue concerns the question of whether language becomes a tool of thought (Vygotzy, 1962; Luria, 1974), or whether it reflects thought and develops in correlation with it (e.g., Carrol, 1974). Since this question is of central importance to us I will deal with it in more detail later on.

Note that research in psycholinguistics is generally restricted to one symbol system. Though much can be learned from it about the cognitive aspects of one symbol system, we are still left with the question as to how, if at all, and why do symbol systems in general differentially relate to cognition and learning. I turn therefore to a theoretical examination of this overall question. This will lead me to a number of temporary propositions and hypotheses, followed by empirical studies.

Aspects of content

In a little known American short story a seeing person tries to explain to a blind person what "red" is. "Red," he says, "is soft, it's warm." "Oh!" says the blind person, "You mean that red is velvet!" The attempt to explain the concept "red" turned into a frustrating experience. Somehow, something in the quality of that color (or, in effect, any color) could not be successfully rendered verbally. The linguistic symbol system can be quite accurate in ruling out alternatives--"Give me the third red object with the blue cover which is three inches to your right." But it fails to render the critical qualities of a color.

In a recent study conducted by Meringoff (1978) children were either read a story or exposed to the identical story told and dramatized over television. When asked to retell the story, children of the television group elicited better recall of story actions (most of which have been seen on the screen) while children from the book-story group relied more upon verbal information provided within the story or based on their stored general knowledge. Although these findings appear to be quite simple, they highlight a very important difference between symbol systems: Different symbol systems address themselves to different aspects of the natural or symbolic world, and present these while excluding others. A caricaturistic pictorial depiction of a political figure renders some qualities which are also rendered by a photograph of his, but each of them also renders unique aspects (Perkins, 1973). Heider and Olivier (1972), studied the codability of colors across languages, and concluded that visual memory plays an important role in recognizing colors. They interpreted the results to mean that visual memory is more appropriate for the specific attributes of colors and is less affected by the distortions and biases imposed by language. This, then, leads me to the first proposition: symbol systems differ from each other as to the aspects of events, ideas and phenomena which they can choose to represent and the ones they leave out.

This does not mean, however, that the symbol systems of media are mutually exclusive in terms of what they can render. A medium "spreads" over a number of instances, but it will have a central tendency which represents its most generic cases. It follows that "neighboring" instances within a medium and across media can render more similar aspects of the world, i.e., more similar contents, than more distal media. Thus, e.g., film and television can render more similar aspects of content than, say, film and maps. Still, even in our latter example, there will be overlaps of the contents which can be presented by the two media.

Cognitive representations

Overlap of rendered contents does not imply equal quality of rendition. Daily experience tells us that some symbol systems are better suited to carry particular contents than others. The motorist, being unsatisfied with a verbal description, asks for another symbol system, a map, which he feels serves better the purpose of guiding his driving. A small child will misuse the medium of drawing when asked to represent a collision betweeen two cars, and use the pencil and paper to symbolically re-enact the process. Drawing, for him, is a relatively poor medium through which to express the quality of movement. Indeed, the intuitive experience that some media can better represent some contents than others was very much at the base of the many intermedia comparisons.

But what does it mean that one medium is "better able" to represent some aspects of content than another? If one medium has the means to represent a particular aspect while another does not, then the answer is self-evident. Pictures cannot inform us of conditional events or causes as they do not entail in their symbol system any logical connections, equivalent to "if," "nevertheless," "because," or "not." Similarly, graphs are better capable of rendering mathematical relations between variables than, say music, because the latter does not entail in its symbol system any code which handles such relations.

There are, however, media that have the symbolic capability of rendering qualities that other media can also represent. Films try sometimes to capture the content of a novel and a verbal direction is given to a motorist in the absence of a map. The "roots" of a family can be verbally described or presented via a "family tree," and students in schools are asked to enact an event they have read. But why do we get the feeling that all symbol systems, even when representing the same content, are not equally well suited to communicate that content?

One way to answer this question is by looking at the "resemblance" between the presented and the represented. One could argue that a symbol system that "resembles" more the referent, or copies it more accurately, can "better" convey it. Gombrich (1974) suggests that pictures should be ranked according to the "amount of information about the prototype that they encode." Gardner, Howard and Perkins (1974) claim that "the information a symbol conveys is taken to be the properties of the referent that can be inferred from the symbol." This in turn implies the existence of "imitative" informing, as when "a property of the symbol implies the very same property of its referent."

However, "resemblance" is an ambiguous term. There are different ways of "resemblance." Moreover, many of the events and entities to be represented by a symbol system are either symbolic themselves, or have no physical dimensions to which a symbol can be resembled. Can the word "freedom" be said to resemble to a larger or smaller extent the quality of life to which it refers? In what ways does the table of chemical elements resemble the elements more (or less) than their verbal description? And why do the subjects in the Jones (1966) experiment have less difficulty complying with the instruction "Mark the numbers 3, 4, 7, and 8," than with "Mark all the numbers except 1, 3, 5, 6"? It cannot be said that the former instructions "better resemble the referent" than the latter. Pictures are usually better remembered, on the average, than words. But this would be the case also with pictures of unicorns or demons, although they neither "resemble" their referents, nor has any of the tested subjects ever seen such objects. Last, if a symbol system "better" communicates some content because its symbols resemble the referent more closely, then no large cultural-age- or individual-differences ought to be found in the ease or accuracy of perceiving a message. Still, the research literature is filled with studies that show such differences (e.g., Olson, 1970; Cole & Scribner, 1974; Cronbach & Snow, 1977). The presence of such observed differences in the perception and interpretation of coded messages clearly suggests that the information to be extracted is not "in" the stimuli, replicating the same kind of information that is available in the "ambient optic arrays of an ordinary environment" (J. Gibson, 1971). Because if it were, no such differences could have been found.

Note that underlying the notion of "resemblance" lies the conception of the symbol user as an active encoder or interpreter. Gardner et al. (1974), Gombrich (1974) and Goodman (1968) speak in effect about the relations between a symbol and one's expectations. Much depends, even with pictures that seem to "resemble" their referents (let alone language) on the mental schemata one brings to bear upon the stimulus. Anderson, Reynolds, Schallert and Goetz (1977) provide evidence to show how one's participation in a special interest group affects his/her schemata that are used in interpreting prose. The same is the case with pictorial material (Deregowski, 1968; Neisser, 1976).

As there is no one way that the world really looks or is, there can be no question of "resembling" it in a "better" or "poorer" way. Rather one can speak of the correspondence between how an aspect of the world is presented and the schemata into which it is to be assimilated. In other words, the factor that makes one mode of presentation "better" than another is the correspondence between the presented coded message, and the mode in which it could best be internally represented and processed. To anticipate my arguments, the closer the correspondence between the way, say, a spatial content is presented and the mode in which one mentally processes spatial information, the less mental "translation" and elaboration is needed, and the "better" the communication. Let us elaborate on this contention.

There are recent attempts to show that all incoming information, regardless of format and symbol system, is processed in a uni-modal fashion (e.g., Pylyshyn, 1973; Palmer, 1977; Rosenberg & imon, 1977). The proposed model for information processing is quite parsimonious, as it postulates that there is one mental representational system ("propositions") "which is well suited to the kinds of operations that are performed upon it" (Norman & Rumelhart, 1975). But a parsimonious model may attribute very non-parsimonious operations to human beings.

The empirical evidence seems to weigh however more heavily in favor of a conception of a dual, even multiple representational system (e.g., Kosslyn & Pomerantz, 1977; Metzler & Shepard, 1974). Attempts to explain the differential effects of pictures and words on memory in terms of internal verbalization (Rohwer, 1970), thus postulating a uni-modal system for internal representation, received less empirical support than dual-modality conceptions (Pressley, 1977). The conception of human cognition that emerges postulates the existence of a verbal representational system, an "analog" or "parallel" system, and possibly additional systems as well (Kintch, 1977). The study of human intelligence (e.g., Snow, 1978) offers additional support to this conception, showing that different types of problems are "served" by different aptitudes.

Neuropsychological evidence, although not unambiguous, supports the general contention that different symbolic modes of information input are processed in different parts of the brain (e.g., Gardner, 1974). With maturity, cross-modal associations in the brain allow increased combinations between incoming modalities. It is nevertheless the case that the left hemisphere seems to play a major part in the processing of linguistic, discrete symbol systems, while the right hemisphere is more active in processing dense figural ones (Gazzaniga, 1974; Gardner, 1977). A recent study by Gardner (unpublished) has shown that people with left hemispheric damage read logos as pictures, while others with right hemispheric damage read them as notational symbols or words.

It becomes evident that different kinds of coded contents are processed by different systems, so to speak, of our cognitive apparatus. From here follows my second proposition that different symbolic modalities of information input are, initially at least, handled by different parts, or systems of our cognitive apparatus. This would be the case even when two messages, differently coded, attempt to present the same content. But if the incoming messages make intial contact and are initially processed by different cognitive parts, systems or schemata, then it follows that different "anticipatory schemata" are brought to bear on them. These schemata, although not totally mutually exclusive, differ in what they entail (stored information) and in what information pick-up they determine (Neisser, 1976).

Amount of mental elaboration required

As the evidence I have cited above tends to indicate, our internal systems seem to specialize in handling different kinds of coded information. We do not have to postulate any absolute correspondence between the symbol systems used in communication and those which serve in thinking (but we will examine this possibility later on). Suffice it to assume, as Kosslyn and Pomerantz do (1977), that internal representations may vary as widely as external (communicational) ones, with each being efficient for certain tasks and contents. Metzler and Shepard (1974) point out with reference to the internal system in which the spatial manipulation takes place, that

> "the crucial requirement is that the internal representation or process correspond to the external object or its transformation by virtue of a relation that is merely one-to-one—not a relation of concrete structural resemblance" (p. 147).

Brooks (1967, 1968) asked subjects to "consider a set of several intersecting streets with which you are familiar . . ." Then a series of specific spatial problems was presented to them. The subjects found it more difficult to check their answers off a piece of paper than to report the answers aloud, indicating that to imagine looking at something makes it difficult to look at something else. In other words, checking answers off a piece of paper forced the subjects to deal with a symbol system which addressed itself to an internal representation already "occupied" with the same kind of stimuli. Huttelocher (1973) points out the consistency with which people report converting verbally-presented spatial problems into spatial modes of internal representations. All of this seems to suggest that there can be different degrees, so to speak, of correspondence between the incoming mode of a presentation and the mode in which the content, so coded, is to be processed and stored. It follows that when there is a poor match between the modes of presented and internally represented information additional "translations," conversions or elaborations are utilized.

There is evidence to show that the amount (and the nature) of mental elaboration has much to do with the correspondence, or match, between the communicational and internal representation. Rosch (1977) noted the consistency of people's ratings of particular category membership ("robins" - "birds") according to their "typicality." She argues that there is a prototype bird—and this is what people have in their minds when they use the word "bird." In studies of verification times it was thus found that the more closely a word came to its stored prototype, the quicker it was verified. In a study by Pressley and Levin (1977) second- and sixth-graders learned a list of paired-associate words which was presented at either a slow or fast rate. They were either instructed to generate interactive images or not instructed to do so. The list entailed either high-imagery or low-imagery words. Second graders benefited from the imagery instruction when the pace of presentation was slow, or—under the rapid pace condition—only with high-imagery pairs. Imagery instructions facilitated learning as they led the children to translate the pairs from one mode to another. But as this process takes time, such instructions could facilitate learning only when enough time was provided.

Research on the comprehension of syntactically different sentences shows a similar pattern: They often need to be transformed from one structure into another and this take time and mental effort (e.g., Savin & Perchonock). The amount of mental elaboration required by a sentence depends to a degree, on the "distance" between the presented surface structure of the sentence and its internal representation arrived at (Olson & Filby, 1972).

The comprehension of a text is, however, also aided by the generation of imagery-like meanings, and this requires additional elaborations. Thus, when children who learn prose are given ready-made pictures to accompany it, their learning improves. This is particularly the case with smaller children or those who usually learn prose poorly (e.g., Guttman, Levin & Pressley, 1977).

If imagery is indeed required for prose learning (see also Singer, 1978), and if smaller children have difficulties generating the images, then providing them with ready-made ones short-circuits, or circumvents, that process and thus facilitates learning by saving the learner additional elaborations. In other words, the structural options available in a symbol system can put a heavier or lighter burden on the receiver of an instructional message, depending on the correspondence between the presented and the receiver's schemata. Writes Kintsch (1977):

> "Novels or movies are easier when the natural order of events is maintained than when they are full of flashbacks and reversals, but since the latter invite deeper processing they are more interesting to read or watch" (p. 315).

In studies on comprehension, Fillenbaum (1971, 1974) asked subjects to paraphrase sentences, some of which were "perverse"—"Don't print that or I won't sue you." Over 60% of the subjects 'normalized' the perverse sentence—"If you print that, I'll sue you." He concluded that the principle of sensible discourse blinds the subjects to perverse information. As each symbol system has some underlying generic characteristics (e.g., non-notationality, density) we may therefore generalize the case by postulating our third proposition that other things being equal, different symbol systems address themselves to different parts of our cognitive apparatus and require different amounts of mental elaboration. The hypothesis follows that a medium such as television, whose principal symbol system is pictorial, may address itself to the viewer's non-linguistic mental system. And as much meaning depends on the viewer's images, the medium can be said to short-circuit the process of imagery-generation and thus be "better" (i.e., <u>easier</u>) than, say, print. Little wonder that it is often preferred over print.

But the amount of mental elaboration to be performed is not determined <u>only</u> by the nature of the symbol system. Three major classes of variables contribute to this: cognitive development, individual differences of skill mastery and processing preferences, and the perceived requirements of the task to be performed. The latter factor deserves some elaboration.

First, there are different levels, or "depths" of processing information. It is quite obvious that one's quick glance at a painting, aimed perhaps only at identifying the depicted object in it requires less mental elaboration than, say, studying its style and mode of depiction. Similarly, studying a list of paired associates in a rote manner requires less effort than attempting to generate sentences or images that interrelate the members of each pair.

Craik and Lockhart (1972) have postulated the existence of levels of processing, suggesting for instance that more elaborate ("deeper") analyses lead to better retention of learned material. The progressive levels extend from shallow (concerned with the physical nature of a stimulus, its surface appearance) to deep processing (semantic analysis). Meaning is given at each such level of analysis, or processing. In two related studies, Bobrow and Bower (1969) found that subjects directed to look for misspelled words or to repeat sentences, apparently processed the verbal material at shallower levels and were subsequently less able to recall either the words or sentences, than subjects whose task required processing at the level of meaning.

Kintsch (1977) argues that the metaphor of "<u>depth</u>" of processing may be misleading. Indeed, if information is translated from one mode (say verbal) into another (visual)--the notion of "depth" may be wrong. But this does not change the essence of the argument: There can be more or less processing of a coded message depending on one's perception of the task.

Secondly, there is no one internal mode into which coded messages need to be translated. The kind of internal representation one ends up having is partly related to the kind of task he/she is to perform on it. Subjects in one of my studies were required upon seeing a film, to either generate alternative hypotheses about its plot or to notice many details. The hypotheses generators, translated the filmic messages into internal verbal propositions, as could be witnessed by a high correlation with verbal ability. Not so the detail-watchers. Relying on imagery seemed to be much more appropriate for them. As also the film was pictorial--they needed to invest much less mental effort.

On the basis of problem solving studies, Olson and Bruner (1974) argue that "information which was coded appropriately for purposes of recall was, as a consequence, coded inappropriately for purposes of solving a problem" (p. 127). Hence the conclusion that "knowledge is dependent on or is limited by the purposes for which it was acquired" (p. 127).

I can now correct our previous proposition by suggesting that--relative to one's cognitive make-up (including cognitive growth and individual differences) and to the task to be performed--different symbol systems require different amounts of mental elaboration.

Why then does one symbol system appear to be "better" than another for the communication of some content? It should be evident by now that "better" means--mentally easier. Hence, the reason why the subjects of Jones' (1966) had more difficulty with the negatively stated verbal instructions was that it required more mental transformations from surface to deep structure. On the other hand, the comprehension of sentences became easier for the subjects of Graf and Torrey (1966) because sentence constitutents were identified for them, thus saving them mental effort.

One symbol system communicates "better" than another not because of the existence of any resemblance between the presented and its referent (should such a referent exist at all). Rather it is because--one symbol system, when compared with another, can present the information in better correspondence to--or isomorphism with--the mode of internal representation which a person (with a given cognitive make-up and task) can best utilize. Thus, it follows that the closer the resemblance, or isomorphism, the easier it is for the learner.

Pictures, or for that matter any medium, do not communicate "better" than, say, verbal descriptions as a general rule. Nor do they communicate better (when they do) because they are more "similar" or isomorphic to the rendered content. Rather, pictures can communicate better to the extent that the symbolic codes they use come closer to, or are more isomorphic with, the internal representation which the learner ought to generate, given his cognitive make-up and the requirements of the task. The same could be true for words or sentences. To the extent that one needs verbal mediation to solve a problem, or to depict a picture, a ready-made verbal presentation would "save" him/her some mental elaborations and hence will be "better," i.e., mentally easier, presentation. The less that person is capable of producing the needed internal verbalization--the more would a verbal presentation facilitate his/her performance. Similarly, mathematical relations between variables are better communicated through graphs than through a verbal sequence, because a graph more closely corresponds to the internal representation of these relationships which the learner should generate.

A number of new hypotheses can be derived from our consideration of the psychological and instructional differences between symbol systems. For instance, television's great appeal can be explained in terms of the relative ease of processing that its primary symbol system allows when one is free to define the task-requirements of home televiewing. As some of its messages address directly the non-linguistic internal systems, thus saving the young viewer cross-modal elaborations, the messages yield relatively satisfactory information with little effort. The next hypothesis then could be that young viewers would tend to show reluctance to deal with the more mentally demanding codes of the medium (i.e., prefer entertainment over educational programs), and television in general over, say, reading. May this not be related to recent declines in SAT scores (see Wiley, 1976)? A similar hypothesis, based on the rapid pace of TV's scenes has been advanced by Singer (1978). Similarly we could hypothesize that the use of a medium such as television could facilitate learning to the extent that its pictorial symbolic components are used to short-circuit critical mental elaborations which learners have difficulties carrying out on their own.

The differential utilization of mental skills

The propositions that different symbol systems render different aspects of content, that they may address themselves to different parts of our cognitive apparatus, and that—for some learners under some task conditions--

possibly require varying degrees of mental elaboration, does not exhaust the range of possible connections between them and cognition. One may ask whether two different symbol systems (attempting to convey the same content to the same person for identical purposes) would require the same sets of mental skills for the extraction and processing of the information. In light of what we have argued this far, the answer appears to be simple enough. As differently coded information is dealt with by different parts of our cognitive apparatus, and is elaborated upon in different ways until it is translated into the person's preferred modes, also different mental operations, or skills, are utilized.

Such an approach is taken by Perkins and Leondar (1977) who state that "symbol systems are neither better nor worse but are simply different as the degree of notationality varies and as they differ in style of information processing they require of the maker or reader" (p. 9). Also, Eisner (1978), Olson (1974b), and Gross (1974) make a similar claim.

Yet, one could raise the question whether the utilization of mental skills is related to the <u>symbolic, structural</u> attributes of a presentation, or to its specific <u>semantic</u> nature. Do two different stories when verbally told require more similar mental skills than one of the two when compared with a visual rendering of the same content?

Oversimplifying a bit an intriguing dispute in cognition and in psycholinguistics, we may say that the answer depends on one's theoretical leanings. It follows from the information-processing, uni-modal approach to cognition (e.g., Pylyshyn, 1973; Norman & Rumelhart, 1974; Sternberg, 1977) that as symbol-systems do not really play a differential, central role in processing and storage, that only the specific semantic meanings of messages are to be considered. Hence, whatever is decoded, translated and analyzed, is then turned into propositions that map upon a semantic network which gives it meaning. A somewhat different answer follows from the dual-system (e.g., Pavio, 1971) and multiple-system (e.g., Kintsch, 1977) approaches to cognition. As information can be processed and stored in more than one way, its surface nature, including its symbolic qualities, should play an important role in determining how it is to be processed.

A parallel dispute can be found in psycholinguistics. Away from Chomski's theory of generational grammar, which strongly emphasizes syntax, there is presently a growing interest in the semantic nature of sentences. This shift deemphasizes the structural, syntactic nature of sentences as carriers of meaning. The argument reasons that since the listener's goal is to determine how each sentence was meant to be utilized, she/he focuses on content words and their meaning (e.g., Fodor, 1975; Schank, 1972; Winograd, 1972).

As is often the case with such disputes, the answer may entail elements from both sides. Our case seems to parallel the contemporary integration of two traditional rivals--behaviorism and cognitivism--into one working model utilized in psychotherapy (Mahoney, 1977). In the present case this would mean that both syntactical as well as semantic information play important roles in comprehension.

Clark & Clark (1977) propose fourteen strategies of inferring meaning from language, seven of which are syntactic and seven semantic. They postulate that listeners rely on flexible combinations of these strategies in order to comprehend a sentence. Thus, they claim, every sentence has two levels of structure--its surface structure (roughly equivalent to the syntactical nature of language) and an underlying representation of meanings (interrelated propositions). Apparently one has to deal with both, in speaking and in listening.

Bever (1970) has argued that since comprehension is goal-directed, the listener (we might add—also the perceiver of other symbol systems) uses specific strategies to get to meaning. But the listener, according to Bever, performs syntactic analyses only when necessary for comprehension. Kintsch (1977) makes a similar point, extending the argument to novels and films, and Gombrich (1974) does the same with reference to pictures.

It seems then, that the question is not whether only syntax or only semantics play a role. Rather, it is a question of when, why and under what conditions does the syntactic, symbolic nature of a system play a significant role in comprehension. There is little doubt that it does play a role under some (internal and external) conditions and for some purposes. This is exemplified in a study by Strohner and Nelson (1974). Children were asked to interpret four sentences:

> The cat chased the mouse
> The mouse was chased by the cat.
> The mouse chased the cat.
> The cat was chased by the mouse.

Two and three-year old children interpreted all four sentences in the same way—the cat chased the mouse. The authors concluded that these children were using semantic information to make sense and ignored syntactic information. By age four- and five-years the children interpreted all four sentences correctly, apparently able to consider syntactic information as well as semantic.

A coded message biases the information relative to the way one would most conveniently represent that information internally. Thus, the larger the bias--the more do we need to "transform" the code from its external code to an internal, more convenient one. When there is good correspondence between the two, as observed by Olson and Filby (1972), the syntactic or symbolic structure of a message can be more or less ignored. But when the deviation of external from internal code is large, the code (or syntax, if you will) needs to be transformed in the service of information extraction.

Since symbolic codes differ as to the ways they deviate from internal representations, they require different amounts and different kinds of mental elaboration. That is, different mental skills need to be employed. This conclusion is in agreement with Olson and Bruner's argument (1974) that while means of instruction converge as to the knowledge they convey, they differ with respect to the skills they require.

Let me narrow the discussion down to two hypotheses. First, other things being equal, different codes require different skills in the service of knowledge acquisition. Second, the acquisition of knowledge from a coded message will depend on the mastery of code-specific skills to the extent that the code deviates from one's way of internally representing the information for the given task.

An experiment: Cohen and I carried out a study to test these hypotheses (Salomon & Cohen, 1977). We decided to take a conservative route, thus not to compare symbol systems or media, but rather--coding elements within one symbol system, that of television. We had one television film shot in five versions. Each version strongly emphasized another code: close-ups and long shots, zoom-ins and out, logical gaps, fragmented space, and a "neutral" version which was as straightforward and common as possible. The content, actors, scenery etc. were identical in all versions. Israeli fifthgraders, 44 in each group, were our subjects. They were all pretested on a battery of mental skill tests whose validity and reliability was examined independently. After viewing the film in either version, we posttested the children on two knowledge acquisition tests pertaining to either the details or the overall plot-line of the film.

The results confirmed our hypotheses. First, knowledge acquisition depended on previous skill mastery, but the nature of the contributing skills differed from version to version, along expected lines. Thus, for instance, the skill of relating parts to wholes correlated .67 with knowledge acquisition in the close-up-long-shot version, but no more than .22 to .39 in the other versions. Similarly, visual memory correlated .41 with knowledge acquisition in the logical-gaps version, but between .18 and -.15 in the other versions. Thus, it seemed evident that even within one symbol system, <u>with content held constant</u>, different coding elements require different skills in the service of knowledge acquisition.

Second, there were two findings that qualify this conclusion in accordance with our second hypotheses. Knowledge acquisition from our "neutral" version did not depend on the mastery of any one of the measured skills. Indeed, we assumed that version to be common enough to code the information in ways that more or less corresponded to our subjects' internal representations. This, as we found, seemed to be the case.

Even more interesting is the comparison between the close-up and the zoom version. These two versions were absolutely identical but for one thing: the close-up version left a gap between each long-shot and a close-up, thus it was likely to <u>activate</u> the skill of relating parts to wholes, while in the other version this gap was <u>bridged for</u> the subjects through the zoom operation.

Indeed, the pertinent skill correlated .67 with knowledge acquisition in the former version, but only .27 (n.s.) in the latter.

Thus, we find that a code can execute for the learner the very same mental operation another code calls upon. The former, we might say, overtly supplants an operation (in our case--relates parts-to-wholes for the viewer) and hence makes mastery of the related skill quite unnecessary. Relative to a code that activates a skill (i.e., calls upon it to transform the code), the supplanting code does that for the learner. By doing so, it seems to compensate for the poor mastery of the skill, as experienced by some learners. Moreover, to the extent that the code overtly supplants (or simulates) the necessary skill, it makes external and internal representations correspond to each other quite well.

Some extensions: If codes within a symbol system, when sufficiently emphasized, call upon different mental skills, it would be reasonable to expect different symbol systems which are utilized by the media, to differentiate among constellations of required skills even more. Some of the ATI studies (e.g., Koran, Snow & McDonald, 1971; Marantz & Dowlaby,) bear this out. Thus, our findings tend to agree with Olson's claim (1974b) that "in mediated experience, or instruction, the content of the medium relates to the knowledge acquired while . . . the code in which the message is represented is related to the skills . . . that are called upon" (Olson, 1974b, p. 21).

But note that while the same general rule may apply whether music is compared with, say, poetry or a zoom-in with a close-up in film, it would be unreasonable to claim that skills of the same magnitude are involved. More likely, the size of the symbol unit involved (e.g., cartography vs. contour lines) will be related to the generality of the skills called upon. As larger symbol units are involved, more general abilities, or skills are called for and when smaller units are involved, more specific skills are employed. This, then, implies two hierarchies--one for symbol systems, ranging from whole systems to specific codes, and one for abilities, ranging from general ability (say, G) to highly specific aptitudes. These two hierarchies can be argued to parallel each other, although we would hesitate to postulate a perfect match between the two.

Crystallized ability (Gc) may be relevant to most acts of schooling in our culture, as it reflects skillful use of past experience in that situation (Snow, 1978, in prep.). But spatial skills may be relevant only when mental rotations or other such transformations are needed (Cronbach & Snow, 1977). Similarly, the cluster of skills identified as "film literacy" (Worth, 1968) may be needed when the filmic symbol system is involved to enable learning from films (Snow, 1963), but one's skill in spatial reconstruction is relevant only when space is fragmented in films, as our experiment shows.

Snow (1978) offers an organizational scheme of abilities and aptitudes, based on recent analyses of large quantities of data. According to Snow, human abilities can be arranged from central (e.g., Letter Series) to peripheral (e.g., Film Memory) in a Radex-like fashion. The continuum from peripheral to central regions of abilities implies, among other things, the processing of increasingly more complex information, and a parallel increase in depth of cognitive processing. Most importantly, the proposed continuum is paralleled by environmental requirements. Drawing upon Feldman's proposed continuum (1978) of achievement domains that ranges from the universal (e.g., conservation) through the cultural (e.g., reading), to the unique (e.g., painting), Snow proposes a similar continuum of environments. These range from the universal through the cultural and disciplinary, to the personal, according to the abilities and skills that they require, and (as we shall see next) also cultivate.

This, then, results in a two dimensional model in which the interaction between environments and mental competencies interact. Note, that a diagonal band is implied by this scheme--starting with the interaction of universal environments with universal achievement on one side and gradually moving to the other corner where highly specific environmental elements interact with specific mental skills. Thus, for example, schooling, as Scribner & Cole (1973) show, uses a wide range of intellectual tools covering a variety of tasks and contents. But the specific method of discovery learning, when used in schools, taps more specific abilities or competencies that are applicable to a narrower range of events (Egan & Greeno, 1973).

Media, and the symbol systems they make use of, seem to belong to the cultural region of this scheme, while specific coding elements within symbol systems would be placed somewhat closer to the other, more specific end. Thus, it follows that while all (say) television shows tap some relatively general skills, partly shared also by other dense symbol systems, the commercial interruption taps more specific skills, and the zoom calls for even more specific ones. The reason, as we have suggested earlier is that a coding element — whether iconicity in general or a specific style in art — requires skill to transform it from surface to deep internal sturcture. The "size" or magnitude of generality of the skill involved will thus depend to an extent on the size of the coding unit.

The Cultivation of skills

The proposition that different symbol systems of media call for different mental skills leads to still another implication: skills which are called upon and successfully utilized may also be cultivated.

Writes Bruner (1964):

> "Where representation of the environment is concerned it . . . depends upon techniques that are learned--and these are precisely the techniques that serve to amplify our motor acts, our perception, and our ratiocinative activities" (p. 2; italics added).

It could be postulated on the basis of cross cultural, instructional, and cognitive research, that as skills are called upon by symbol systems -- they can also become cultivated. Furthermore, to the extent that a symbol system calls for a more general skill, one that is higher up on the skill hierarchy discussed earlier, it may cultivate a more widely transferable skill. On the other hand, a highly specific code will activate and cultivate a less transferable skill, thus contributing only to "media literacy."

For example, the newly introduced social orders in Central Asia studied by Luria (1974) in the 20's affect skills higher up the hierarchy than those affected by schooling, as studied by Scribner and Cole (1973). Schooling in turn affects more general skills than the ones developed by the use of the abacus (Hatano et al, 1977), which are more general than those affected by specific Tv codes studied by us. Note, however, that the same principle governs all of these, thus -- to paraphrase Bruner -- function may cultivate organ.

However, there may be a far more interesting way through which media affect congition. Eisner (1978), Olson (1977b), and numerous others speak of the use of symbole systems as tools of thought, analogous perhaps to our use of language in thought. Such a possibility is quite reasonable if we assume as Brown (1965), Bruner (1966), Olson (1977), Shepard et all (1975), Kintch (1977) and others do, that there is some isomorphism between communicational and internal codes. Here is a personal account given by a Stanford graduate:

> "I am fascinated by how my daydreaming is influenced by movies. Processes and techniques of presenting events by this Hollywood symbol system are powerfully implanted within my cognitive system. I have observed 3rd person narration, flashbacks, zooms, slow motion emphasis of action, audience viewing, "time tripping," re-takes, "voice of conscience," multi-personality dialogue, background music, and many other movie menas of expression in my head. I fear that there is very little original style to my daydreaming. It is all influenced by celluloid. . . . There are exenes where I am climbing steps to address a large audience and television shots in slow motion symbolize the slow and hard road to this point in my career. There are zoom-ins to significant others and flashbacks to significant moments. . . ."

The whole idea may sound to you as coming straight out of Whorf. This possibility is examined somewhere else (Solomon, 1979, in prep.) and is partly rejected. I think that the possibility of using media's codes in thinking is more akin to Schlesinger's account of the interplay between cognitive development and linguistic input (Schlesinger, 1977) according to which:

> "After he has constructed a map of the world through his extra-linguistic experience, the child utilizes linguistic input to draw in the borders between adjoining categories. Now we suggest that linguistic input may also be responsible for constructing certain parts of the map itslef" (p.).

The same, claims Schlesinger, applies to the interpretation of the world by the developing child.

But note that the language that figures in thought (if this is to be our best example) comes from the outside world of communication. How then is it transformed from a communicational sysbol system into an internal one? I think that Vygotzky's (1962) and later Luria's (1974) accounts of <u>internalized speech</u> can serve us well. Still, the promising analogy between language and other symbol systems may badly mislead us. For language is acquired and possibly internalized through <u>active interactions</u> with a language community. <u>But few, if any children at all, interact with others through the symbol systems of non-linguistic media</u>. Does this mean that coding elements from the media cannot be internalized and used as tools of thought?

Let us note that a child apparently does not internalize speech but rather language.[3] It is not necessarily the activity that counts, (although it strongly facilitates the internalization of language). No wonder, therefore, that even deaf children learn to use language in their thinking (Furth,). Thus, if it is language, the symbol system, that ultimately serves cognitive functions, then why not other symbol systems as well?

Observational learning appears to be a possible mechanism through which communicational coding elements can become internalized. This possibility has been suggested in studies of linguistic observational learning (e.g. Bloom, Hood and Lighbower, 1974); Brown, 1976). This then could answer our question.

Not quite. Lest we oversimplify our case by arguing that all the symbol systems we encounter through the media can be internalized, we have to at least show why a code would be learned at all. For a coding element to be used in thought needs to accomplish a useful function for the learner.

One function is to call upon a mental transformational skill in the service of information extraction. However, this assumes the learner to have already some mastery of it. You cannot exercise a skill that isn't there. While cultivation-by-activation may benefit learners of initial fair mastery of the relevant skill, it cannot serve the one with initial poor mastery. Moreover, this function (skill activation), helpful as it might be, has little to do with the internalization of a code.

Given the assumed possible isomorphism between external and internal codes, I would argue, as I did earlier, that a code can supplant a mental operation, i.e., execute overtly an activity that the learner ought to carry out internally. Indeed, to the extent that a code can overtly simulate an operation that the learner should have — but could not — generate on his/her own, it

3 For a discussion of this point see Olson (1970) chapter 10, Olson (1973) and Olson & Bruner (1974).

could be learned by observation and internalized to be used as a schematised tool of thought. Thus, it would lead one to become capable of "dissecting nature or creating artifacts in terms of whatever symbol systems one considers relevant, useful or interesting" (Olson, 1977b, p. 9).

But only transformational codes, (e.g., zoom; rotations, etc.) that are isomorphous to transformational thought (Berlyne, 1965) could supplant a mental operation; and this — only when the cognitive goundwork has been parpared and there's a need for such an operation. What about stationary codes (e.g., spatial arrangements, category labels, perspective, styles in paintings)? Here, as I have argued earlier, a code can short-circuit a process by providing ready-made its resultant stationary representation. Thus, for instance, a "family tree" is the result of some organizational operations, and a graph — the result of interrelating operations. But such a coding element does not carry the operations out.

I would submit that while a stationary code can be learned, to be used as a mental tool it requires the previous mastery of the skills that could generate it internally. One could not learn to think in terms of, say, the spatial representations of maps unless he/she has mastered certain spatial operations that lead to that representation. This, I think, is the reason why Sinclair-de-Zwart (1967) failed to enhance children's conservation by providing them with ready-made verbal principles, but did succeed to enhance the developmentally earlier behavior of seriation. Similarly, the Kendlers could train children to use specific category labels to enhance non-reversal shifts only when prerequisit skills were already mastered.

I have identified here three possible functions of symbolic codes that could facilitate their acquisition for mental use. A code can activate a skill, it can short-circuit it, or it can overtly supplant it. Activation of skills can cultivate their mastery, but it requires the prior existence of some reasonable mastery of the skill. Otherwise there would be nothing to cultivate. Thus, a skill-activating code could benefit only learners of relatively moderate mastery of the relevant skill. Short-circuiting, as I have argued, while saving mental effort, cannot teally cultivate the mastery of a skill, as it assumes the prior mastery of it. Finally, overt simulation can allow a learner to internalize the code itself, provided it supplants a needed operation which the learner does not yet master. It would benefit mainly those with initial poor mastery of the skill.

There are two points to be noted here. First, the hypotheses advanced above are skeleton hypotheses. They do not enumerate the codes that function in one way or another, as a code's function depends very much on the learner's cognitive make-up and the demand characteristics he encounters. I could argue that some symbol systems (e.g., in film) have the potential of supplanting specific — usually figurative — mental skills and therefore can be made to have skill-cultivating effects. But I cannot attribute a fixed psychological function to each code and assume that it accomplishes it for all learners under all conditions.

Secondly, we should note the relationship between the hypothetical single code with which we have dealt with here, symbol systems, and media. Coding elements can be of varying sizes: the zoom-in, the flashback, the editing style or the non-notational character of films in general. Some coding elements are minute, while others are much larger units that entail some of the most pervasive characters of a symbol system (e.g., notationality of musical scores). Yet, the hypothetical function which we have attributed to coding elements are independent of their sizes. To paraphrase Singer's hypotheses (1978) we could argue that the non-notational, dense, nature of television's pictoriality short-circuits the processes of generating images. The medium's symbol-system provides the images ready-made and may therefore make young viewers dependent on them, without, at the same time, developing their imagery ability. Note that the same logic applies equally to small as well as large coding elements.

Empirical Evidence

Shortage of time and space prohibits me from describing in any detail the series of studies which were carried out to test these, and additional hypotheses. Interested readers could find them described in Salomon (1974, 1974c, 1976, 1977 and 1979, in prep.), and in Salomon & Cohen (1978).

In one series of experiments we wanted to see whether coding elements of film or TV can be made to have skill-cultivating effects. This was not an attempt to show that that's the way codes affect us "naturally." Rather, we asked whether such effects are possible at all. In that series we studied the cultivation of such skills as cue-attendance, spatial transformations, field dependency, and changing points of view. Rovet (1974) continued this line of work studying Shepard's spatial rotations.

The results, by and large, were consistent. Both skill activating and skill supplanting codes led to significant improvements of the studied mental skills when compared to either short-circuiting codes or to controls. As expected, Ss with initially fair mastery of the relevant skills benefited from codes that activated them. Supplanting skills for them caused interference. On the other hand, Ss with poor initial mastery benefited from supplanting codes but not from the activating ones.

Interestingly enough, it became evident that filmic supplantation, and the observational learning it allows, compete with internal verbal processes. Thus, verbally inclined Ss seemed to rely even more heavily on their verbal skills in the face of non-linguistic supplantation. On the other hand, less verbally inclined Ss learned best from supplantation, which seemed to compensate them for their poor verbal ability.

These stidies, although of short duration, have shown that coding elements of a symbol system can be made to cultivate the mastery of mental skills by either activating or by supplanting them.[4]

It is, of course, an unresolved issue whether skills were indeed cultivated. In light of Cole's comments on Luria's findings (Cole in his forward to Luria, 1974), it is possible to interpret our findings as showing changes in the application of previously available skills to new problems encountered in the experimental settings. Such an interpretation woudl suggest that nothing new has been added to the Ss' congnitive apparatus. But then, the cultivation of a mental ability -- expressed in its new applications --, may be exactly that. Wrote Luria (1974):

> "The entire complex process, which is closely related to the incorporation of language into the child's mental life, results in a radical reorganization of the thinking. . ." (p.11).

If the coding elements of media's symbol systems serve "only" such functions, then the use of media as mere transmission systems would look uninteresting, and their study as missing the central issue.

In a second series of studies we tried to see whether the coding elements of television affect mental skills also under "natural" conditions. The first study took place when Sesame Street, with its radically novel codes, was shown to (then) television-naive Israeli children. A large scale pre and post test design, with a number of intermediate measures of exposure to the program was used. Two controlled experiments accompanied the field study. Altogether about 500 children took part in the study. Generally, our hypotheses pertaining to the program's effects on skills, were upheld.[5] Exposure to the program (remember its novelty of codes and formats as compared to what appeared to the Israeli kids as common contents) led to improved mastery of specific skills which were either called upon or supplanted by the novel codes. As in the

---

[4] For more specific details of the studies see Salomon (1974c) and Rovet (1974).

[5] For more specific details see Salomon (1974b) and Salomon (1976).

previous experiments, significant ATI's, as well as interactions with SES, emerged.

There were also important age differences. Preschoolers were less affected by the codes than second and third graders. In agreement with Gardner's findings (1972) pertaining to style sensativity in children, KG children were much more subject-matter oriented than our grade school children. The former, it appears, felt little discrepancy between the level of information processing they aimed at and their inability to transform most of the rather demanding codes. Thus, they extracted mainly that knowledge (usually in bits and pieces) that did not require transforming new codes into internal representations.

School children were much more affected. In addition the more they were exposed to the program, the stronger became the correlations between relevant skill mastery and knowledge acquisition. But there were also undesirable results: Ss who were experimentally assigned to watch a heavy diet of the program showed a drastic decrease in their wilingness to stick to a non-rewarding task. Apparently, not only abilities, but preferences as well, can be affected by a medium's symbol system.[6]

In our last study we compared American and Israeli children. We reasoned that as Americans are the heaviest know TV viewers they should have, other things being equal, a significantly better mastery of (only) the TV-related skills than Israeli children. We also reasoned that in both groups accumulated exposure to TV should correlate with the mastery of these skills. The results, by and large, supported our hypotheses but in unexpected ways.

Defining "exposure" as one's attempts to cope with coded messages and extract at least the simplest kinds of information, we developed a measure

[6] This change, which we attributed to the program's overall mosaic-like structure is in agreement with a similar finding by Singer, Tower, Singer & Biggs (1977).

of "literate viewing." To our amazement we found that something akin to channel capacity takes place, which limits amount of processed TV messages, regardless of amount of viewing time.

More importantly, we found the Israelis -- with one channel to watch, one set at home, and no color TV — to be heavier viewers than their American counterparts. Apparently, different social settings define television watching differently, thus encouraging children to invest more (or less) mental effort in coping with the messages. Consequenlty, it was the Israeli sample whose studied mental skills were more affected by the medium and correlated higher with amount of exposure. When children try to cope with the codes of a message to get at more information, their mental skills can be affected more profoundly.[7]

Tying It All Together

I did a great injustice to the field and to my own research by trying to summarize it all in one paper. I can easily imagine the harassed reader being bombarded by sketchy arguments and hurried through the much too brief discriptions of empirical studies. Let me then try to put all this together in a relatively concise form.

I have started out with the bold claim that media research in education has, by and large, run out of steam. And perhaps for good reason as the overriding finding was that media *per se* have no consistent differential effects on learning. That research was mainly exploratory, and it served a purpose: It taught us to avoid the a-theoretical and much too general questions. A turning point has come and we can move from exploration to more focused search.

But focus, I claimed, on the most generic class of media attributes, that which not only differentiates among them but also touches theoretical grounds

---

[7] For a more detailed description of this complex study, please see Salomon 1977 and 1979 (in prep.).

with learning. This class of attributes is media's modes of packaging and presenting information -- their "languages," or symbol systems. These, I think, relate to cognition and to learning more than any other generic attribute of media. Moreover, by dealing with media's symbol systems we can touch base with the study of the arts, and psycholinguistics.

In what ways, I asked, can media's symbol systems be related to those cognitive functions that may interest us as educators? First, they address themselves to different aspects of the content conveyed through them. Secondly, they are processed by different congitive systems or apparati, hence -- given a particular learner and a particular task -- some require more mental effort in processing than others.

Third, symbol systems vary as to the mental skills they require. These mental skills are needed to transform communicationally coded messages into internal representations. There are different degrees of correspondence between external and internal codes, depending on the person and the task to be performed. Different amounts of transformational activity and qualitatively different kinds of skills are required by symbol systems. This, I suggested, is the case regardless of the "size" of coding elements, be it, say the alledged linearity of print or a passive sentence. In fact, there may be two hierarchies - one of coding elements ranging from whole symbol systems to specific codes, and a second, parallel hierarchy, of mental abilities, ranging from general to specific.

I have not mentioned here, although the issue begs itself, the topic of meaning. Do symbol systems vary only as to the mental skills they require, but converge as to the knowledge they specify, as claimed by Olson and Bruner (1974)? My guess is that this can indeed be the case, provided the coded messages carry knowledge that can be mapped onto a large knowledge base.

We can assume that the large body of stored knowledge has reached the person through different symbol systems and has been elaborated upon, processed and transformed by the different cognitive systems. Knowledge we know, does not necessarily stay in the system in which it was initially processed, nor does it stay unconnected to other, related knowledge. This suggests that as we have a wider knowledge base pertaining to some entity, the less modality (or symbolically) specific it is likely to be. To use then Piagetian concepts, as the information can be more easily assimilated into one's schemata without requiring its accomodation, the less would it matter how it is symbolically "dressed."

But what when the incoming coded information entails very novel information relative to one's schemata? Generally, it requires greater changes in one's schemata, and more mental elaboration (Greeno, 1977), much like the message carried by a symbol system that does not correspond well to one's representational system.

Thus, as more elaboration needs to take place, and as symbol-system-specific skills are involved, also different meanings ought to be construed on the way. We can formalize this point by proposing that the extent to which different symbol systems yield different meanings, other things being equal, is a function of the novelty of the conveyed information. It follows that it may not matter much through what symbol system I acquire information about, say, a new experimental design, but it matters alot whether I learn about space flights from a picture-film or a lecture.

Finally, I suggested that media's symbol systems can cultivate mental skills, perhaps like language that is internalizable and used as a tool of thought. Language acquisition heavily depends on human interaction. What about the symbol systems of media? These, I argued, could be acquired through observational learning.

Three functions were attributed to codes to qualify them as skill-cultivators: Activating skills, short-circuiting skills and supplanting skills. Only the former and the latter could be expected to cultivate skill in strong interaction with individual differences. The experiments, field-, and cross-cultural studies that I have mentioned, generally supported these expectations.

What does all this imply? First, the research findings lend credence to the overall claim that media ought to be looked at through the keyhole of their symbol systems. Secondly, both the rationale and the findings suggest that there is to media more than meets the eye. For if media's symbol systems can indeed affect, or be made to affect, the mastery of mental skills, then using and studying media as convenient postal services misses perhaps their <u>greatest</u> potentials and dangers.

What, for instance, about the possibility that television cultivates mental skills which are at odds with those required by the print oriented school? We know hardly anything about the former skills. Could they develop <u>at the expense</u> of school related skills? In addition, if television's symbol systems save, so to speak, mental effort by allowing pleasurable extraction of information with little mental elaboration, what <u>preferences</u> are cultivated by the medium?

There are positive aspects to all this as well, some of which have been suggested by Gardner (1977), Olson (1977b) and Eisner (1978). But we are only now beginning to study them.