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ABSTRACT

The author reviews and evaluates the principal theoretical measures of attention categorized in three areas: self-report measures, operant behavioral measures, and psychophysiological measures. Self-report measures include a variety of rating scales, interest and attitude scales, Krugman's "number of 'connections,'" and program audience analyzers. Operant behavioral techniques evolve from the conditioning paradigm of Skinner and include response accumulators, tachtiscopic studies, and "shadowing." The psychophysiological measures are connected to attention by the Sokolov theory of the neuronal model. The author discusses these measures in terms of recent studies, methodological pitfalls, and future opportunities for those engaged in communications research and the specific variable of attention. Finally, he develops a mathematical model of attention, based on McPhee's survival theory. The model is constructed on the premise that the brain is a random system and that it is the attentional process that establishes the cognitions from which language and other social behaviors evolve. (Author/RN)

Attention as a Variable in Communication Research--The Status Quo

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A B S T R A C T

The measures of attention are reviewed in three broad categories--self-report measures, operant behavioral measures and psychophysiological measures. Self-report measures include a variety of rating scales, interest and attitude scales, Krugman's number of "connections," and program analyzers. Operant behavioral measures have evolved from Skinner and include response accumulators, tachtiscopic studies and "shadowing." Psychophysiological measures are connected to attention by Sokolov's notion of the "neuronal model." Overall there is considerable agreement about the notions of attention in spite of the diversity in measures. A mathematical model of attention based upon McPhee's survival theory is finally proposed and discussed. The model appears to explain the selective mechanism of attention as it operates on the individual and the social level.

ATTENTION AS A VARIABLE IN COMMUNICATION RESEARCH--THE STATUS QUO

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William James discussed the phenomenon of attention at some length:

> The immediate effects of attention are to make us:
> (a) perceive
> (b) conceive
> (c) distinguish
> (d) remember
> better than otherwise we could--both more successive things and each thing more clearly. It also:
> (e) shortens 'reaction-time' (James, 1890, pp. 424-425).

To one extent or another each of the effects enumerated by James has been used to measure attention. Associated with the measures for attention are several seminal notions of the phenomenon which are of some consequence to communication researchers. In the discussion of attention measures which follows the various techniques have been grouped into three general classes--self-report, operant behavior and physiological.

Self-Report Measures

An instance of a self-report measure used in the evaluation of printed material are the Readex, Incorporated, ratings of pharmaceutical advertising evaluated by Robert Ferber (1966). These Readex ratings were concerned with material distributed to physicians in Modern Medicine. For every issue of this journal a sample of physicians was sent an extra copy with instructions to mark advertisements and editorial items remembered as of interest. Ferber found that this measure of attention was affected by the physical characteristics of the advertisement but unaffected by dislike of the item advertised or discussed.

Krugman (1967) has proposed a measure of advertising involvement which seems related to other self-report measures of attention. Drawing from the introspective analyses of Titchener, Krugman defines involvement as "the number of 'connections', conscious bridging experiences or personal references per minute, that the subject makes between the content of the persuasive stimulus and the content of his own life (p. 584)." The connections are determined in face to face interviews as the test stimuli are being presented.

A means of collecting self-reports of interestingness (and probably attention) from a group of subjects assembled in an audience is the program analyzer. Each member of the audience controls a switch which may be turned through three to five positions marked off by adjectives from uninteresting or dull or boring to interesting. Over some specified time interval each switch is sampled electrically, and a cumulative counter or pen recorder provides a total for each possible response during the interval. Lindsley (1962, p. 2) reports that the first program analyzer was built by Lazarsfeld prior to 1940 and that a newer analyzer built for CBS is now used by Screen Gems in program evaluation. The Wisconsin Sequential Sampling Program Analyzer is a portable version of this device and was used by Irwin and Brockhaus (1963) in evaluation of public relations speeches. These investigators found their program analyzer measure to be dependent on the novelty content of speeches being presented but independent of the good will produced. Highlander (1954) found program analyzer results to be positively related to recall. A number of commercially manufactured devices called responders or response evaluators are on the market today and suitable for use as program analyzers.

By far the most common self-report measure of interestingness (a notion which appears to include both attention and attitude according to Fletcher, 1971) is a five position paper-and-pencil rating scale with poles of interesting and uninteresting or equivalents. In one version for evaluating broadcast entertainment a series of such scales are printed consecutively on a long page or in a booklet. Members of the in-home audience are asked to check a scale at each of a number of predetermined intervals during selected programs. Goldberg (1950) used this technique to evaluate a radio and television simulcast of Arthur Godfrey's "Talent Scouts." He found the television group recorded higher interest and performed better on a retention test of program content.

The typical experimental situation in which interestingness is examined is one in which a single rating scale for interestingness is administered following presentation of a stimulus. Dietrich (1946) measured attitude change and interestingness following two radio commercials. He reported correlations of .40 and .48 between interestingness and attitude change. Tiemans (1965) attempted to validate ratings of informative speeches with retention tests. He reported "some positive" correlation between ratings of interestingness and retention. Trenaman (1951) reported a curvilinear correlation between interest and information gain such that both very low and very high interest produced low information scores. Livingston (1961) reports no connection between interest and retention. An exception to the single scale pattern was Brandon (1956) who used an interestingness instrument of four scales to compare instructional television production techniques. He did not indicate the reliability of his instrument but did report a slight relationship between interestingness and information gain.

In sum, little of the reliability or validity of self-report measures of interest and attention has been reported. Some inferences may be drawn, however, from studies in which interestingness has figured as one of the scales of a semantic differential. Carroll (1969) in his semantic differential study of prose style used an interesting-boring scale. He reported an item reliability for this scale of .78. In addition, the interesting-boring scale weighed .84 on his principal factor, "General stylistic evaluation (p. 596)." In their evaluation of twenty psychological journals Jakobovits and Osgood (1969) employed a semantic differential which included a dull-interesting scale with a reported communality of .78. This scale weighed .73 on a factor also described by an impersonal-personal scale and labeled "interestingness (pp. 610-611)."

Operant Behavior Measures

A quite different approach to attention and interestingness was proposed by Lindsley (1962), a student of B. F. Skinner. Based on his study of operant conditioning, Lindsley felt that attention values could be established by determining the effort a subject would put forth to continue the presentation of a test stimulus. A button was installed in the arm of the subject's chair. The button had to be pressed at least sixty times per minute in order for adequate brightness to be maintained on the screen of the television set presenting the stimulus. The rate of button pushing by the subject in his attempt to see the stimulus on the screen was recorded by a cumulative response recorder. Lindsley reported that the attention value of commercials during a rerun movie on television were about ten per cent lower than those for the movie itself.

Nathan and Wallace (1965) used the same principle in a study of the effectiveness of television commercials. Subjects were required to push one foot pedal at a programmed rate to maintain screen brightness and a second pedal to maintain adequate volume for the auditory channel.

Buchanan (1964) incorporated a related idea in a paper-and-pencil test. He presented subjects with a list of film titles, asking which they would like to see. Choices were interpreted as desire for additional information--the interestingness of product names which had been incorporated into the film titles.

Berlyne (1965) used tachtiscopic presentation of stimuli as a dependent variable in studies of curiosity, a variable Berlyne and others have associated with attention. The subject was allowed to operate the switch controlling a tachtiscope which consisted of a short-decay phosphor fluorescent light box in which stimulus cards were placed. One press of the switch by the subject lighted the stimulus for .14 seconds. The attention value score was taken as the number of times the subject lighted the tachtiscope for each stimulus, an indicator of the effort the subject was willing to put forth for the stimulus. Caffyn (1965) recommended a similar technique for evaluation of advertising materials.

Still another interesting approach to the measurement of attention is summarized by Norman (Ch. 2) who reviews the contributions of information theorists to the study of attention. He describes message shadowing, first used by E. Colin Cherry in the early fifties, as an applicable technique. Two aural messages are simultaneously presented to the subject. The subject is then required to orally repeat--shadow--as he listens, one of the two competing messages, while ignoring the other. The number of errors made by the subject in this task may be taken as the failure of the message being shadowed to attract attention from the competing message.

The Orienting Reflex and Physiological Measures of Attention

The concept of the orienting reflex (OR) has been traced to a 1910 address by Pavlov (Sokolov, 1963, p. 11). Lynn (1966, p. 1) suggests that Pavlov's interest was attracted when dogs being conditioned by his students turned their attention to the entrance of the professor at the expense of conditioning tasks conducted by Pavlov's students. The OR is defined by Sokolov (p. 11) as a non-specific reaction which better prepares ("tunes") a sensory analyzer to perceive a new stimulus. Maltzman and Raskin (p. 1) list the objective measures of the OR as "depression of the cortical alpha rhythm, the galvanic skin response, pupillary dilation, and a complex vasomotor response consisting of cephalic vasodilation and peripheral vasoconstriction."

Lynn (p. 5) gives the function of the OR as preparing the organism to deal with a novel stimulus. Berlyne (1960, pp. 96-103) has listed as collative variables--stimulus characteristics which should influence the OR--intensity, color, indicating stimuli, novelty, surprisingness, complexity, uncertainity, incongruity, and conflict. Both of these lines of reasoning would seem to connect the OR to attention and Maltzman and Raskin advocate "attention" as the appropriate explanation for the OR. They observe (pp. 10-14) that the conditions antecedent to attention in older conceptions of the term arouse the OR. Further they point to the instrumental influence of the OR as a determinant of learning. As noted in the quotation from

William James, a positive effect on learning has traditionally been associated with higher levels of attention. Lynn and Sokolov summarize a considerable number of studies which tend to confirm the nature of the OR and its positive effect upon sensitivity to stimulation and upon learning.

Sokolov (pp. 282-294) has advanced a "neuronal model" explanation for the influence of stimulus novelty upon the OR. His explanation posits that a cell system (model) recording the characteristics of a given stimulus situation is established in the cerebral cortex while the OR is elicited by that stimulus situation. When the model is established, incoming sensory information is compared (matched or mismatched) with the model. If a match occurs, a signal is sent to the reticular activation system (RAS) (which controls the OR) inhibiting the OR. This process accounts for the habituation (decreasing physiological evidence for the OR) that occurs as a stimulus is repeatedly presented.

The burden of the "neuronal model" explanation is that a series of filters established by sensory experience determine whether or not the OR--attention--is to be directed to a stimulus. This explanation resembles Broadbent's filter explanation of attention (1953) and seems to fit the Deutsch and Deutsch (1963) requirement for a threshold of attention, non-specific in nature and residing in the reticular formation.

A Stochastic Explanation for Attention

Berlyne (1960) invokes the Shannon and Weaver mathematical theory of communication (1949) in his explanation of arousal. The model that follows is similar in that it is also an attempt to explain in probablistic terms how the OR determines the attention patterns and response inventories of people.

Let us stipulate that the possible interneuronal connections of the cerebrum represent a sample space of events of very nearly equal probabilities. Some of the probabilities of interneuronal connection depart from equality by reason of proximity to specialized areas, such as afferent pathways, or by reason of propensities, such as structural capacities for interconnection with other neurons. In addition to these initial nearly equal probabilities of neuronal interconnection, two other rules govern the probabilities of the system: (a) interconnection of any two neurons at one time increases by some small amount the probability of their interconnection at a later time, and (b) every afferent signal entering the cerebral system must leave it as an efferent impulse.

Let us follow a new signal entering the system. A series of interconnections are made. Since the probabilities of interconnection for this first signal are very nearly equal, the path described by this series of interconnections (let us call such a path a trace) is very nearly random. Hence we say that there is much uncertainty, ambiguity or novelty about this incoming signal. Those stimulus characteristics, as we know, trigger the OR, and the sensory system is made more sensitive to signals like the one just received. Because of the heightened sensory sensitivity resulting from the OR, a second signal with about the same characteristics as the first will enter the system of interneuronal connections. Since the first trace now has had its probabilities of interconnection slightly increased by the first signal, the second signal is somewhat less likely to take a random course. As a result, the second signal represents less uncertainty, ambiguity or novelty, and the OR, which responds to those stimulus attributes, is somewhat smaller. The process is repeated until a later trace encounters a highly probable path of interconnections, one which departs considerably from the random. When the probabilities of a particular path for a given signal are high enough, the signal has become certain, clear or familiar. In this case the efferent impulse from the cerebrum becomes an inhibition of the OR, and we conclude in Sokolov's terms that a "neuronal model" has been established for that stimulus and the sensory signals it causes to be delivered to the cerebrum.

The model has explained how a single "neuronal model" happens; what about association, the case in which a signal activates more than one "neuronal model"? In association we may imagine that an incoming signal is partly familiar, partly novel. The novel part activates the OR and a "neuronal model" for this novel component of the signal is established. The new "model" has a certain probability of costimulation with the original but familiar "neuronal model," corresponding to the familiar elements of the new stimulus. We may call collections of related "neuronal models" schemata using Bartlett's term (1932).

Schemata, in turn, may be classified functionally or ontogenetically. In functional terms, some schemata may be perceptual, summarizing signal attributes which are triggered by a particular stimulus in any sensory apparatus--ears, eyes, et cetera. Other schemata are response schemata, providing repertories of familiar responses to expected perceptions--attitudes, habits, response tendencies.

Ontogenetically one might isolate relational schemata which record appropriate relationships among signals about self, symbolic schemata which associate language symbols with certain patterns of perception, syntactical schemata which affect expectations about sequences of symbols, and social schemata which establish patterns for interaction of the individual with others.

The model offered here is admittedly brief and simplified but is consistent not only with Sokolov's concept of "neuronal model" but with Staats' explanation for acquisition of language and attitude (Staats, 1967a, 1967b; Staats & Staats, 1967) and with Maltzman's (1968) conception of semantic generalization.

Building a Mathematical Model for Attention

The various attentional measures summarized above reflect a basic concensus about the construct, attention, as described by advocates of consciousness-centered psychology, by students of attitude change and persuasion, as well as by psychophysiologists. In each case, attention to some stimulus is seen as determined by past patterns of attention, by specific attributes of the stimulus and by the relationship of the stimulus to the context of the subject. For example, Pillsbury (1911, Chap. I) emphasized the importance of past experiences, especially education in "determining the stimulus that shall be appreciated (p. 113)." Hovland and his associates in Experiments on Mass Communication (1949, p. 81) recognized that attention and interest were, in turn, important concomitants of the educational process. Sokolov and other psychophysiologists (Fletcher, in press) agree that attention is a basic process establishing the cognitive and behavioral domains of the individual.

A potentially useful step in refining and integrating behavioral data and findings with respect to attention may be to develop a mathematical model of the attentional process incorporating those features about which the available evidence is unambiguous and on which the authorities seem to agree. From the discussion above the verbal form of such a model would appear to be:

a. Attention is a selective mechanism. . .

b. By which the organism processes external stimuli. . .

c. According to the familiarity of the stimuli in the contexts in which the stimuli occur,

d. Consistent with the associations aroused by the stimuli which in turn have evolved from past associations and social influence . . .

e. And collectively act to produce the behavioral repertory of the individual.

The notion referred to earlier--that the brain is a random system--may provide justification for a stochastic model for attention. One formal model that appears appropriate is McPhee's survival theory (1963, Chap. I) which has the general form (pp. 29-34):

$$S = (A+B+C) + (aA+bB+cC) + (a^2A+b^2B+c^2C) + \ . \ . \ . + (a^nA+b^nB+c^nC)$$

where S = sum of surviving cultural offerings

A = proportion of new cultural offerings each period which are of Class A

B = proportion of new offerings which are Class B

C = proportion of new offerings which are Class C

1.0 = A+B+C = "input" = total new offerings each period

a = probability Class A offerings will survive one elimination, i.e., survive into the next period

b = probability Class B will survive one elimination

c = probability Class C will survive one elimination

A more general form of McPhee's model, one which would provide for N classes of material in the culture undergoing n eliminations might be:

$$S = \sum i_N^n I_N$$

where S = sum of cultural offerings still in currency

I_N = the communication in the Nth category into which offerings have been divided

i_N = probability that category I_N will survive a single elimination

n = number of eliminations

In this light the culture of any group would consist of the sum of communications in currency or available for consumption within the group. Another way of summarizing the burden of McPhee's model is to point out that it describes the result of the "selective attention" exercised by a society. In short, it is a mathematical expression for the "cultural indicators" proposed by Gerbner (1968) and the socialization process as it is evidenced in the mass media (see Gerbner, 1964, p. iii).

Significantly, at the same time, the general form of McPhee's survival theory aptly characterizes the process of building "neuronal models" described by Sokolov. In this case the mathematical form is the same with some modification of the definitions involved:

$$P = \sum s_N^n S_N$$

where P = personality, the sum of stimuli for which "neuronal models" have been established

S_N = Stimuli in the Nth category into which stimuli in the individual's context have been classified

s_N = probability that S_N will elicit a detectable orienting response after a single presentation

n = number of repetitions of S_N

Furthermore it is apparent that s_N can be entered into a prediction formula of the Bayesian form, for s_N is the probability that a specified response, the OR (or R_O), will be present when S_N is presented. In other [redacted] terms

$$s_N = p(R_O \mid S_N)$$

In addition, the literature in psychophysiology has developed a number of stimulus characteristics which are known to influence the magnitude of the orienting response (hence attention). It may be possible these same characteristics influence the likelihood of a communication's survival in culture, i_N. Stated in proposition form, the magnitude of i_N or s_N are affected as follows:

I. All else being equal, the more prevalent or probable the occurrence of a stimulus (S_N) in the context of an individual or the occurrence of a communication I_N in a culture, the smaller s_N or i_N.

II. All else being equal, the greater the likelihood that S_N or I_N is already known as the specific sign for a greater demand of any nature upon the individual or the society, the larger will be s_N or i_N.

III. All else being equal, the greater the relevance of S_N or I_N, or, in other words, the greater the number of related, associated "neuronal models" or current social communications connected with the S_N or I_N, the greater the value of s_N or i_N.

Other similar propositions are possible. These three appear supportable from evidence cited in the references.

The implications of the observation that similar propositions control the attention of the individual's attontion and of the attention of society provides additional insight into the operations of society, for it explains the influence of individual attention on society and vice versa.

A fascinating line of research by the Finn psychophysiologist, Carl Hagfors (1970) is discussed at length elsewhere (Fletcher, in press). The basic rationale involved is that the physiological responses indexing socialized attentional patterns will be synchronized in time across subjects. As a result the electrophysiological signals are additive when individual patterns of attention are synchronized (socialized) representing socialized patterns and tend to cancel each other when not synchronized (not socialized).

Hagfors' method provides a means by which the influence of society is manifest in individual patterns of attention. At the same time, in his studies of audience response to feature films, Hagfors has demonstrated that these socialized response patterns can be used with other data to produce predictions of box office success which result in multiple correlations as high as +.92 with actual box office figures (p. 118). In short, these patterns of socialized attention, in turn, influence what is current in the culture at large.

Overall the potential significance of attention as a construct in the study of communication and in the behavioral sciences at large appears to be in a promising and attention-worthy renaissance.

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