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ABSTRACT

The relationship of eye movements while watching television to reading ability, cognitive style, and mode of presentation was studied using as subjects 85 third-grade children who had been classified as good or poor readers by scores on the Gates-MacGinitie Reading Test; their cognitive style was measured by the Children's Embedded Figures which classified subjects as field dependent or independent. A Polymetric Eye Movement recorder was used to measure attention as children viewed seven static and seven dynamic segments from The Electric Company. The results indicated that the effects of these factors varied from segment to segment although several overall effects achieved significance. It was concluded that eye movement research is a useful tool for assessing individual differences across instructional modes. (Author)

Eye Movement Research and the Interaction Between Television and Child-related Characteristics

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Synopsis

The relationship of eye movements while watching television, reading ability, cognitive style, and mode of presentation was studied. Eighty-five third grade children were classified as good or poor readers (Gates-MacGinitie Reading Test). Cognitive style was measured by the Children's Embedded Figures which classified subjects as field dependent or independent. A Polymetric Eye Movement recorder was used to measure attention as children viewed seven static and seven dynamic segments from The Electric Company. The results indicated that the effects of these factors varied from segment to segment although several overall effects achieved significance. It was concluded that eye movement research is a useful tool for assessing individual differences across instructional modes.

Eye Movement Research and the Interaction between Television and Child-related Characteristics

Lois J. Baron

Research (Gagne, 1970; Salomon and Snow, 1968; Snow and Salomon, 1968; Salomon, 1972) has stressed the importance of the three-way interaction between the medium, the individual learner, and the learning task. This study exemplifies what Salomon and Clark (1977) have called a "fusion" of what had previously been examined through linear investigations of main effects. The research performed here can be described in terms of the definition of media research as the investigation of the psychological and instructional effects of media on the responses of individuals. This particular study describes, through the analysis of eye movements measured during the viewing of both dynamic and static television presentations, the perceptual analysis of individuals possessing differing degrees of field-independence-dependence and reading proficiency.

In perceiving, the individual constructs his world according to both the features of the stimuli before him, and the organization of his own cognitive structure. The gaze, as it is called

(Mackworth and Bruner, 1970; Mackworth and Morandi, 1967), is initially controlled by the display, but eventually becomes an instrument of thought. Studying the eye movements of field independents and field dependent individuals, and good versus poor readers lends insight into comparisons, if any, of developmental shifts from global processing to highly differentiated modes of perception.

Wolf (1971) and others (Fleming, 1969 and 1970) have supported the view that "the study of eye movements allows for an unusual opportunity for determining the reaction of viewers to stimuli materials." (Wolf, p. 113).

The research carried out here was based on the underlying assumption that a child's eye fixations reflect his cognitive approach to the task and that eye movements are indicative of attending behavior. Support for such an assumption is well founded in the literature (Mackworth and Bruner, 1970; Mackworth, 1967; Guba, Wolf, de Groot, Knemeyer, Van Atta, and Light, 1965; Gould, 1967, 1973; Gould and Schaffer, 1965a, 1965b; Gould and Dill, 1969; O'Bryan, 1969; O'Bryan and Boersma, 1971; Noton and Stark, 1971; Vurpillot, 1968). The research performed here investigated both individual difference and stimulus-related characteristics while at the same time examined the interaction between these factors. The primary objective of this research was to study by means of eye movement photography the attentional

processes related to the organismic variables of field-independence-dependence and differing levels of reading proficiency, and to test whether there was an interaction between these factors and the element of movement in the stimulus presentation.

Eye movement research into the process of reading has generally found that reading proficiency varies with both the ability of the reader and the complexity of reading material (Tinker, 1947; Taylor, 1957, 1960; Conant, 1965; Fleming, 1969; Mackworth and Bruner, 1970; Nodine and Lang, 1971; Edelfat, 1975; Rayner, 1975). There is no doubt that eye movements can provide a way of observing the relative effectiveness with which a person reads (Taylor, 1960). Without attending to the stimuli it would be very difficult to process any information which in turn benefits reading operations (Mackworth, 1972). By providing descriptive information, this eye movement research attempted to lend insight into possibly different response availabilities between poor readers, bound to simple decoding, and good readers, analyzing at higher levels up the hierarchy of word and letter recognition.

There has not been much eye movement research as it relates to the area of field-independence-dependence although two particular studies (Conklin, Muir, and Boersma, 1968; and Boersma, Muir, Wilton, and Earham, 1969) have found differences in such scanning strategies as track length and information search. Originally defined by Witkin (1954, 1962, 1964, 1977), field-

independence-dependence has been used to describe individual differences in overcoming embedding or potentially distracting contexts. Field independent persons possess a more analytic approach to tasks, in contrast to the global field approach characteristic of field dependent individuals (Witkin, 1962). The eye movement indices chosen for this study served as a description of those behaviors which are normally attributed to field independent individuals while at the same time specified the global characteristics of field dependent persons. An intention of this study was to assess the possibly embedding nature of various televised stimulus segments and to examine through eye movement analysis how embeddedness (or distractibility) may have affected the attention of field independent and field dependent children. Of particular importance to this study was the ability of the television code variable of motion to separate figure from ground. A number of arguments for action on the screen are found in research (Fowles, 1973; Rovet, 1974; Allen, 1975).

The appeal for research whose major aim is to examine stimulus characteristics as well as person-related variables had motivated this study.

Previous research comparing the various media as methods of presenting visualized instruction had been inconsistent in its conclusions, although it was generally acknowledged that no significant differences had resulted in most studies comparing

the effectiveness of two or more visual media (Dwyer, 1973; Jamison, Suppes, & Wells, 1974). Salomon (1974) suggested that researchers must look at those variables peculiar to one medium itself. The importance of looking at the "symbol system unique to each medium" (p. 386), and how it interacts with certain learner characteristics results in more insights concerning individualization and the nature of the medium. Looking at the various forms of information representation and how they are operated on by an individual is more beneficial than studying differences across the technologies themselves. Studies of this sort touch the heart of the issue - "the relationship between the way information is externally represented and how it is internally processed" (Conway, 1970, p. 159).

Television possesses pictorial, symbolic, and verbal characteristics (Allen, 1970). According to some theorists (Olson, 1974; Olson & Bruner, 1974), the individual learner must become aware of the code within a symbol system in order to benefit from instructions. When producing a symbol system code for a particular learner it is important to take into account the possibility that too many irrelevant cues may also hinder learning. Rust (in Fowles, 1973) reiterated the point that such high appeal characteristics as rhythm, rhyme, and electronic bridges may be distracting as well as attention-getting.

In looking at the medium of television, one would classify movement as a code variable. Allen (1970) proposed the need for

studies comparing action and non-action within the medium. He also stressed the necessity of including individual aptitude variables in research of this sort and advocated further investigation into those variables dealing with the perceptual processes and how they interact differentially toward certain media elements.

The appeal for research whose major aim was to examine stimulus characteristics as well as person-related variables motivated this study.

In the nature of formative research, existing segments of the Children's Television Workshop program The Electric Company were examined by means of eye movement photography. By doing so insights into the nature of the attentional behaviors of good and poor readers, and field independent, field dependent children were observed in interaction with televised segments from the program. As well, the nature of the stimulus element of movement and its resultant effect on attention was observed.

The independent factors of reading proficiency, field-independence-dependence, and dynamic versus static stimuli were examined in terms of their contribution to five eye movement measures - (1) orientation time to target or the length of time taken by a subject before making a fixation on a target area (word or sentences) once it appears on the screen (ORIENT) (2) percentage of fixations on target (FIXATION) (3) percentage of time on target (TIME) (4) left-to-right movements or direct-

ional attack (L→R) and (5) average length of fixation or fixation duration on target (AVERAGE). These measures have been used in past eye movement research studies which, in being selected for this research were considered useful indicators of how persons would interact with a stimulus presentation on the television screen, (particularly one involving "reading"). These indices provide information as to whether and how an individual is directing his eye fixations to targets on the screen, and also furnish insight into the effects of stimulus variables on eye movements.

In light of the literature concerning field-independence-dependence, reading proficiency, mode of instructional presentation, and eye movements, the following objectives or research questions were formulated:

1) By means of eye movement data, to gain more insight into the relationship between field-independence-dependence and reading proficiency.

2) By means of eye movement research, to determine the effects of the media element of movement on the visual patterning of good and poor readers and field independent and field dependent individuals.

3) By means of eye movement research, to further investigate differences in perception between good and poor readers.

4) Utilizing eye movement research, to examine perceptual differences between field independent and field dependent persons.

The general objective of this research study was the following: In the line of formative or ongoing field research using eye movements as a dependent variable, the research was performed in order to acquire more knowledge about the communication process between the medium and the individual.

It was hypothesized that good readers, field independent individuals, and dynamic stimuli would yield the more proficient and analytical scanning strategies exemplified by significantly faster orientation times to print, a significantly greater percentage of fixations on the target words, a significantly larger percentage of time on target, a significantly larger percentage of directional attack on target, and significantly shorter durations of fixation.

Method

Subjects

The subjects (Ss) were 85 third-grade pupils (42 boys, 43 girls) from eight elementary schools in the Scarborough, Ontario, Board of Education. The Ss were chosen according to their comprehension scores on the Gates-MacGinitie Reading Test, Primary C, Form 2 (1964). The test scores were obtained by examining the individual record file for each grade three student in the normal stream for each school.

Those students scoring at least one and one-half standard deviations above or below the Borough mean reading score were

respectively assigned to good reader and poor reader groups. The Ss consisted of 41 good readers (15 boys, 26 girls) with a mean reading score of 40.82 and a mean grade equivalent score of 5.63, and 44 poor readers (27 boys, 17 girls) with a mean reading score of 10.93 and a mean grade equivalent score of 1.76.

Apparatus

A Polymetrics Eye Movement Recorder (Model V-1164-1) was used to record eye movement patterns (EMPs) in this study. Mackworth (1967) provided a detailed description of this line-of-sight recording equipment. Utilizing the corneal reflection method characteristic of this apparatus, a spot of light superimposed over the stimulus field was produced. These eye spots were recorded by a video camera as the Ss viewed the stimulus field on a nine-inch television screen housed at eye level approximately two feet from the subject. The location of eye spots was transmitted as digital signals to a PDP-9 computer.

Stimulus Materials

Segments from the Children's Television Workshop program The Electric Company (TEC) were used as a stimulus material. It was necessary to produce a stationary presentation from the already existing dynamic segments in order to assess possible differences in the quality of eye movements between dynamic and static modes of presentation. Doing so involved "freezing" the moving segments at particular intervals, juxtaposing the frozen

bits (or segments) in the same order as that of the dynamic presentation, and dubbing the identical voice track over the resultant visuals. This method insured maximum content comparability between the two presentations.

A dynamic and a static presentation were created consisting of seven "bits" or segments each. In the nature of formative research, the segments were chosen for their individual stimulus qualities (e.g. computer or electronic bridges, animation, distracting versus non-distracting field).

Procedure

Administering the CEFT

The Children's Embedded Figures Test (CEFT) was administered individually to all Ss to assess cognitive style. A standardized procedure for administering the test was outlined in the Manual (Witkin, Ottman, Raskin & Karp, 1971). For the purposes of the analyses carried out in this study, a mean split was performed to divide those Ss who were considered field independent (FI) from those who were field dependent (FD).

Eye movement recording procedure.

Subjects entered the eye movement laboratory individually. The eye movement recording device was explained to the Ss. They were told that the E was interested in monitoring their television-watching and that by allowing the E to do so, they were contributing to the betterment of television programs for all children.

The next task was to assure that each S was in an appropriate and comfortable position for viewing the television set. The height of the chair was raised such that the S's forehead would rest comfortably on a headrest attached to the equipment. A bite-bar was utilized to minimize any head movements of the Ss. Each S also had an elasticized sweatband placed around his/her head for the same purpose.

Once in a proper position for watching television, calibration of the recording equipment took place. To calibrate, Ss were asked to look at four corner dots and a center dot affixed to the blank television screen. The recording equipment was then appropriately adjusted.

Each subject viewed the two stimulus presentations--dynamic and static. The order of presentation for each S was previously determined with the aid of a table of random numbers. Between presentations each S was given a two-minute rest.

Scoring procedure.

As outlined previously, five eye movement measures were chosen for investigating the questions and hypotheses of this research study.

Before measuring the eye movements, it was necessary to specify the criterion for defining an eye spot as a "fixation" for the purposes of this study. Taylor (1960) points out that the average length of fixation for a third-grader is .28 seconds

(or 280 milliseconds) per eye spot. Owing to the fact that subjects in this experiment included children reading at levels as low as grade one, it was decided to establish .10 seconds or 100 milliseconds as the minimum amount of time necessary for an eye spot to be considered a fixation.

Before analyzing the data, it was necessary to insure validity of the measurements by eliminating defective recordings. Upon completing the data gathering, the video tapes of each subject's EMPs were reviewed without knowledge of the characteristics of that particular subject. Those segments lacking in calibration, as indicated by the eye spot being off the center spot of the screen following the termination of a segment, were excluded from analysis. This elimination process led to a possible situation in which for one particular subject there may have been only one or two good segments from which data could be analyzed. The program used in the final analyses comprised the necessary measures for the handling of missing data.

Preparation of Data for Analysis

In order to assess the eye movement patterns, information as to the exact time and location of each target was provided as data to the PDP-9 computer. The targets within each stimulus segment were a word or group of words, and the target field in which the eye movement measurements were made consisted of a four-sided figure surrounding these words. Targetting the dynamic segments

consisted of either targetting certain areas during the presentation where a target letter or word would lie at a particular point in time (e.g. Try, Dry, Shy), or targetting a larger area in which whole words or sentences would appear (e.g. the Princess and the Frog). Targetting the static segments consisted of a similar process in which the unmoving words or letters were targetted for their position on the screen. Targetting constituted transmitting a pulse from each corner of a target to be changed to numerical coordinate information in the computer (in the same manner as an S's eye spot). Once this information became computer data, the location and analysis of subject data, already stored on computer tape, was carried out on the eye spots occurring within the time of target appearances. With the time and coordinate information available within the computer, a series of programs reduced the data in terms of the five eye movement indices of interest to this study--orientation times (in thirtieths of a second), fixations on target (as a percentage), time on target (as a percentage), average duration of fixation (in thirtieths of a second), and left-to-right (L→R) movement (as a percentage). The eye movement information was identified and categorized for each segment and subject. In the final analysis only data from the stimulus first presented to a subject (dynamic or static) was utilized in the calculations.

Statistical Treatment of Data

A regression procedure was used specifying the analysis of

variance model. The particular program utilized was taken from the Statistical Analysis System (Service, 1972).

The program applied the method of least squares in fitting a linear model to the data. The variation attributable to each of the independent variables in the model (treated as classification variables) was examined as were the interactions of these variables on the five dependent or eye movement measures. Treating the variables as independent of each other was of concern to this study. For this reason, the partial sum of squares was the source of variation examined. The data analyzed was that available from each subject classified under either the dynamic or static condition, good reader or poor reader category, and field independent or field dependent classification.

Results

Regression analyses were calculated for each segment (referred to as ALL) as well as an overall analysis averaged over all segments together (MODE-AVERAGE). To account for the possibility that differences or lack of differences in the dependent measures could be due to long exposure to a stimulus, a regression analysis on information gathered during the early seconds of a segment's exposure was executed (INIT).

1) Orientation Time

Mode-Average data gathered throughout the segments revealed the only significant differences for this measure. Good readers did orient significantly faster than did poor readers ($F = 5.07$;

$p < .05$). Significant differences were found between field independent and field dependent subjects ($F = 4.74$; $p < .05$) and between males and females ($F = 5.49$; $p < .05$). Field independent subjects oriented to the target words significantly faster. Males also possessed significantly faster overall orientation times although in one particular cartoon segment girls oriented significantly faster to the target words ($F = 4.92$; $p < .05$).

Orientation time measures yielded three-way interaction and only on averaging data over all segments. The interaction of CEFT x SEX varied significantly with the presentation mode ($F = 4.63$; $p < .05$). The dynamic mode yield the shortest orientation time for both field dependent boys and girls.

The interaction of READ x CEFT x SEX was also significant ($F = 6.30$; $p < .01$). Both male and female, field dependent, good readers had the shortest mean orientation time.

Mode of presentation also varied significantly with the combination of both READ x CEFT ($F = 3.69$; $p < .05$) and READ x SEX ($F = 5.17$; $p < .05$). Shorter orientation times were discovered for field dependent, good readers in the dynamic condition, while female good readers also exhibited the shortest times in the dynamic condition.

Fixation

Significant differences in percentage of fixation on target between field independent and field dependent subjects were discovered in one segment ($F = 4.07$; $p < .05$) where field indepen-

dents were characterized as having more fixations on target.

Data for mode of presentation also confirmed the hypothesis on another segment for both ALL ($F = 4.57$; $p < .05$) and INIT ($F = 6.34$; $p < .05$) data. The percentage of fixations on target were not substantially differenct across modes for the other segments and averaged over the segments. Significant differences did occur between male and female on one segment (different than the above two segments) for ALL ($F = 4.38$; $p < .05$) and INIT data ($F = 4.80$; $p < .05$). In both cases girls fixated on target words significantly more than did boys.

One segment uncovered a READ x CEFT x PRES interaction (ALL - $F = 5.66$; $p < .05$) with the combination of poor reader x field independent x dynamic, demonstrating the largest percentage of fixations on target. Furthermore, two-way READ x PRES ($F = 4.83$; $p < .05$) led to significant findings when data was averaged for the segments taken together and only on INIT data.

Time

Data for two different segments (one for ALL data $F = 5.75$; $p < .05$ the other for INIT data $F = 5.57$; $p < .05$) resulted in significantly different percentages of time on target between good and poor readers. Both results supported the hypothesis. On examining Mode-Average data the hypothesis calling for reading proficiency differences on this measure was not confirmed.

Significant differences between the dynamic and static segments were revealed for ALL data on one segment ($F = 8.65$;

$p < .01$). In this particular case it was the static rather than dynamic presentation that resulted in more time spent on the target words.

Mode-Average data, on examining whole segments, resulted in significant male/female times ($F = 4.95$; $p < .05$). Girls spent a significantly greater percentage of time on targets than did boys.

CEFT x PRES was significant for one segment ($F = 10.08$; $p < .01$) with the combinations of field-independent static and field-dependent dynamic resulting in greater percentages of time on target.

Left-To-Right Directionality (L→R)

Significant results in an opposite direction than that predicted were found in early data for one particular segment ($F = 11.42$; $p < .01$). As well, early data for the same segment revealed that there was a significantly larger percentage of left-to-right movement in the dymanic presentation ($F = 8.65$; $p < .01$).

Average Duration of Fixation

In both ALL data for one particular segment ($F = 4.46$; $p < .05$) and averaged across segments ($F = 5.18$; $p < .05$) field independent subjects possessed larger fixation durations. Early data for two different segments showed that the static as opposed to the dynamic presentation did indeed lead to larger fixation durations ($F = 6.35$; $p < .05$) in one segment; while boys' fixations on target were significantly larger than girls' in another segment ($F = 6.60$; $p < .05$). ALL data on one particular cartoon segment lead to

significant CEFT x PRES ($F = 5.54$; $p < .05$) and READ x PRES ($F = 3.83$; $p < .05$) interactions. CEFT x PRES was also significant for Mode-Average data (ALL - $F = 3.80$; $p < .05$). In both cases the shorter fixation durations were characteristic of field independent subjects viewing the static condition.

Discussion

The following is an interpretation of the results as they relate to the more general research objectives asked of this study.

1. By means of eye movement data, to gain more insight into the relationship between field articulation and reading ability.

Past research has indicated that field-independence-dependence was not closely related to the verbal component of reading. From the perceptual analysis performed here, there was very little evidence to suggest that field-independence-dependence was related to the perceptual component of reading proficiency (at least on the eye movement measures used to describe reading proficiency in this research). Although there may be communality on other measures between those leaning toward high reading proficiency and field independency, eye movement data in this study revealed little evidence to demonstrate that good readers were good readers because they possessed a field independent cognitive style. Naturally such an influence is limited to the eye movement data in this particular study, but it does raise the question as to what is the link between the two variables.

2. By means of eye movement research, to determine the effects of the media element of movement on the visual patterning of good and poor readers and field independent and field dependent individuals.

The media element studied here was the dynamic versus static quality of the medium of television. It had been purported in the literature with little supportive research that the dynamic qualities of television were a useful aid in attracting and maintaining attention to the screen. Gross (1974) and Allen (1975) believed in the essential information - relaying nature of the code of instruction. Studying the dynamic versus static quality was essentially an investigation into the code of the medium of television.

It appears from the data that in a rather complex stimulus presentation the dynamic mode did prove to be beneficial in the case of a few of the eye movement measures while in another more slow-paced animated segment the static presentation lead to more time being spent on the target words. In another segment in which sentences were formed in a left-to-right manner by means of animation, left-to-right scanning patterns were reinforced.

Generally, the visual cueing characteristic of dynamism within the medium of television did not result in many significant differences in viewing patterns as measured by the eye movement indices of this research. The auditory component of the stimuli may have diminished differences, for as Mock (1975) indicated, the

auditory channel is a very strong cue as to where to look.

The general lack of significant findings in interaction with presentation mode seems to negate the possibility of visual supplantation. The results of this research suggests that movement was not necessarily an essential aid to particular reading or field-independent-dependent groups. Information as to where significant differences and interactions did in fact occur as a result of movement or lack of it should be exploited as a means of instructional assistance to particular viewers.

3. By means of eye movement research, to further investigate differences in perception between good and poor readers.

The results suggest that readers were only differentiated in the presence of particular qualities of a stimulus segment. As Rayner (1975) and Conant (1965) believed, it would appear that text not individual hypothesis testing determined eye movement patterns.

Questions which come to mind as a result of the analysis include the following: Was supplantation responsible for matching the eye movements of poor readers with those of good readers? Was it good readers' "sampling" (Wiener and Cromer, 1967) of the target that resulted in similar eye movements to those of poor readers in many instances? Were the stimuli not exciting enough to hold the attention of good readers? Were some of the segments not visually complex enough to allow for differences between the two groups ? Research questions such as these could be examined

by strictly producing segments geared toward such an investigation.

The results of this eye movement study did not support previous claims that good readers exhibit shorter durations of fixation when reading. In more cases than not, they not only paused as long when on target but also spent more time on the words than did poor readers. The findings related to the effects of dynamic versus static stimuli also seem to weaken the supplantation argument as it relates to readers.

The results of this study point toward stimulus-specific qualities of particular segments that resulted in any differences between the two reader groups. Further analysis into isolated elements of these segments would yield information as to the possible occurrence of common elements that differentiated the groups. Knowledge such as this would be useful to instructional media designers.

4. Utilizing eye movement research to examine the perceptual differences between field independent and field dependent persons.

Similar to the results related to reading proficiency, there existed rather segment-specific eye movement differences involving field-independence-dependence. In one particular segment and for Mode-Average data, field dependents did pause significantly longer when on target as they made an attempt to decode the words. These results were supported in the literature by claims of cognitive delay and the global field dependent style of processing, while the shorter durations were more characteristic of the focusing

in analytic mode of field independent individuals.

The question arises here as to whether the lack of significant differences is caused by individual or stimulus properties. Are qualities of the stimulus supplanting operations for field dependents or boring field independents? Are the stimuli not embedding enough to differentiate between the groups?

The shorter durations of fixation involving field independent subjects (at least for one segment and for Mode-Average data) seem to support a field independent sampling process that suggests that, characteristic to their style of processing information, field independent individuals spend time comparing target with non target areas as they attempt to find meaning in a stimulus complex.

It appears from this study that the task and its inherent qualities were what made light of the cognitive style differences individuals possessed. Further study of these stimulus-specific elements is one direction where future research could take aim.

Future Research

Of the questions posed by this research, the one which stands out is that which asks whether eye movements are stimulus or person-specific. The research performed here did lend insight into the problem as main effects and interactions were examined. The data indicates that individual qualities of each segment played a large part in where the subjects were looking. Further study of these stimulus specific elements is one direction where future research could take aim. As Olson (1974) and others suggested,

we must research in depth the code or syntax of particular medium. More knowledge should be ascertained as to the effects of specific cueing devices, particularly auditory cues. Research comparing EMs, eliminating the voice-over, would no doubt yield worthwhile information as to the effects of the visual cues. The auditory component may have been the sole channel from where some of the subjects received information that assisted them in analyzing the field.

From the results of this study it appeared that in more cases than not the dynamic stimulus did not make a difference in the eye movements. If an asymptotic level was reached where the dynamic stimulus did not serve as a cueing aid, what was that level? Further research ought to concern itself with such a question. In other words, was there a level at which dynamism ceased to be beneficial and became an information processing hindrance?

Further study of EMPs as they relate to cognitive style variables ought to be performed. Resultant information would be useful to instructional designers and those researchers exploring the area of cognitive style. Other organismic variables including anxiety, stage of development (à la Piaget or Bruner), or locus of control could be included in such investigations.

Although many studies exist in this area, complete information concerning eye movements and reading has not been totally uncovered. Recent research (Mitrani, in Edelfat, 1975) has suggested that good readers "read" during saccadic EMs. Information such as this is

useful in interpreting results although further exploration is needed in this area to substantiate his findings.

Not specifically compared, varying results were acquired between ALL and INIT data. What happened to the attention of subjects as they viewed a segment over time was a factor that must be taken into consideration when studying individual differences and different modes of instructional presentations. Further research into the most beneficial length of time for the exposure of a stimulus presentation ought to be investigated keeping attentional factors and pacing of a segment in mind.

Finally, sex differences as they relate to eye movements, the medium and organismic variables ought to be investigated further. This study produced some interesting main and interactive sex-related effects. However, it was one of the few EM studies to have done so. Many organismic variables have been correlated with sex, but it is rare to find an EM study which not only differentiated the "looking" behaviors of males and females, but also correlated these EMPs with other measures.

Educational Implications

Implications resulting from EM data surrounding organismic variables as they stand alone and in interaction with other factors related to the medium of television are useful to those involved in instructional design. Application of theory into practice need not be made solely to the medium of television, but can also be applied to other methods of communication (including the teacher) that are

available in the teaching-learning environment. Knowing that qualities of a stimulus field may evoke certain EM responses in individuals, with a further investigation into the elements of these stimuli, instructional packages can not only be designed so as to take advantage of these attention-getting and maintaining devices, but can also be paced according to the perceptual style of information processors. Although it was found that the dynamic mode produced positive effects for some individuals while negative results for others, generally there were no significant differences due to mode. Information such as this is useful to those who have only looked at movement on the screen as a positive characteristic of the medium. Instructional materials designed for certain individuals might best be produced avoiding what may prove to be hindering devices.

As the National Institute for Education Report (Gibbon et al, 1974) suggested, EM studies are a useful "real-time" indicator of the perceptual processes of certain individuals. Eye movement studies allow one to study the style of individual processors and to investigate, as in this study, the effects of these styles under the influence of certain environmental factors. There are few dependent variables that can produce such useful information as it relates to individual differences. Individual differences are a major concern to educators as they investigate "person" qualities interacting with various environments and instructional methods. Knowledge of information processing skill gained from EM studies is useful to teachers

and producers of instructional television who set up teaching-learning environments while keeping in mind an instructional pace suitable to various learners.

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