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ABSTRACT

The eye movement patterns of good readers, poor readers and functionally illiterate children are discussed in relation to television and filmstrip viewing and comic book reading. Studies conducted since 1972 on the eye movement patterns of children between 9 and 11 years of age are described and the results discussed. Suggestions are presented concerning the production of TV shows, comic books and filmstrips for use in reading remediation. These include (1) the most effective use of printed material on the screen in conjunction with action in children's educational television shows; (2) the best placement of print, amount and size of print, type of presentation, relationship of words to action, and types of art work for comic books; and from preliminary findings, (3) the best timing, visual to audio relationship, and position and type of print for filmstrips based on comic book formats. (ED)

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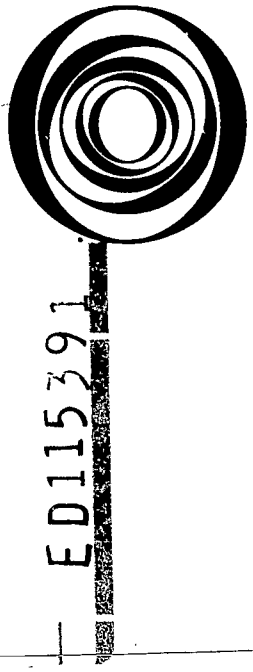

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EYE MOVEMENTS AS AN INDEX OF TELEVISION VIEWING STRATEGIES

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EYE MOVEMENTS AS AN INDEX

OF

TELEVISION VIEWING STRATEGIES

Since 1970 the development of eye movement technology has led to wide ranging use of systems designed to examine children's performance of tasks in which there is a major component dependent on visual scanning, that is, of examining a stimulus, either static or dynamic and extracting information from it through the use of the eyes. While much of this research has been of a highly complex and microscopic nature directed towards examining basic human psychological processes, a number of researchers, myself and my students included, have become increasingly interested in the applied aspects of the work, especially where these are related to technological advancements in educational media.

Our first involvement in the question of how children watch television programs arose out of research conducted at the University of Alberta in Edmonton. There we found that significant differences existed in the way children of different developmental levels viewed static pictures based on the experiments of Jean Piaget. Piaget's work, which has had massive impact on education throughout the world, suggested that children who were at different stages of intellectual development, would react differently to the presentation of apparently similar

situations. We thought that this different reaction might be reflected by different scanning patterns and devised various sets of Piagetian-type experiments to test the supposition. In the event, the hypothesis held and we were able to describe different viewing patterns as Piaget might have predicted (O'Bryan and Boersma, 1971).

Other experiments were carried out subsequently by the Alberta group, and differences in viewing patterns were found among children with various levels of intelligence, and with differing degrees of ability to perform simple search tasks. At this point of its growth, however, the research was primarily theoretical and few attempts at translating or adapting it to answer questions of educational relevance were undertaken. Nevertheless, I became increasingly interested in the scanning patterns of children as they attempted to read and was especially intrigued by the failure of earlier studies of eye movements and reading. In those studies (reported in the main by Tinker, 1958) emphasis had been placed on "training" the eyes to move, on the premise that poor reading may be the result of inefficient scanning patterns. This premise proved inadequate as little gain in performance arose out of the very substantial studies conducted.

Our research led us to believe that the poor patterns reported by earlier researchers were the result rather than the

cause of reading failure. While this supposition was interesting it had little practical implication until it became apparent, in a series of early studies we conducted at O.I.S.E. during 1972, that there were distinct similarities in the scanning patterns of poor readers and functionally illiterate children. Accordingly, with the cooperation and funding of Children's Television Workshop, a major study was undertaken on the eye movements of children watching the instructional reading program "The Electric Company".

Using a Mackworth eye movement recorder employing the principle of corneal reflection, real-time eye movement patterns (EMPs) were filmed on 16mm movie film. A series of experimental segments of "The Electric Company" were presented as the stimuli and three groups of children aged between nine and eleven representing good readers, poor readers, and non-readers were the subjects of the research.

The study indicated that there were differences in looking behaviour among all three groups. Good readers looked at all printed material immediately on presentation and displayed EMPs consistent with known reading patterns. They rarely referred back to words left on the screen but quickly looked at, and probably accurately processed, changes in words, additions, deletions and expansions. They displayed rapid and concentrated eye movements on computer bridges and animations and oriented quickly to new material. It seemed clear that position of the printed material at the level of difficulty presently being

employed, was not a positive or negative variable to the good reader. In short, he read it, related it to the action, had plenty of time for later referral and was not negatively affected by action or distraction.

The slow reader was not so quick to orient to printed material as was the good reader, but the difference was barely significant overall. However, there were some notable differences.

Slow readers were often distracted by action not directly related to or performed by the printed material. They often failed to proceed past the first two or three letters, displayed many regressive eye movement patterns (backward looking), looked more often at the speaker than at the words, and, most markedly, seemed to require considerably more time to fixate on the material. While the measured fixation points indicated that EMPs appropriate to reading were employed by most of the slow reading children and that they were directed towards an attempt at reading, the looking often ceased before the whole word was fixated and, when looked at again, the fixations appeared once more at the beginning of the word. An interesting variation of this occurred, however, when computer-formed words or animated words appeared. In these cases the carriage of the action in the word itself seemed to increase the number of left to right reading type fixations and also to provide a greater time of viewing to salient stimulus - i.e. the

words themselves. On the basis of the results obtained there seemed little doubt that high quality action sequences distracted the slow reader and withdrew his attention from the word. This phenomenon might be related to the length of the word or to the length of the sentence. When action occurs with a short word, or letter group, that can be picked up in one or two fixations it is possible that it could have facilitating effects as in the high concentration of fixations of all groups noted in such segments used in the study. But, when there are more than 3 or 4 letters the slow reader rarely managed to read further than the first two before his attention was drawn elsewhere. It is suspected that this will not be an easy problem to overcome.

Those children who could not read displayed notably different EMPs . The most striking feature was their random looking behaviour at printed material. There was some evidence of action causing attention to the print but in this group the printed message seemed largely irrelevant. Whenever there was action on the screen,the illiterate children were drawn strongly by that action. Whenever single words appeared, EMPs fluctuated, showed only minor resemblance to reading-type patterns and often resulted in attacks being made on the word or sentence from the middle of the stimulus. Orienting to new stimuli was significantly slower in this group and one might again speculate that much more emphasis needs to be placed on the message material to attract attention to it. Where the message was carried in,

or preferably, carried the action, fixation levels for the non-readers increased, duration of fixation increased and left to right movement was more often generated. Other interesting findings included a tendency observed in illiterate children to fixate on a flashing letter longer than did children in other groups and to ignore, or at least not fixate, the other letters in the word.

In interpreting the effect of presentation of materials on viewing strategy it was important to remember that the groups differed strongly in their qualitative EMPs , and that the suggestions made below refer primarily to slow readers and non-readers.

Essentially, the specific findings summarized below emerged from the research. When considering the question of position of print on screen it was noted that the best location appeared to be central, preferably between eyes or at eye level was best in terms of number, duration and pattern. It was found also that balloons draw more attention than other forms of presentation, while bordering variations seemed to have little marked effect on looking behaviour. Nevertheless, zoom boxes were very effective and perhaps if placed at eye level of the actors (centre screen) would generate more activity. In terms of type of print our findings suggested that static print proved least effective, while flashing but stationary print drew substantial looking behaviour. Better scan patterns were generated by animated print but there was clear evidence that computer produced

print was most effective of all, especially when not in competition with live actors.

We were interested, too, in examining special effects and the results indicated that animated and graphic presentations produced the highest level of looking behaviour and reflected the closest approximation of normal reading eye movements scan patterns in all groups. Cartoon sequences tended to produce more fixations on the stimulus among poor readers than did live action, perhaps because of reduced distraction material, and as a result of clearer lines, specific pointing, etc. This is a difficult comparison to make, but it may be that the incorporation of position, zoom, animation and minimal "business" would increase attention to the primary message.

Although not measured quantitatively, there seemed to be a high negative correlation between the amount of action and attention to the educational message. Live actors were most compelling, and all groups attended much more to the actor than to stimulus words whenever the two appeared simultaneously. When action occurred first, followed by the message, reading EMPs improved in the slow readers and the children attended directly to the stimulus, often displaying EMPs similar in type to good readers. A similar phenomenon was observed when the message was greater in magnitude, dominant in intensity or preeminent in position.

The studies were generally replicated by both Briggs (1973) and Mock (1974) and, from them, various suggestions for production techniques were made (O'Bryan and Silverman, 1973, 1974). The research group is continuing this line of investigation of television stimuli, but in recent months primary attention has been directed towards the examination of scanning patterns displayed by poor readers on static displays. The stimuli have included both comic books and film strips based on comic book characters with audio overlay.

The work on the comic books was funded by the Children's Television Workshop while that on the film strips was commissioned by Dinosaur Publications.

The studies were conducted during 1973-74 on a number of comic book presentation styles as viewed by children classified as good, poor, and functionally illiterate "readers".

The methodology consisted of the preparation of slides of single pages from a variety of comic books containing a wide range of action-to-print variability, different modes of print presentation, different levels or complexity of art work, different degrees of vocabulary difficulty and a range of subject matter. The original study was followed by others for validation and for specific reference to "Spidey Super Stories".

The purpose of the studies was to define some parameters of the children's viewing strategies as they related to attempts to read the pages in question. The original study was a fact-finding formative research effort directed at establishing basic

guidelines for the development of the most effective comic book layout and content possible for poor readers.

Essentially, the following points were noted:

- Whenever good readers were shown a comic book page, they inevitably read all the words, usually before they made a close examination of the artwork and often in integration with salient features of the art work. By contrast, poor readers almost always were attracted to the art work first and rarely attempted an extended effort to read the print, while the functional illiterates never made more than cursory efforts to read. In fact, they appeared to actively avoid print, especially when it was presented to them in large chunks.

- Good readers displayed a systematic reading pattern easily discernible in the movie records. They consistently read from left to right in the planned order of arranged sequences and quite often referred to key elements in the artistic layout as they read cues in the print. By sharp contrast, poor readers' eye movement patterns displayed generally haphazard attack with many more off-stimulus fixations and random attention to order of planned print. Functionally illiterate subjects rarely displayed anything but random, unsystematic viewing patterns and even appeared to have difficulty in examining pictures. Apparently, the functionally illiterate has problems in viewing any visual display even when print is at a minimum. It is unlikely, therefore, that the illiterate will be helped by complex comic strip or book presentation without very extensive rethinking of presentation modes, or without teacher involvement and assistance.

- Print presentation variables were clearly important factors. In brief, our findings from the first study indicated that:
(a) Amount of Print. Blocks of print should be avoided as much as possible since this mass tended to overwhelm the eye movement patterns of the poor readers.

(b) Use of Blocks. Where blocks were used, it was apparent that they should be short in number of included words, well spaced and very clearly printed.
(c) Type of Presentation. Balloons were easily the most effective means of generating looking behaviour approximating reading patterns among the poorer readers. Several ballon formats were examined and results indicated that balloons with jagged edges induced higher degrees of eye movement concentration. That is, the children looked at this type of balloon format most often. "Think balloons" also had a very high attention-getting power. Square or rectangular balloons were less effective and multiple balloons, beyond two to a frame, were very often confusing to the poor readers and appeared to have strong negative effects on reading efforts. In short, balloons were better than blocks of print and balloons with emphasis edges always attracted higher eye movement fixations than standard or square balloons. This was probably the result of their novelty level or impact potential and they therefore might be valuable to introduce new words or more difficult words and sentences. In all likelihood, their value would diminish were they to be used exclusively, therefore it was recommended that balloons be used before blocks (which should be avoided as much as possible) and that special impact balloons be reserved for the key educational tasks in the comic.
(d) Print Size. This appeared to be a relevant variable not so much in terms of absolute size as in the variability of size and intensity. Our data suggested that clearly printed, moderately large, well spaced words were desirable in general, but that variation in print-size is more important. If the key thought, word or intention was presented in larger, higher intensity (thicker) print than the rest of the sentence, there was clear evidence that this would substantially increase the looking behaviour of poor readers at the print in question. This is not to say they will necessarily read it (although later studies have indicated that this is so) but they certainly will look at it. This finding applies to both balloons and print, and has been replicated in later research.
(e) Amount of Print Per Frame. Good readers tolerated almost any amount of print per frame and in fact, seemed to enjoy the comic book more if it contained substantial amounts of print. This was definitely not the case for poor readers who rapidly gave up on print-loaded frames. They gave a cursory glance at the art work and turned to the next stimulus. By-and-large, more than ten words to a frame appeared to

produce a definite turn-off and more than two balloons produced the same effect. It was better to have the balloons very clearly attached to the speaker involved and to avoid complexity in their arrangement. This was not so for good readers who seemed, rather, to enjoy such complexity.

(f) Relationship of Words to Action. The most striking feature of the results was the way in which many children were able to avoid the necessity of reading by being able to invent stories (often very much like the original) from examination of the pictures alone. It would seem that the pictures should be interesting in themselves but that the continuity between them should not be too explicit. In other words, our data have some indications that children will attempt to read when they need the information to establish the story-line. If the story-line can be integrated with the pictures so that it is dominant, the chances of it being read are likely to be much increased. Here, the use of "flash" balloons may be most important as these definitely catch the eye movements of all groups. The key story-line could be carried in the flash balloons provided they are reasonably sparingly used to avoid habituation. Another indication in the data suggested that leads from one frame to the next may be useful, that is, continuation of the sentence from one frame to the next. This should, however, be sparingly used and will probably work best in cases where the difficulty level of the material is low.

(g) Position of Print. The most effective positioning of the print appears to be at the eye or mouth level of the speaker while boxes should generally be in the upper part of the frame, especially when there is no narrative or voice-over. The data indicate much higher intensity of fixation patterns under these conditions than is the case when boxes are placed at the bottom of the frame. Of course, much is dependent here on the actual story-line of the comic.

(h) Types of Art Work. Action art work of moderate to low complexity was the best"read" by the poor readers. In all the examples studied, the Spiderman type of strongly outlined, vigorous drawing appeared to develop most interest and to create the highest degree of eye movement. If the frame was oversimplified, little activity was generated and very few fixations occurred. If the frame was overloaded with characters and with highly complex activity, it was read by the good reader but it appeared to overwhelm the poor reader who generated very low quality search strategies for information and who almost invariably avoided the print.

Many of these variables were replicated by Badanes (1974), who also noted that the combination of simple print and simple action worked best for poor readers. Badanes' study was conducted with more difficult stimuli than the first research and she found that reading fixations in balloons were almost double that in boxes when simple print was used. When difficulty levels were high the poor reader scarcely attempted to read at all and therefore no differences were found in print borders.

A limited study was undertaken to examine eye movements on the first edition of "Spidey Super Stories". In total, 30 children were tested over a period of two months. Ten of these children were good readers and were used as a quasi-control group to provide a model of the skilled reader's approach to the first edition of the comic. The remaining children were evenly divided between boys and girls aged between 9 years, 4 months and 11 years. All were classified as poor readers by their teachers, and each was reading at least 1½ grades below placement. All were drawn from remedial reading classes in the Toronto area and tested in the O.I.S.E. laboratory on actual slide mounts of the first edition. In summary, the following results were obtained:

- Good readers reported a thorough enjoyment of the comic and read each page fully and very quickly. Their eye movement patterns were consistent with those of very skilled readers and they encountered no difficulty with either text, story-line or artwork.

Poor readers displayed marked improvement in many aspects of their reading from comic books insofar as fixation patterns were concerned. Most notable of these were as follows:

(a) Higher intensity of fixations on the print, especially print inside balloons.
(b) More systematic attempts of a reading type. Clearly the simplified print combined with simple story-line effect found by Badanes was confirmed in the first edition reading patterns. The data suggested that poor readers, when not overwhelmed by either highly complex art action or by too advanced textual material, will directly attempt to read the print. This is especially the case when Spideyman speaks, so that there appears to be identification of the primary character in the segment and an attempt to understand his utterances. It would be encouraging to the creators of Spidey Super Stories to note that there was much less"turn-off" found in their comic books than was apparent in the previous study or on comparisons in the current study made on the prior stimuli. In effect, there is evidence that Spidey Super Stories is succeeding on the first educational count, that of getting the children to look with greater favour on the printed word. Success of the comic book as an entertainment vehicle will, of course, be measured by the more precise instrument of total sales.
(c) An interesting change in eye movement patterns occurring as children examined the artwork was noted. The subjects were more inclined to look from the print to the speaker or to the salient action described by the print. This may suggest a degree of increased comprehension of the print and a heightened awareness of the relationship of print to picture. It is in marked contrast to earlier findings in which the poor readers rarely, if ever, returned to the print after they had left it, either in a systematic or unsystematic fashion.
(d) The big frame approach appeared to be highly acceptable and there was more activity apparent in general viewing of the whole frame. When very small frames appeared, as in the story "Spidey Signs Up", there was evidence of greater distress among poor readers. It would appear that the aversive effect of reading failure is pervasive, even to comic books, and that every care needs to be taken to avoid laying stress on the already distressed reader.

(e) Follow-up questions produced a high degree of support for "Spidey Super Stories" from poor readers. Almost a third claimed it was the first time they had liked "reading" a comic book, although almost all bought comic books regularly. This is rather interesting in that two thirds of the children were clearly incapable of reading the print in their favoured comics (Spiderman, Archie, Westerns, etc.).

Some negative findings were apparent in the results. The small print size and low variability of print intensity appeared to trouble some poor readers as did the small frames found in large numbers on some pages. It was notable in the data that children in the poor-reader group declined in reading eye movements much more quickly on the small print than on the large print. Furthermore, there were clear data that compact print in boxes was the least successful of all print presentations. When, however, print in balloons was multi-coloured and multi-sized, reading-type eye movements were markedly increased. This also was the case for all "think" and "flash" balloons.

There was an initial problem in the first edition caused by the very intensive and solidly packed print on the first story page. Much of this was the copyright information but it had a marked negative effect on poor readers which could explain a generally poor attack apparent early in the story. Indeed, the worst page in the entire production was the first story page, which was cluttered, complex and over-printed.

Our most recent research has been conducted in the area of film strips with audio overlay. Again, using the Spiderman

character, the research has been conducted on stimuli specifically prepared by Dinosaur Productions. This research is in the very early stages but shows great promise in that the principles of print-to-picture relationships established from the earlier research, together with knowledge gained on presentation modes were used to design the first film strip for testing on slow readers.

It was considered largely unnecessary to use a group of good readers or a group of non-readers since the parameters of their performance were relatively well known from the previous research. Hence the initial study was conducted on thirty slow readers to whom the "series one" film strip was shown. The strip was a typical introduction to Spiderman and was drawn by artists and writers associated with both the comic book film (Marvel Comics) and Children's Television Workshop. Similar procedures, equipment and research analyses were used as for the studies described above and the following preliminary results were obtained.

The film strip proved very popular with almost all respondents, none of whom had read the Spiderman comics but six of whom were aware of the character and had seen him on television. It was clear that the format was acceptable to the subjects, but the primary purpose of the research was directed towards assessing the effectiveness of the program in drawing attention to the salient (that is, the printed) messages.

Essentially, the same results were obtained as for the later edition comic books developed by the Children's Television Workshop. This is not surprising when it is noted that both were designed on similar principles. In summary, the following major findings were noted, but it must be remembered that this research is in its preliminary stages and only the first, or main effects data have been analysed.

(a) Print Position and Type.
Eyelevel presentation was most effective and the balloon format was again substantially more heavily fixated than box presentation. A major factor appears to be the relationship of the print to picture in that on those frames where the circumstances are obvious, least reading occurs. This is a tricky problem in that there needs to be a relationship between print and picture but it must remain necessary for the print to be present, otherwise stories will be invented and only the pictures will be "read". Overall, the comic strip produced by Dinosaur handles the problem most effectively and there is clear evidence that substantial reading efforts were made by the subjects in the study.

(b) Timing.
Arising out of previous studies was the suggestion that extended time be allowed for slow readers to attempt the print. While for the good reader this time allowed would almost certainly be excessive and would probably lead to impatience, the results clearly demonstrated the importance of the timing. Very slow readers needed even more time in certain instances and it may be that this need has been seriously underestimated in the past. Indeed, one of the major advantages of the film strip appears to be its flexibility in timing and its adaptability to both the individual and group requirements. In short, it would appear that the comic book film strip may be a very effective way of presenting printed material of the comic book type to the slow learner.

(c) Visual to Audio Relationship.
The audio track accompanying the tape proved to be well received by all subjects. The tape did not contain a voice-over reading the words (except in particular instances as noted below) but instead, held sound effects, music, some "filler" narration and after-presentation reading of linking boxes presented, usually, prior to a printless frame. Consequently, it was not possible for the subject to use the audio to gather the meaning of the sequence presented on the strip but it was possible for him to assess the affective content. The eye movement patterns tended to reflect this as there were instances of related EMPs to specific sound cues. We shall be following these indications in a later series of studies involving "The Electric Company", the "Super Spidey Stories", and the Dinosaur film strips, but our current results suggest that the use of the audio track substantially increases attention to the strip without detracting from attention to the print segments.

(d) Degree of Attention to Printed Segments.
As was the case for Super Spidey Stories, there is now no doubt that the presentation of the print as upper case comic-book type is the most effective in producing highest degrees of attention. The film strip was most successful in generating eye fixations indicating attention on almost every presentation of printed segments. While many of the subjects were experiencing difficulty with some of the harder words, there was every indication that definite reading attempts were being made.

We suggest that, in common with the C.T.W. produced comic books, the film strip is a major step forward in the design of reading materials. This position is taken largely because of the effect these presentations have in reducing avoidance behaviour by slow readers. There is ample evidence in the reading literature and in the results of our previous research that clumsy, cluttered, badly positioned text associated with too specific visual material produces little attempt at reading by

those for whom it is intended. In effect, we suggest that the clean display of well spaced prints carried by a popular character in a popular format can do much to encourage reading attempts by children who otherwise have developed difficult-to-break avoidance patterns towards the printed word. As such, the creation of programs of high visual quality, allied with careful attention to print level and presentation, such as "The Electric Company", "Super Spidey Stories" and the Dinosaur film strip series, offer very substantial aid to the teacher engaged in reading remediation.