The Davis Visual Scan Test

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Abstract

The clinical evaluation of visual scanning behavior has lagged behind the evaluation of other oculomotor functions. Scanning behavior generally requires sophisticated electrodiagnostic instrumentation to adequately measure this function. The Davis Visual Scan Test (DST) was designed to provide a quick and inexpensive evaluation of an individual's scan path. However, there was no standardized protocol.

In the present study, 68 adult subjects were administered the DST in a group setting, using a standardized protocol. The data was evaluated in terms of gender and scan patterns by counting the number of correct responses made in one minute. Performance differences were found between genders; males performed significantly better than females. Three different scanning behaviors: horizontal, vertical and random were evident. The horizontal and random scan scores were higher than the vertical scans.

This pilot study indicates that the DST has the potential to be a quick and efficient method to evaluate a patient's visual scanning behavior. However, further normative data should be developed by gender and age. This could prove to be a significant addition to the optometric testing battery.

Key Words

Davis Visual Scan Test, reading, saccades, visual information processing, visual scan

INTRODUCTION

Oculomotor function is essential for the sighted individual to gather information about the world.[1-16] Fixation is the most basic of all visual oculomotor functions. Any performance other than steady central fixation should be considered abnormal.[1-3] Departures from stable, steady fixation are observed as nystagmus, or eccentric fixation strabismus with amblyopia. When two fixations are combined, the result is a saccade.[4-6] Saccadic behavior is considered to be an essential factor in the person's reading ability. A fixation that moves is a pursuit.[7-9] Pursuits, while not as useful as saccades in the reading task, can predict academic performance.[7] The oculomotor skills of vergence and accommodation are also significant factors in the efficient gathering of visual information.[10-12] The culmination of all these visual skills is the person's ability to visually scan a scene to gain information.

Visual scan is recognized as an important aspect of visual information gathering and processing.[13-21] The scan path of an individual is developed quite early; by 13 weeks of life, the unique scan path of the individual is recognized.[13] Noton and Stark, in a landmark paper, described the human visual scan.[14] They related it to visual memory, proposing that the individual learned a particular scan path for an object, and that scan path was recognized and followed in subsequent viewing of that object. They termed the scan path for a particular scene as the "feature ring." This, too, became constant for that scene.

Subsequent literature on scan paths is equivocal. Scan paths have been reported not to be different for cognitive and non-cognitive tasks.[17] However, others have proposed that scan paths can be different for reading and non-reading tasks.[18] Forrest implied that habitual scan paths, without head movement, is a factor in the development of astigmatism.[15,16]

The effect of acquired brain injury (ABI) on visual scan has been a topic of clinical interest.[19-22] The stroke or traumatic brain injured patient, who has incurred a visual field loss, is most impacted. For example, a person with a right homonymous heminopsia is likely to have trouble reading, since the area of space for the next saccade and fixation is not visible. Scanning behavior may offer the clinician valuable information on how these patients "attack" visual space.

Research on the visual scan of the ABI patient has shown that, in at least 60% of patients, it is disorganized.[20] It has further been demonstrated that the visual scan can be controlled by a "top-down" paradigm, and that rehabilitative training can improve the person's ability to scan the visual array for information.[21,22]

The "top-down" control of visual scan is accomplished by two different areas of the cerebral cortex. Visual-spatial organization is controlled by the posterior parietal cortex, while motor planning is controlled by frontal cortex.[22] Rehabilitation procedures, which are based on this "top-down" paradigm, have been shown to improve visual scan in many cases.[20,21]

Research on visual scan requires sophisticated electrodiagnostic instruments. A visual scan test has been devised by Morton Davis, O.D.[23] The Davis Scan Test (DST) has been used and recom-

Table 1.
Means and Standard Deviation of the Total Sample by Gender M=Males, F= Females

Mean		S.D.	
M	F	M	F
56.9	48.3	9.3	13.4

Table 2.
Means and Standard Deviations by Gender and Scan Paths (M=Male, F=Female)

Horizontal				Vertical				Random			
Mean		S.D.		Mean		S.D.		Mean		S.D.	
M	F	M	F	M	F	M	F	M	F	M	F
58.9	49.7	7.5	14.8	45.3	40.2	4.2	13.0	58.2	52.7	9.3	9.6

mended by Dr. Davis for a number of years. He proposed an instructional set and developed normative data with 38 male student test pilots, aged 22 to 36 years. Dr. Davis also proposed a scoring system. The DST is not a "pure" test of visual scanning since it involves visual-motor execution. Nevertheless, it has been used by some optometrists as a diagnostic instrument.

PURPOSES

The purposes of the present study were to: simplify the administration and scoring protocols of the DST's original version; determine if there were adult gender differences in performances of the test; characterize and investigate scan patterns.

SUBJECTS

The test was administered to a group of 39 female and 29 male optometry students. Their ages ranged from 21 to 40 years (mean 24.9, standard deviation 3.6). The test was administered under normal classroom lighting.

MATERIALS AND METHOD

The DST is printed on an 8.5 by 11 inch sheet of paper. There are 435 letters, numbers and symbols. (Appendix A) The 56 different types of letters, numbers and symbols are randomly organized on the sheet. Imbedded within the test are 66 "***O***'s."

Testing was conducted under normal classroom lighting. Subjects were seated at a desk. The following instructions were given to the subjects before the administration of the test:

Before you is a sheet of paper. On the other side of the sheet there are letters, numbers and symbols. When I say go, turn your sheet over and circle the first ***O*** *that you see, and then, without picking the pen up, draw a line to the next* ***O*** *you see and circle it. Continue drawing lines and circling all of the* ***O's*** *you see on the paper until you are told to stop. Are there any questions?*

The procedure was then illustrated on a chalkboard. The testing was then conducted for one minute.

RESULTS

The circled ***O's*** were totaled for each subject. The range was from 18 to 66. The average of the total sample (N=68) was 51.9, (S.D. 12.5). Males scored significantly higher (56.9; S.D. 9.3) than females (48.3; S.D. 13.4) at the .003 level as determined by the student t test. (Table 1.)

The data were then separated into three groups, according to observable scan patterns: horizontal, vertical, random. In the horizontal pattern the connecting lines generally flowed across the page from left to right, and then from right to left. The vertical scan generally started in the upper left of the test and continued in a zig-zag pattern; when the bottom of the page was reached, it proceeded up in a zig-zag, vertical scan pattern. The random scan traversed diagonally, horizontally and vertically. The horizontal pattern was used by 31 subjects; the random by 24, and the vertical by 13.

These scan pattern scores were compared. There was not a significant difference between the mean horizontal (54.1; S.D. 12.6) and mean random (55.2; S.D. 9.7) scan scores. However, both horizontal and random scan scores were significantly higher than the mean vertical scan (40.7; S.D. 11.5) scores (horizontal vs vertical, p=.002; random vs vertical, p=<.001; student t test).

These three performance groups were then separated into gender and scan paths. (Table 2) The mean horizontal scores show a gender difference, with males performing significantly higher than the females (58.9; S.D, 7.5 : 49.7; S.D. 14.8, respectively; p= .039; student t test). The mean random scan path showed that the males did not score significantly higher than the females (58.2; S.D. 9.3; 52.7, S.D. 9.6, respectively). There were insufficient numbers of males (3) in the vertical scan category to make a meaningful comparison of the gender differences of the means.

DISCUSSION

It is an interesting finding that our male subjects, as a group, performed better on the DST than our females. Generally, by adulthood, gender performance differences on visual skills tests have disappeared.[24-28] Further study will be needed to evaluate if this is truly a gender difference in adult visual performance, or whether it is an artifact that disappears with a larger and more random sample of adults.

The relationships of the various scan paths to reading and overall academic performance is an area that could bring significant clinical information. However, it must be remembered that the present study was done with adults; when age related normative data is available, these and other relationships can be investigated. It is possible that different scan paths might be appropriate for different ages.

To facilitate future investigation, instructions might be written on the back of the test sheet. In addition, a clearer description to differentiate between random and vertical scan patterns should be crafted.

There are minimal distracters in the DST. There is only one C, 6 D's, 7 G's, 2 U's and no Q's. More of these distracters might mislead the subject when taking the test. No subject in this investigation indicated that they were guided to these distracters. The results could be different in children of certain ages.

CONCLUSION

In this pilot study of the DST

1. Males scored higher than females
2. The majority of our subjects used a horizontal or random scan pattern.

3. Horizontal and random scanners scored higher than vertical scanners.
4. Further research is needed with more random and age related populations to obtain further normative data and test reliability and validity.

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APPENDIX A.

VISUAL SCAN TEST