DAVIS VISUAL SCAN TEST NORMATIVE DATA FOR A SAMPLE

by

Jason David Bennett

This paper is submitted in partial fulfillment of the requirements for the degree of

Doctor of Optometry

Ferris State University
Michigan College of Optometry

May, 2006

ABSTRACT

Purpose: The purpose of this study is to provide normative data for the Davis Visual Scan Test (DVS Test). *Method:* Subjects will be selected at random from the Michigan College of Optometry (MCO) Clinic in Big Rapids, MI and a private optometrist's practice in Grand Rapids, MI. The subjects must have experience using a pencil in a paper and pencil task, otherwise no other restrictions apply to the selection of subjects. The Davis Visual Scan Test will be administered to the subjects, and the data will be recorded. *Results:* The data was recorded and statistically analyzed to determine normative data for performance on the DVS Test in the different age ranges of the randomly selected subjects that were selected. It was found that the mean score was 44.33 with a standard deviation of 11.46. The mean age was 25 years. *Conclusion:* Normative data for the DVS Test will be useful to clinicians for diagnosing a problem with visual scanning ability. This will further lead to the proper focus of therapy for the patient.

ACKNOWLEDGEMENTS

I would like to thank those who helped in the collection of data for this project, Misty Bennett, Robert Hohendorf, O.D., Paul Harris, O.D., and Robin Lewis, O.D. I would also like to thank Michael Cron, O.D. and Robert Hohendorf, O.D. for their guidance in pursuing this project.

This paper is dedicated to my loving wife, Misty. Her love and support is the source from which I gain my strength and inspiration for pursuing all my life ventures.

TABLE OF CONTENTS

LIST OF TABLES

Introduction:

Humans use their eyes to gain critical information about their environment[1]. In order to do this in a fast and efficient way, the brain uses the eyes to scan the area of interest. A number of different eye movements and a certain amount of neural processing take place to make up the visual scan[2-6]. Fixations, saccades, and pursuits are three important eye movements used in this process[3]. A fixation is the steady, fixed gaze at a particular distance[3]. Saccades are defined as ballistic eye-movements from one visual target to another[1]. They have been shown to be especially important in reading tasks[3]. Pursuits are eye movements used to keep the eye fixed on a moving target[1]. Because saccades are the most important eye movement for reading, and due to the fact that this study focuses on a reading type task, saccades will be discussed the most.

Saccades are fast eye movements from one fixation point to another[3]. Though they appear to be fast enough to appear uncontrolled, they are not. A saccade is directed by the visual system[5]. Activity in the primary visual cortex has been shown to precede a saccadic eye movement, giving rise to the idea of presaccadic activity[5]. It was previously believed that visual memory did not play a role in determining the position of the eyes in recalling a previously viewed scene[4]. It was later shown, however, that during memory guided saccades, the expected position of the eyes was again preceded by activity in the primary visual cortex[5]. The saccadic eye movement is one that is important during a visual scan to attain a large amount of information in an efficient amount of time.

It has been shown that the organization of pursuits, saccades, and fixations into a visual scan developmentally progresses into a pattern[2]. A study done by Lanyon and Denham in 2004 showed that along with the development of object-based attention in the extrastriate cortex, information about object features is sent to the posterior parietal cortex. This leads to the development of the ability to scan the environment for relevant positions. These scanning patterns are important for humans when it comes to performing certain jobs. A study done by Tvaryanas in 2004 looked at the visual scan pattern during simulated flight. It was shown that normal scan patterns proved ineffective when searching for gauge information needed to fly an aircraft[6].

Visual scan patterns have also been studied in patients who have major depressive disorder[8]. It was found that those people with major depressive disorder will scan a picture that corresponds to their mood longer than other pictures[8]. While this study did not measure the actual eye movement pattern, it is interesting to note the time spent on a visual scan and how it correlates with a person's mood.

The Davis Visual Scan (DVS) Test was developed by Dr. Morton Davis[3]. The purpose of the test is to measure the visual scan pattern of patients. While the test, itself, does not solely measure the pattern of a visual scan due to the fact that it is a paper and pencil task and involves the process of visual motor integration, it can be used clinically to gain insights into a patient visual scan pattern across a page of text[3]. The information from this test could then be applied to treatment and therapy for the patient. In order for this to be clinically applied, the DVS Test must have normalized data. Normalization of the DVS Test could also lead to other studies that looked at how the test correlates to different treatments. Other normalization studies could then be carried out to determine

normal values for groups of patients with specific diagnoses like Aquired Brain Injury, Autistism, or other developmental delay problems.

Purpose:

The purpose of this study is to provide normative data for the Davis Visual Scan Test.

Methods:

This project was approved by the Human Subjects review committee at Ferris State University prior to the collection of data.

A subject was seated at a table and given a pencil and a copy of the test sheet from the Davis Visual Scan Test (see Appendix A). The test sheet was turned over so that the subject could not see the test. The subject was told that they will be given a test. The subject was told that he or she is to connect as many Os as he or she can in the time period of one minute. They were also told that they may start when the investigator says,"start", and must stop when the investigator says, "stop." The exact dialogue that was read by the investigator to the subject was taken from a study published in Volume 15 of the 2004 Journal of Behavioral Optometry done by W.C. Maples, O.D., Anne Gorissen, and Katrien Demaerschalk. It reads,

> "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 administrator of the test then demonstrated how to take the test by showing the demonstration page provided shown in Appendix B. The subject was also asked to fill out a demographics information form shown in Appendix C. Informed consent was obtained before the test was administered through forms that were read to the subject and signed by the subject and a parent or guardian, if the subject was under the age of eighteen. These forms are shown in Appendix D.

Results:

The results of this study showed a mean test score of 41.78 with a standard deviation of 14.98. The mean scan pattern was 1.90 indicating a vertical pattern. Table 1 gives a summary of the descriptive statistics from the sample of data from the study.

Table 1: Summery of the Descriptive Statistics of the Data

Number of Subjects	Average Age	Average Occupation	Average Education	Average Race
90	25.66	Student (68.9%)	Some College (31.1%) or Other (28.9%)	Caucasian (86.7%)

Table 2 gives the mean scores and mean patterns from the data. These averages were divided into age ranges. There were three different types of patterns that were observed: horizontal, vertical, and other. The category labeled as other is defined as an unrecognizable or random type pattern. Each pattern was given a number that was coded into a statistical program for analysis. A horizontal pattern was label 1, a vertical pattern was labeled 2, and an other pattern was labeled 3. The mean patterns for different age ranges fall in between these numbers; however, the data in different age ranges shows a tendency to be closer to one type of pattern. For example, the 11-13 age range shows a

mean pattern of 1.71, which is closer to 2 than it is to 1. So, that age range shows a tendency to be closer to a vertical scan pattern.

Table 2: Mean Scores and Mean Patterns in Different Age Ranges

Age Range (years)	Mean Score	Mean Pattern
4-7	24.50	2.75
8-10	34.82	1.82
11-13	37.29	1.71
14-19	41.80	1.60
20-23	45.66	2.05
24-29	57.50	1.75
30-40	39.60	1.60
41-50	45.80	1.00
51-60	47.50	1.50
61-85	26.40	2.60

Table 3 provides the percentage of different scan patterns in the study.

Table 3: Percentage of Scan Patterns

Horizontal	Vertical	Other
44.4%	21.1%	34.4%

Discussion:

The data from this study provides normative data from a sample taken from three different optometric practices in three different states and one college class. The general data shows that most people from the sample visually scan in a horizontal pattern. The next most common pattern was unrecognizable or a random type pattern, while the least common pattern was vertical. It appears from the data that the younger the subjects are, the more likely they are to have a scan pattern that is unrecognizable or random. As age increases, the scan pattern appears to become more vertical and levels off to completely

horizontal in the 41-50 age range. As the age increases past 50, the pattern appears to become slightly more vertical and finally unrecognizable in the 61-85 age range.

The mean score appears to steadily increase until the age of 29. There is a steep drop off of score in this age range, but it should be noted that there were not many subjects that were 30-40 years of age. Because of this, the data for this age range could be erroneous. As age increases past 41, however, the score steadily decreases. Finally, in the age range of 61-85, the score was closer to that of the 4-7 age range.

This study was done in an effort to provide normative data for the Davis Visual Scan Test, which can then be transferred to a clinical setting. With current normative data, this test can be accurately used to access the visual scan patterns of patients. It should be noted, however, that there are errors in this study. A true normative study would take a sample completely at random from the entire population of the world. Due to the time constraints on this study, the investigators attempted to provide data that was as random as possible, in different areas of the United States. This is, however, a source of error. The sample was taken from 3 optometric practices and one college class, which are not representative of the entire world population.

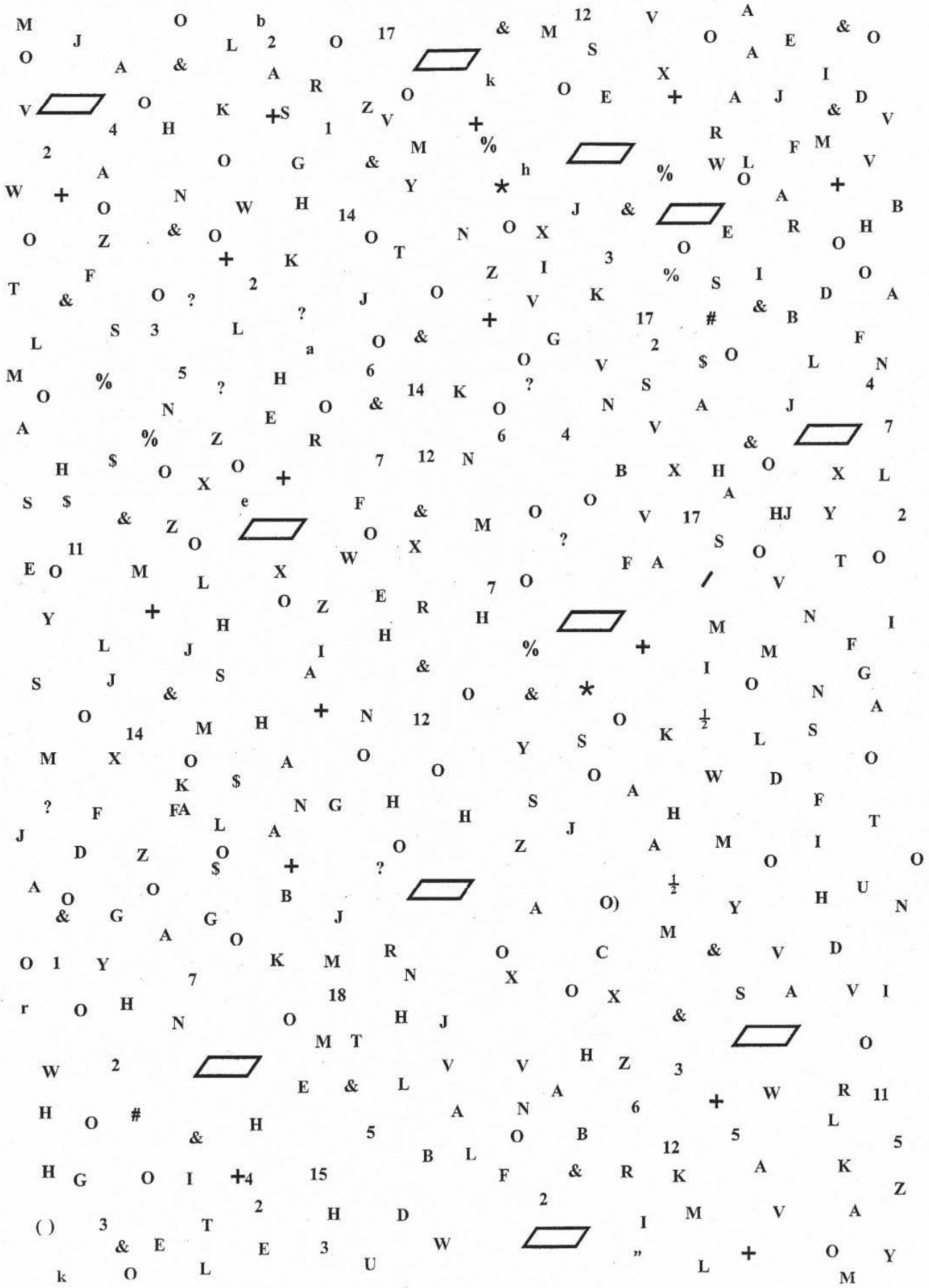
The data was collected by five different people. This can also be a source of error. Certain subjects received the instructions from different investigators. Though a standard form was followed for administering the test, the tone of voice, enunciation, and the atmosphere set by different investigators could all be different and thus be considered as possible sources of error.

This study can be used to further the normalization of the Davis Visual Scan Test. More studies must be done in different locations and non-optometric settings, and more

data must be gathered before the test can be considered to be normalized. The data from this sample can be used to help compile a larger amount of normative data to then be used in the clinic with confidence.

APPENDIX A

DVS Test Form



OEP Foundation, Inc., 1921 E. Carnegie Ave., Ste 3L, Santa Ana, CA 92705-5510 (949) 250-8070 Reorder #DVST100

APPENDIX B

DVS Demonstration Page

Demonstration Page

O s r Y p
O d O
G d
F 3 1

T m m n
O
5 3 O b 7

APPENDIX C

Demographic Information Form

DVS-Test Research: Demographic Information:

Instructions: Please answer the following questions. Some require a checkmark whereas others require you to write information. If a particular question makes you feel uncomfortable, you may skip the question. Thank you very much for your participation!

What is your age? _____yrs

What is your marital status?

- Married
- Living with Partner or Significant Other
- Divorced
- Widowed
- Single

What is your occupation?

- Professional / Technical
- Manufacturing / Laborer
- Farming
- Salesperson
- Manager or Administrator
- Student
- Service/Hospitality
- Medical Industry
- Unemployed
- Educator – Teacher, Professor, of Educational Administrator
- Other: _____

What is the last level of education you completed?

- High School / GED
- Technical / Vocational School
- Some College
- Associate's Degree
- Bachelor's Degree
- Master's Degree
- Doctorate
- Other: _____

What is your gender?

- Male
- Female

What is your race?

- Caucasian
- Hispanic
- African-American
- Asian
- Native American
- European
- Other: _____

APPENDIX D

Adult and Child Informed Consent Forms

Davis Visual Scan Test Informed Consent:

I agree to participate in the research, which is being conducted by graduate student Jason Bennett, Michigan College of Optometry faculty member Dr. Michael Cron, and Optometrist Dr. Robert Hohendorf. I understand that participation is entirely voluntary, that is, I can withdraw my consent at any time and have the results of my participation returned to me, removed from the experiment record, or destroyed.

The following points have been explained to me:

1. The purpose of this research is to gather normative data for the Davis Visual Scan (DVS) Test.
2. The benefit I may expect from this project is the following: the opportunity to learn about and participate in a study that will produce current norms, which can be used to effectively interpret the results of a DVS Test, and therefore aid in more accurately diagnosing certain visual complaints.
3. I will be asked to participate in a single data collection session. The data collection involves sitting for a Davis Visual Scan Test, which is a paper and pencil task that takes one minute.
4. I understand that by participating in this study my test results will be released to the researchers. The researchers will code this information anonymously into a data set. The test does not ask for personal information such as my name or any otherwise identifying information. I understand that demographic information (e.g. age and ethnicity) will be requested.
5. Any information that I provide will remain strictly confidential and anonymous. That is, my individual responses will in no way be directly linked to me.
6. I expect that there will be no known discomforts or stress during the experiment.
7. I have been encouraged to direct any questions now or at the completion of the study to Jason Bennett (benn36@fsuimail.ferris.edu) or Dr. Michael Cron (cronm@ferris.edu).
8. I understand that at any point in the experiment I can change my mind and withdraw from the study.

The nature and purpose of this research project have been satisfactorily explained to me. I indicate my voluntary agreement to participate by completing and returning this questionnaire. In addition, I have read and understand the information provided above.

_____

Signature of Participant

Any questions about this study may be directed to Jason Bennett at benn36@fsuimail.ferris.edu or 989-621-4102 or to Dr. Michael Cron at cronm@ferris.edu or 231-591-2171. Thank you for your time!

If you have questions about violation of research participants' rights, please contact Dr. Connie Meinholdt, FSU Human Subjects Research Committee Chair, phone: 231-591-2759, e-mail: Connie_Meinholdt@ferris.edu.

Davis Visual Scan Test Informed Consent:

I agree to my child's participation in the research which is being conducted by graduate student Jason Bennett, Michigan College of Optometry faculty member Dr. Michael Cron, and Optometrist Dr. Robert Hohendorf. I understand that participation is entirely voluntary, that is, I can withdraw my consent at any time and have the results of my child's participation returned to me, removed from the experiment record, or destroyed.

The following points have been explained to me:

1. The purpose of this research is to gather normative data for the Davis Visual Scan (DVS) Test.
2. The benefit I may expect from this project is the following: the opportunity to learn about and participate in a study that will produce current norms, which can be used to effectively interpret the results of a DVS Test, and therefore aid in more accurately diagnosing certain visual complaints.
3. My child will be asked to participate in a single data collection session. The data collection involves sitting for a Davis Visual Scan Test, which is a paper and pencil task that takes one minute.
4. I understand that by participating in this study the test results will be released to the researchers. The researchers will code this information anonymously into a data set. The test does not ask for personal information such as my name or any otherwise identifying information. I understand that demographic information (e.g. age and ethnicity) will be requested.
5. Any information that I provide will remain strictly confidential and anonymous. That is, individual responses will in no way be directly linked to my child or me.
6. I expect that there will be no known discomforts or stress during the experiment.
7. I have been encouraged to direct any questions now or at the completion of the study to Jason Bennett (benn36@fsuimail.ferris.edu) or Dr. Michael Cron (cronm@ferris.edu).
8. I understand that at any point in the experiment I can change my mind and withdraw consent for participation in the study.

The nature and purpose of this research project have been satisfactorily explained to me. I indicate my voluntary agreement to my child's participation by completing and returning this questionnaire. In addition, I have read and understand the information provided above.

_____ _____

Participant's Name Signature of parent or guardian

Any questions about this study may be directed to Jason Bennett at benn36@fsuimail.ferris.edu or 989-621-4102 or to Dr. Michael Cron at cronm@ferris.edu or 231-591-2171. Thank you for your time!

If you have questions about violation of research participants' rights, please contact Dr. Connie Meinholdt, FSU Human Subjects Research Committee Chair, phone: 231-591-2759, e-mail: Connie_Meinholdt@ferris.edu.

REFERENCES

1. Griffin JR, Grisham JD. *Binocular Anomalies: Diagnosis and Vision Therapy.* Woburn, 2002: 3, 7-8.

2. Lanyon LJ, Denham SL. A model of active visual search with object-based attention guiding scan paths. *Neural Network.* 2004 Jun-Jul;17(5-6):873-97.

3. Maples WC, Gorissen A, Demaerschalk K. The Davis Visual Scan Test. *Journal of Behavioral Optometry.* 2004 15(1): 3-5.

4. Melcher D, Kowler E. Visual scene memory and the guidance of saccadic eye movements. *Vision Research.* 2001;41(25-26):3597-611.

5. Super H, van der Togt C, Spekreijse H, Lamme VA. Correspondence of presaccadic activity in the monkey primary visual cortex with saccadic eye movements. *Proc National Academy of Science USA.* 2004 Mar 2;101(9):3230-5.

6. Tvaryanas AP. Visual scan patterns during simulated control of an uninhabited aerial vehicle (UAV). *Aviation Space Environmental Medicine.* 2004 Jun;75(6):531-8.

7. Weir, CR. Spatial localization: does extraocular muscle proprioception play a role? *Graefes Archives of Clinical Experimental Ophthalmology.* 2000 Oct;238(10):868-73.

8. Eizenman M, Yu LII, Grupp L, Eizenman E, Ellenbogen M, Gemar M, Levitan RD. A naturalistic visual scanning approach to assess selective attention in major depressive disorder. *Psychiatry Research.* 2003 May 30;118(2):117-28.