EFFECT OF LIGHTING LEVELS ON PERFORMANCE ON THE WAYNE COMPUTERIZED SACCADIC FIXATOR & WAYNE PERIPHERAL AWARENESS TRAINER

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Abstract

The Wayne Computerized Saccadic Fixator and Wayne Peripheral Awareness Trainer have been advocated as methods of measuring eye/hand coordination and peripheral vision reaction time respectively in athletes. The purpose of this study was to investigate the effects of varying illumination levels on performance with the Computerized Saccadic Fixator and Peripheral Awareness Trainer. Eighteen subjects were evaluated on the proaction and reaction eye/hand coordination tasks on the Computerized Saccadic Fixator at lighting levels of 1.0 ft.-c., 61.3 ft.-c., and 135 ft.-c. Seventeen of the subjects were then evaluated on the eight light test program for the Peripheral Awareness Trainer, using the same illumination levels. Performance improved significantly as illumination levels were decreased on both instruments. The results suggest that illumination levels must be controlled if these tests are to be used for comparison among athletic populations.

Key Words

Wayne Computerized Saccadic Fixator, Wayne Peripheral Awareness Trainer, illumination levels, eye/hand coordination, peripheral vision reaction time

Sports vision testing of athletes to assess the relationship between visual skills and athletic performance is a growing sub-specialty of optometry. The testing battery developed by the Sports Vision Section of the American Optometric Association has become the accepted standard for the evaluation of athletic visual performance.[2,4,8-10] Two of the tests used in this battery are the Wayne Computerized Saccadic Fixator (WSF)[a] (Figure 1) and the Wayne Peripheral Awareness Trainer (PAT)[b] (Figure 2). The WSF is used to measure eye-hand coordination, while the PAT is used to measure reaction time to a peripheral stimulus.[3]

Normative data for performance on the WSF and PAT were established on athletes at the National Sports Festival in 1986 and 1987.[5-7] However, studies[1,5-8,11] using these devices show variability in the norms derived by the various investigators. In addition, our Sports Vision Service (Illinois Eye Institute) has examined over 1,800 professional and college athletes over eight years and also established norms.[11] Our norms varied from the results in the studies cited. We noted significant variability in our results from season to season upon repeated testing of similar populations. Certain teams we tested demonstrated significantly higher values, while other teams' values were significantly lower. The reasons for the variability may be the lack of standardization of administration for the two testing devices. This may in part be due to differences in testing protocols, background illumination levels,[12] or to a learning curve associated with multiple exposures to the devices.

The purpose of this investigation was to determine the effects of varying lighting levels on performance with the WSF and PAT and then to develop a protocol which

Figure 1. Wayne Computerized Saccadic Fixator

Figure 2. Wayne Peripheral Awareness Trainer.

will allow for the comparison of the performance of athletes in different sports. Because lighting levels can vary even within the same sport, depending upon the environmental conditions (i.e., site of competition), the basis for a reliable and repeatable test protocol needs to be developed.

Methods

Eighteen subjects (Nine males/nine females) were recruited from the student population at the Illinois College of Optometry. Group 1 consisted of all 18 students, with ages ranging from 21 to 28 years (mean age = 24.3). Group 2 consisted of 17 of the students (eight males/nine females), ranging in age from 21 to 28 years (mean age = 24.2). All subjects had 6/6 vision in each eye best corrected. For those subjects requiring corrective lenses to achieve 6/6 acuity, contact lenses were worn as opposed to spectacles to maximize peripheral vision. All subjects exhibited no strabismus or ocular disease, and had no prior experience with the instrumentation. With regard to prior athletic experience, 88% of Group 1 and 89% of Group 2 had participated in varsity-level, high school or college sports.

Three distinct illumination levels were chosen for the test protocol. Illumination levels were strictly controlled by monitoring with the UDT Illumination Probe Model 61 Photometer.[b] Illumination levels were set at 1.0 ft.,-c, 61.3 ft.-c, and 135 ft.-c. as measured from the surface of the unit. The high setting was the illumination level surrounding each LED as measured with bright sunlight coming through a window and falling on the surface of the unit. The middle setting corresponded to usual ambient room illumination. The low setting corresponded to a dimly lit room as found at the Sports Vision Service's research facility without direct lighting on the instrument.

These trials were conducted using the Illinois Eye Institute's Sports Vision Service's testing protocols (see Appendices A and B on page 158). Each trial was conducted during a different office visit separated by at least one week. The order of the presentation of the lighting levels was randomized in order to minimize practice effects.

Group 1 was tested on the WSF proaction mode and reaction mode (Gartner Program) at all three background illumination levels. The proaction mode involves all the buttons over the surface of the unit. Each button randomly illuminates, one at a time. The subject fixates the lighted button and then presses it with the fingertip of his/her dominant hand. The light remains lit until it has been correctly located and extinguished by pushing it in. Then the program advances and a button at a new location illuminates. The subject is allowed to move his/her head as needed throughout testing. The total number of buttons pressed in a 30-second time period is recorded.

The reaction mode (Gartner Program) also involves all of the unit's buttons. This program was developed by Jack Gartner, O.D., along with Harry Wayne of Wayne Engineering. The purpose was to more adequately determine an athlete's maximum performance level. This was achieved by modifying the original reaction program by designing a progressively decreasing interval of stimulus exposure. The original reaction mode design utilized a fixed interval of exposure. With the Gartner Program, each button randomly illuminates one at a time, with the subject pressing the lit button with the fingertip of the dominant hand. However, the button's period of illumination is for only a brief period of time. If the subject does not press the button within this time frame, the light moves to another location. The faster the subject presses the button, the faster the device moves the lights. The initial speed with which the lights progress is 60 lights per minute. If two consecutive correct responses are made, the speed will increase by a factor of an additional six lights per minutes (e.g., from 60 up to 66 lights per minute). If two consecutive mistakes are made, the speed will decrease by a factor of three lights per minutes (e.g., from 60 down to 57 lights per minute). Again, the subject is allowed to move his/her head throughout testing. At the end of the 30-second trial, the number of lighted buttons pressed is recorded (score) along with the speed of the last light detected (number of lights per minute).

Group two was tested on the PAT at the same three illumination levels, utilizing the testing protocol as outlined in Appendix B. The PAT unit consists of a six-inch circular hub from which extend eight clear lucite rods with red LEDs. Also attached to the hub is a joystick with which the subject responds based on his/her peripheral awareness of a randomly illuminated LED. The subject's head and eyes remain stationary as he/she fixates a small green light centrally at approximately 2/3 of a meter test distance. There is no feedback if fixation is lost; however, the examiner encourages the subject to maintain central fixation at all times. The PAT records the amount of time between the activation of the LED and the subject's reaction to it for the eight positions of the visual field.

PROACTION

Illumination	Mean	SD
High	34.44	5.02
Medium	38.33	4.04
Low	42.22	5.76

Table 1. Proaction Score is the number of buttons pressed during the 30-second trial.

REACTION/GARTNER (SCORE)

Illumination	Mean	SD
High	20.61	4.07
Medium	23.39	3.20
Low	25.61	4.45

Table 2. Reaction/Gertner Score for each illumination level is the number of buttons pressed during the 30-second trial.

REACTION/GARTNER (SPEED)

Illumination	Mean	SD
High	80.33	12.50
Medium	87.50	9.94
Low	94.39	12.48

Table 3.Reaction/Gartner Speed for each illumination level is the number of lights per minute based on the last light detected during the 30-second trial.

Results

Statistical analysis of the data was performed, using the Paired T-Test and the Analysis of Variance (ANOVA). The results from the proaction testing on the WSF (Table 1) indicated that the medium light level of 61.3 ft.-c. showed the smallest standard deviation or least variability as compared to the other two lighting levels. The low light level of 1.0 ft.-c. showed the highest scores, as well as the greatest variability. The results from the Gartner Reaction Program testing (score) on the WSF (Table 2) again showed the same

	LIGHTING LEVEL		
Position	High (N=19) 135 FT.-C.	Medium (N=19) 61.3 FT.-C.	Low (N=17) 1.0 FT.-C.
UP	3.24	2.55	.72
UR	1.20	1.04	.53
RT	.89	.60	.50
DR	1.96	1.24	.47
DN	2.33	1.21	.54
DL	1.98	.57	.47

Table 4. Peripheral Awareness Trainer (PAT) score for each illumination level at each position indicates the time, in seconds, between the lighting of the LED and the patient's response during the 60-second trial. Standard deviations are available upon request.

trend with regard to illumination level as the proaction testing mode on the WSF. The results from the Gartner Reaction Program testing (speed) on the WSF (Table 3) showed the smallest standard deviation or least variability was again at the medium light level. The low light level of 1.0 ft.-c. revealed the highest scores, but yielded greater variability in the resultant scores. The high light level of 135 ft.-c. yielded lower scores than the other two illumination levels, but had equal variability to the low light level. The results from the PAT (Table 4) indicated that the low light level of 1.0 ft.-c. yielded the fastest reaction times in all positions, while showing the least variability. The results also indicate that the higher the illumination, the slower the response time and the greater the standard deviation or variability in performance. All test results indicated a statistically significant ($p.<001$) increase in performance as the lighting level decreased. The results of Tables 1-3 are graphically displayed in Figure 3, while the results of Table 4 are graphically displayed in Figure 4.

Discussion

A research effort is underway to determine which visual skill factors have predictive value for athletic success. In order to compare the results from different investigators of the visual performance of athletes at various levels of competition for a given sport, a standardized testing battery should be developed.

The results of this study indicate that variations in environmental conditions, such as lighting levels, can significantly influence visual performance on the WSF and PAT. The results we found indicate that increasing illumination decreased the performance and increased the variability on both units. It is, therefore, necessary to control lighting levels when using these devices for the evaluation of athletic visual performance. We recommend for standardization of the protocol with these units that the medium lighting level of 61.3 ft.-c. for the WSF and the lowest lighting level of 1.0 ft.-c. for the PAT be used when testing. It is with these settings that the smallest variability in test results occurred. This should allow for better comparison of the performance of athletes within a given sport. Future research will be designed to compare performance with regards to variation in illumination levels between different sports.

Resources

a. Wayne Engineering, Inc., 1825 Willow Road, Northfield, Illinois 60093, (708) 441-6940
b. UDT Illumination Probe Model 61 Photometer - measures in foot candles. United Detector Technologies, 3939 Landmark Street , Culver, California.

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APPENDIX A

WAYNE SACCADIC FIXATOR (WSF)

Evaluates:	Visual motor response time to visual stimuli based on a precise, visually-guided motor response (finger press of a lighted target button). Also measures eye-hand coordination and speed.
Test Distance:	Dependent on athlete (see Position)
Illumination Level:	40-70 cd/m^2 incident on the instrument
Position:	Standing relaxed with feet a shoulder width apart with the center of instrument at eye level. With one arm extended directly in front of subject, the palm of the hand should touch the center button.
Critical Factors:	Illumination and test distance are critical. Subjects may either move their eyes to the stimuli, or may gaze to any other desired position at their discretion. Subtests 1 and 2 run for 30 seconds. Only one hand and one index finger are allowed. Programming Unit: Subtest 1 (Proaction): Press Enter 9-1 Enter Subtest 2 (Reaction: Press Enter 9-21 Enter
Criterion:	Proaction: Mean = 42, Std. Dev. = 5 Reaction: Mean = 27, Std. Dev. - 4 Speed: Mean = 94, Std. Dev. = 13
Instructional Set:	"This instrument measures eye-hand coordination. There will be two tests." (Set instrument for Proaction.) "For the first test, using only your index finger from one hand, I want you to touch the lighted button. As soon as you touch one button, the light will randomly relocate to another position. Touch as many buttons as you can in 30 seconds." "The second test is similar to the first; however, the light might not wait for you. It's set to a predetermined speed, so if you don't get to it in time, keep chasing after it. The faster you are, the faster the light will switch to another position. Again, use only your index finger from one hand and touch as many buttons as you can in 30 seconds."
Recording:	Subtest 1 (Proaction): Record the number of buttons touched as recorded on the LED display. Subtest 2 (Reaction): Record the total score and the presentation speed as recorded on the LED display. (Note: you must watch the LED display as the athlete performs the number of buttons pressed to total score as soon as the test is over.) Press the #3 on the key pad to access presentation speed.

APPENDIX B

WAYNE PERIPHERAL AWARENSSS TESTER (PAT)

Evaluates:	Visual motor response time (via lever press) to peripheral stimuli in eight visual field locations.
Test Distance:	30 inches
Illumination Level:	40-70 cd/m^2 incident on the instrument
Position:	Standing relaxed with feet shoulder width apart with eyes approximatelyt level with the center light on the instrument at eye level. Alignment is critical with those athletes wearing spectacles which might restrict their visual field.
Critical Factors:	All PAT screenings should be performed in accordance with the PAT diagnostic testing protocol reproduced below: Instrument should be mounted against a neutral light-colored background. It is critical that the patient fixates the RED center light on the PAT unit continuously during the testing procedure.
Criterion:	< than 0.6 seconds per location
Instructional Set:	"This instrument measures your peripheral vision. I'd like you to always look at the center light. When you are aware of a light at the end of one of the arms, move the joystick quickly in the direction of the light and release it immediately. One light will turn on every 2-4 seconds. Use your peripheral vision and always look at the center light. Programming Unit: Display: Testing Mode Switch: 8 lights/position 60 sec. Times: Off
Recording:	Once the test is completed, record each of the eight scores in order, starting with the "up" position once the test is completed. Order should be: UP UPRT RT DNRT DN DNLT LT UPLT