

EFFECTS OF SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

by

Dylan James Williams

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Has been approved

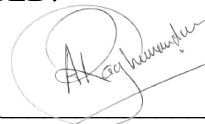
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APPROVED:



Faculty Advisor: Alison Jenerou, OD

ACCEPTED:



Faculty Course Supervisor

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EFFECTS ON SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

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ABSTRACT

Background: This study will examine the relationship between sports vision training and peripheral awareness. Peripheral awareness is essential to an athlete's performance. Whether it's noticing a teammate's location earlier in basketball or noticing a defender's location earlier in soccer or hockey, peripheral awareness enhances one's athletic performance. Noticing the location of a teammate or defender even milliseconds quicker can improve an athlete's performance by making a difference in a possession which can lead to a difference in a game. The visual system may be trained to enhance peripheral awareness. *Methods:* An athlete in the age range of 18 to 30 years old was recruited for this experiment. Pretesting was performed on the subject to measure their baseline peripheral awareness capabilities. Training was then performed on each subject through 8 training sessions at 1 hour/session within a 4-week time period. Several exercises were completed during each training session. *Results:* A 10 percent improvement in the pre and posttests of peripheral awareness was achieved. *Conclusions:* Peripheral awareness can be trained and improved. There are anatomical restrictions limiting improvements to peripheral awareness. This enhanced peripheral awareness may translate to enhanced performance of their sport.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	v
CHAPTER	
1 INTRODUCTION.....	1
2 METHODS.....	3
3 RESULTS.....	7
4 DISCUSSION.....	11
APPENDIX	
A. IRB APPROVAL LETTER.....	15
B. PERIPHERAL AWARENESS TRAINING EXERCISES.....	16
C. AT HOME TRAINING EXERCISES	20

LIST OF TABLES

Table		Page
1	Pre/Posttest #1 (Letters Exercise) Results.....	7
2	Pre/Posttest #3 (Meeple Exercise) Results.....	8
3	Pre/Posttest #5 (Tennis Ball Catch Exercise) Results	9
4	Pre/Posttest #6 (Tennis Ball Throw Exercise) Results.....	10

CHAPTER 1

INTRODUCTION ON EFFECTS OF SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

Athletes use two primary components of their visual system when performing sports; their central vision and peripheral vision. The central vision is processed largely by cone photoreceptors while the peripheral vision is processed largely by the rod photoreceptors (Nan et al., 2014). Though the central vision is undoubtedly important to every sport, peripheral vision and how quickly an athlete can shift attention to objects in their peripheral field, termed peripheral awareness, can take an athlete to the next level. Visual information from the periphery is processed quickly by the rod photoreceptors allowing the athlete to shift their focus of attention using their peripheral awareness on that particular object or event (Knudson and Kluka, 1997).

To enhance an athlete's performance, peripheral awareness can be trained to increase the reaction time in an athlete's peripheral visual field. Peripheral awareness ability allows an athlete to monitor their surrounding without constantly turning their head or moving their eyes (Knudson and Kluka, 1997). For example, if a basketball player can become aware of his teammate or opponent in his peripheral vision faster, it may allow them to make a play that he or she would not have been able to make if they took a longer time to process their peripheral vision. In soccer, if the player is unable to

focus their attention on their teammate in their peripheral environment, they may lose control of the ball while fixating in the periphery to locate their teammate. With enhanced peripheral awareness, a player can locate their teammate earlier allowing them to make the correct play quicker and with higher success. The vast majority of sports involve some level of activity in the peripheral visual field. This leaves a large number of athletes to benefit from sports vision training targeting peripheral awareness.

The human peripheral visual field can extend 190 degrees horizontally (Anderson, 1987). Though most athletes have the ability to see 190 degrees, their reaction time and awareness to this large field of view could be trained and enhanced to fully utilize the athlete's potential. Research has shown that peripheral awareness can be enhanced through sports vision training (Ward and Williams, 2003). Several exercises have been used with varying success rate. This study will assess the efficacy of various exercises and how they effected the participant's peripheral awareness.

CHAPTER 2

METHODS ON EFFECTS OF SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

For this study, one test subject was trained. The subject was a 23 year old male. IRB approval of the exercises was attained before any testing or training took place. The subject was put through 6 pretests prior to any peripheral awareness training. The subject was then trained for a total of 8 hours through 8 training sessions at 1 hour/session within a 4-week time period. Several exercises were performed and during each exercise, the subject was fixating at a centrally located target, to simulate how an athlete would be using their vision during athletic play. Following the training, the initial 6 pretests were repeated and used to compare the athlete's peripheral awareness performance pre and post training.

Pretests

Pretest 1:

The first pretest used several cut outs of one-inch letters. Two letters were chosen and placed in each of the participant's hands. The participant, while staring at a distant, centrally located target, extended his arms and slowly, at a steady pace, bringing the letter inward (with their arms still extended) until he could correctly identify the letter. Seven different sets of letters were used for the pretest. The same seven sets of letters were used

as the pre and posttest measurement. The distance, measured in degrees, at which the two different letters were correctly identified was recorded.

Pretest 2:

For the second pretest a Wayne Saccadic Fixator (WSF) was used. The participant stared at a centrally located dot at the center of WSF while standing an arms-length distance away. The participant was then told to see how many buttons he could press within one minute using his peripheral awareness to locate and press the buttons. The test was performed three times and the average number of buttons pressed was used for the pre and posttest analysis.

Pretest 3:

For the third pretest, a meeples (small wooden figure) and a poster board was used. A poster board was located in front of the participant with various location marked. The locations were two feet away at 25, 35, 45, 55, 65, 75, and 85 degrees eccentricity. The researcher continually moved the meeples to the locations while asking the participant to pick up the meeples with just two fingers while staring at a central distant target. The participant closed his eyes between movement of the meeples to avoid anticipation of the next location. This was a timed event. The time stopped once the participant successfully grabbed the meeples twice from each location. A maximum of two unsuccessful attempts/location was allowed. Time and success rate were used for analysis.

Pretest 4:

The fourth pretest test required a laser. The researcher stood behind the participant while he was staring at a fixation point four inches away at eye level. The

laser location was moved in at twelve inches above or below fixation. The researcher shined the laser in the participant's periphery in one of four spots (top right corner, top left corner, bottom right corner, bottom left corner) and asked the participant where and when they saw the laser's light. Four measurements/trials from each spot were taken and recorded in inches. The average of the four measurements were used for the pre and posttest measurements.

Pretest 5:

For the fifth pretest the participant used his peripheral awareness to catch a tennis ball. The participant fixated on a centrally located target at eye level. The researcher then lightly threw the ball at 25, 35, 45, 55, 65, 75, and 85 degrees of eccentricity. The participant attempted to catch the ball (touching the ball with their hand received credit as a "catch"). For pre and post testing, the researcher threw a total of five balls/eccentric angle on each side of the participant. The percent increase in number of caught balls was used to monitor for improvement.

Pretest 6:

For the sixth pretest the participant threw tennis balls at various targets. During this test the participant threw tennis balls at five-gallon buckets while staring at a distant centrally located target. This test measured accuracy and reaction time for focusing. The locations were at 25, 35, 45, 55, 65, and 75 degrees eccentricity. For each eccentric path, targets were staggered, to prevent distance rhythm, at 11 or 14 feet, alternating. There were 2 locations/eccentric angle for a total of 12 spots. Each spot was thrown at 3 times. In order for a throw to be considered successful, the throw must have hit the bucket. This whole process was repeated while staggering the buckets the opposite way. Accuracy and

reaction time, the time to focus on the bucket before throwing, was recorded each time for analysis.

Training Sessions:

Each training session included 2 warm-up exercises followed by 10 training exercises targeting peripheral awareness. Two were computer based. The remaining were performed in physical space often involving catch, throwing, or kicking various balls using his peripheral awareness. A detailed description of each training exercise can be viewed in Appendix B. Progress notes after each training session were made. Each training session lasted an hour and was often performed twice a week. In addition, the test subject performed 30 minutes of at-home peripheral awareness exercises twice a week. A detailed list of the exercise performed at home can be found in Appendix C. A detailed progress log was kept by the subject monitoring progress of at-home activities.

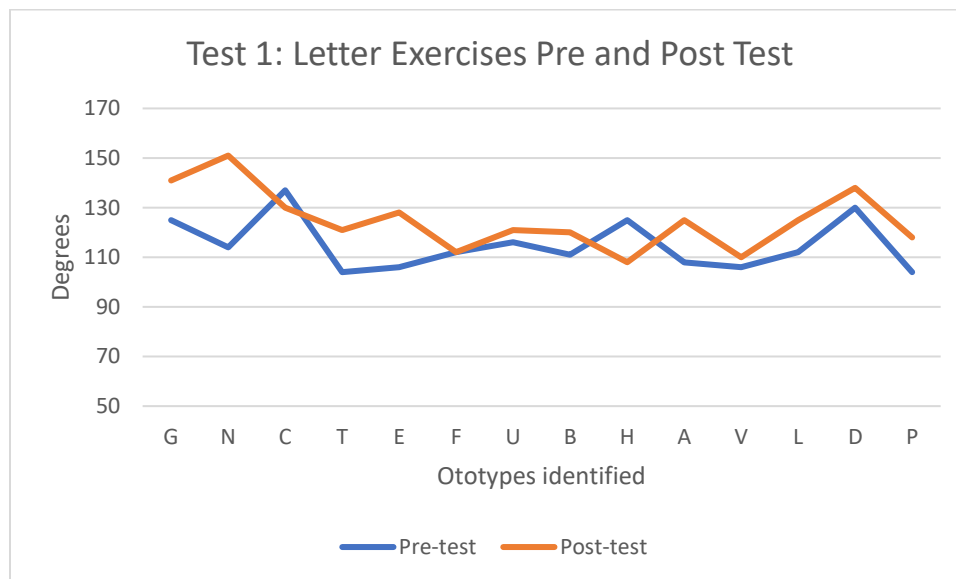
Following the training course described above, posttest exercises were performed to monitor for improvements. The posttests were performed in the same location as the pretests, a controlled indoor environment. No difficulties were encountered discrediting the pre and posttest results. Percent increase in accuracy, time, and improvement were recorded and used for analysis.

CHAPTER 3

DATA ANALYSIS ON EFFECTS OF SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

The results of pre/posttest exercise #1 (letters exercise) can be viewed in Table 1. There was an average of a 9.86 degree improvement. There were 2 letters during the posttest that came back with worse results than the pretest. In addition, there was 1 letter than had no improvement.

Table 1: Pre/Posttest #1 (letter exercise) results



For the pre/posttest #2 (Wayne Saccadic Fixator exercise) the average number of buttons pressed in one minute was 10.7, the average of 11, 11, and 10 buttons pressed.

Upon post-testing the average amount of buttons pressed was 16.7, the average of 13, 21, 16 buttons pressed. This results in a 56 percent increase in buttons pressed during the one-minute interval.

The results for the pre/posttest #3 (meeple exercise) can be viewed in table 2. The test subject showed a 24 second improvement in time with a slight decrease in successful attempts. The net change in successful attempts decreased by one. The participant was more successful at attempts at increased eccentricity. However, the results were affected for the worse when the patient had two unsuccessful attempts at 145 degrees eccentricity during post-testing when he was successful at both attempts on pretesting.

Table 2: Pre/Posttest #3 (meeple exercise) results

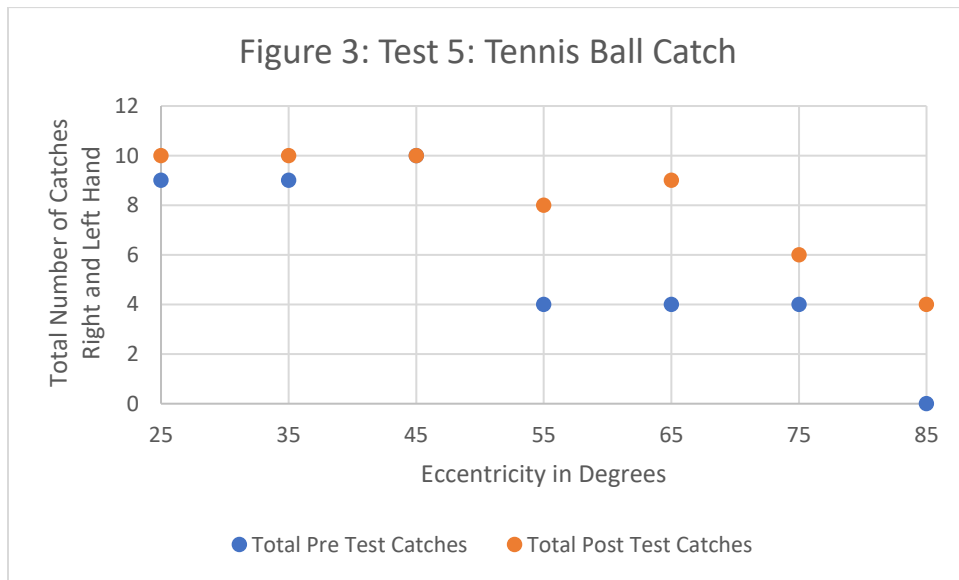
Eccentricity (Degrees)	Pre-Test successful attempts (Time= 2.13 mins)		Post-Test successful attempts (Time= 1.49 mins)	
	Right	Left	Right	Left
115	2	2	2	2
125	2	2	1	2
135	2	2	2	2
145	2	2	2	0
155	2	2	2	2
165	2	2	2	2
175	1	0	1	2
		Net change in successful attempts: (-1)		

During pre/posttest #4 (laser exercise) the average distance of the participant spotting the laser in the upper right, lower right, upper left, lower left quadrant was 12.0, 15.8, 12.8, and 17.7 centimeters respectfully. During laser post-testing the average distance of the test subject spotting the laser in the upper right, lower right, upper left,

lower left quadrant was 12.5, 15.3, 13.3, and 17.0 centimeters respectfully. This results in an average of a 0.05 centimeter improvement in laser recognition per quadrant.

The results for pre/posttest #5 (tennis ball catch exercise) can be found in Figure 3. A total of 35 balls were thrown to each side of the participant. During pretesting the subject had high success at the small angles of eccentricity and slowly tapered as the angle of eccentricity increased. During the posttest the participant maintained the high success of catches at the smaller angles of eccentricity. In addition, the participant significantly increased his accuracy at higher degrees of eccentricity until 85 degrees was reached. At this point the participant still made minor improvements compared to the pretesting. The overall increase in catches was 24 percent.

Figure 3: Pre/Posttest #5 (tennis ball catch exercise) results for total catches right and left hands



The results for pre/posttest #6 (tennis ball throw exercise) can be viewed in table 4. The change in time between the pre and posttest was minimal. The change in overall

time for round 1 was 1 second longer during the posttest and for round 2 it was 7 seconds longer during the posttest. The patient also had a decrease in successful hits. Out of the 72 throws the patient had 5 fewer successful hits during the posttest than he did during pretesting. In addition, there were not any major trends to the participant's lack of success. The targets at a lower degree eccentricity were expected to be hit with a much larger success rate than what actually occurred.

Table 4: Pre/Posttest #6 (tennis ball throw exercise) results

Tennis ball throw	Pretest	Tennis ball throw	Posttest
Round 1 buckets hit (total)	T= 1:50	Round 1 buckets hit (total)	T= 1:51
Left side	9	Left side	8
Right side	9	Right side	9
Round 2 buckets hit (total)	T= 1:47	Round 2 buckets hit (total)	T= 1:54
Left side	11	Left side	8
Right side	10	Right side	9

CHAPTER 4

CONCLUSION ON EFFECTS OF SPORTS VISION TRAINING ON PERIPHERAL AWARENESS

The pre/posttest #1 (letter exercise) results came back with a 9.86 degree improvement. Though the results can be considered significant as most letters increased by 10 percent, anatomical restriction likely limited further improvement. One study revealed that visual acuity at just 30 degrees eccentricity was 20/100 (Frisen and Glansholm, 1975). This is based on the density of the photoreceptors and cannot be trained. The letters for this exercise were large, but not large enough to minimize the restriction of peripheral visual acuity. The percent improvement in this exercise was due to increased peripheral awareness time. The subject was able to locate the letter quicker leading to the improved measurements.

The pre/posttest #2 (Wayne Saccadic Fixator exercise) faced minimal anatomical restrictions. The target was large and bright enough to not be affected by peripheral visual acuity and no other restrictions were encountered. A 56 percent increase in buttons pressed was noted. This is a significant improvement. A 56 percent improvement in any vision-related sporting activity would improve athletic performance.

Pre/posttest #3 (meeple exercise) showed a 24 second improvement, equivalent to 17.8 percent. This would be a significant improvement in any sport. If an athlete can

locate a player or target 17.8 percent quicker, their performance would be improved.

There was a small decrease in accuracy during the posttest. Poor peripheral visual acuity at the larger angles of eccentricity limited improvement in that area.

Pre/posttest #4 (laser exercise) results came back with minimal improvement of 0.05 centimeters. The likely cause of these poor results are physical and anatomical restrictions. A person's visual acuity is dependent on the density of the photoreceptor cone cells (Chung et al., 2011). With the small laser size, the subject's photoreceptors likely didn't acquire enough stimuli to fire indicating that the laser has been seen. In addition, with the design setup the patient was 4 inches from the centrally fixated target. Therefore, the patient's facial features may have played a role in the recognition of the laser.

Unlike some of the previous tests, pre/posttest #5 (tennis ball catch exercise) had limited anatomical restrictions. Density of cone photoreceptors did not play a role due to the large size of the tennis ball. In addition, receptive field diameter did not play a role as there was only one tennis ball being thrown each time. This resulted in a significant improvement in peripheral awareness. Improvements were made at every degree of eccentricity tested leading to an overall 24 percent increase in catches. This is a significant improvement. For example, if an athlete can catch a ball 24 percent more efficiently without having to look directly at the passer, athletic performance would be improved.

Pre/posttest #6 (tennis ball throw exercise) results were likely limited due to receptive field size. Improvements were anticipated as the progress notes during training showed improved peripheral awareness capabilities. However, the pre and posttest set up

had the buckets relatively close to each other in the periphery. The receptive field diameter of the human visual system increases linearly as the eccentricity increases (Wurbs et al., 2013). Therefore, at larger angles of eccentricity the participants receptive field diameter was too large to differentiate the buckets from one another. Though using peripheral awareness to throw sporting items can be improved, anatomical restriction limits how many targets an athlete can differentiate at varying degrees of eccentricity.

Overall, ocular anatomical restrictions limited peripheral awareness improvement in some of the activities performed. This should be taken into consideration when training peripheral awareness. Peripheral acuity is based on the density of cone photoreceptors in each athlete's retina and therefore, cannot be trained. In addition, peripheral receptive field diameter can restrict the number of targets one should use to train peripheral awareness, especially at large degrees of eccentricity. Though restrictions did hinder some results, tests like the Wayne Saccadic Fixator and tennis ball catch suggest peripheral awareness can be improve through sports vision training to a significant level.

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APPENDIX A
IRB APPROVAL LETTER

FERRIS STATE UNIVERSITY

Institutional Review Board for Human Subjects in Research
Office of Research & Sponsored Programs, 220 Ferris Drive, PHR 308 · Big Rapids, MI 49307

Date: July 7, 2016

To: Alison Jenerou and Dylan Williams

From: Dr. Gregory Wellman, IRB Chair

Re: IRB Application #160606 (*Effect of sports vision training on peripheral awareness*)

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, "*Effect of sports vision training on peripheral awareness*" (#160606) and determined that it meets Federal Regulations Expedited-category 2D. This approval has an expiration of one year from the date of this letter. As such, you may collect data according to the procedures outlined in your application until July 7, 2017. Should additional time be needed to conduct your approved study, a request for extension must be submitted to the IRB a month prior to its expiration.

Your protocol has been assigned project number (#160606), which you should refer to in future correspondence involving this same research procedure. Approval mandates that you follow all University policy and procedures, in addition to applicable governmental regulations. Approval applies only to the activities described in the protocol submission; should revisions need to be made, all materials must be approved by the IRB prior to initiation. In addition, the IRB must be made aware of any serious and unexpected and/or unanticipated adverse events as well as complaints and non-compliance issues.

Understand that informed consent is a process beginning with a description of the study and participant rights with assurance of participant understanding, followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document and investigators maintain consent records for a minimum of three years.

As mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) the IRB requires submission of annual reviews during the life of the research project and a Final Report Form upon study completion. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.

Regards,



Ferris State University Institutional Review Board
Office of Research and Sponsored Programs

APPENDIX B

PERIPHERAL AWARENESS TRAINING EXERCISES

1. Warm-up:
 - a. Side Show: This exercise did not require any materials. The subject stared at a centrally located target at eye level. The researcher stood behind the subject and instructed him to locate the researcher's fingers and then state how many fingers the researcher was holding up. If the subject incorrectly identified the number of fingers being held up, the researcher moved their fingers assisting the subject in identification. This test was performed at distance and near.
 - b. Catch: This exercise required a tennis ball. The researcher and participant played catch while the participant only used his peripheral awareness to catch the ball.
2. Circle the Letter: This test required a Surface Pro 4 and a Surface Pen. A small letter was typed on one side of the paper. The participant was fixating on a small x on the other side of the paper. While fixating on that small x, the participant was asked to circle the letters in the periphery of the paper. Time and accuracy was recorded.
3. X in the Circle: This exercise required a Surface Pro 4 and a Surface Pen. Several circles of varying sizes were drawn on a word document. A target (black dot) was located on the other side of the digital paper. The participant was then be asked to draw an x inside the circle while staring at the target on the other side of the paper. 10 different format pages of circles were used. The X was deemed correct

if the center of the X was inside the circle. Time and percent correct was recorded.

4. Tennis Ball Recognition: This exercise required a tennis ball. The subject was to stare at a centrally located target on the ceiling while the researcher stood behind him. The researcher then threw the ball lightly over the participant's head and the participant was instructed to catch/attempt to catch the ball. Eccentricity of where the tennis ball was thrown varied. Number of catches in 2 minutes was recorded.
5. Wall Ball: This exercise required a wall and a tennis ball. The participant was to stare at a centrally located target slightly above eye level. While staring at the centrally located target, the participant threw the ball against the wall from right hand to left hand and then from left hand to right hand. The subject was to use his peripheral awareness to track and catch the ball. To add difficulty to the test, the researcher taped a piece of paper on the wall. When throwing the ball back and forth, the participant was instructed to hit the piece of paper on the wall while staring centrally. The piece of paper was located 1 foot from the centrally located target. Number of drops in 3 minutes were recorded.
6. Multi Catch: This test required 2-3 tennis balls. The researcher was to stand about 7 feet in front of the participant while holding 2-3 tennis balls. For 2 balls, the researcher threw and asked the participant to catch the 2 balls while staring at the researcher. For 3 balls, the participant was asked to focus on the center red ball while catching the 2 balls in the periphery. This process was repeated 15 times. The total number of successful catches out of 15 throws was recorded.

7. Tennis Ball High Toss: This exercise required a tennis ball. The subject was to stare at a centrally located target located approximately 10 feet away that was slightly below eye level. The participant softly threw the ball over his head from one hand to the other. The ball was to leave the subject's peripheral field, then come back. This required the subject to track and catch the ball using his peripheral awareness.
8. Soccer: This test required a soccer ball and a mini soccer net. The participant was to try to kick the soccer ball in the net using his peripheral awareness. Between shots the researcher asked the participant to close his eyes when the researcher moved the net to a different location. To track progress the participant will be timed. Six different degrees of eccentricity were used and the time stopped when the participant successfully scored at the six different spots, twice. This was performed on each side of the participant. The participant wore headphones to block out movement of the researcher. Time was recorded.
9. Tennis ball bucket shot: This exercise required six 5-gallon buckets and several tennis balls. The 5-gallon buckets were located in various locations and at various distances depending on the skill level of the participant. The subject was to stare at a centrally located target about 5 feet away. The subject then threw the tennis balls into the 5-gallon buckets. To track progress, the participant was timed. Timing stopped when the participant successfully threw 3 tennis balls into each bucket. Time, distance of the buckets, and number of shots were recorded.
10. Basketball: This test required a mini basketball hoop and several small balls. The participant was asked to shoot the ball into the basketball hoops at varying

degrees of eccentricity. Four (2 on each side) different degrees of eccentricity were used and the time was stop when the participant had successfully thrown into the mini basketball hoop into the four different spots, twice. The participant closed his eyes while the researcher moved the basketball hoop. Difficulty was increase once the participant shot 50 percent on that side. The participant wore headphones to block out movement of the researcher. Time and shooting percentage was recorded.

11. Football: This test required a tennis ball. The participant threw the tennis ball at various degrees of eccentricity to the researcher. The researcher changed location after every throw. The participant closed his eyes after each throw so the location of the researcher was not known. For the participant to be credited with a successful throw, the participant must have hit the bucket the researcher is holding. To track progress the participant was timed. Four (2 on each side) different degrees of eccentricity were used and the time stopped when the participant successfully threw to the four different spots, twice. This was performed on each side of the participant. Difficulty increased once the participant successfully hit the buckets on one side 50 percent of the time. The participant wore headphones to block out movement of the researcher. Time was record.

APPENDIX C

AT HOME PERIPHERAL AWARENESS TRAINING EXERCISES

1. **Tooth Pick and Straw:** This exercise required a toothpick and straw held at 40 cm. The subject was to stare at the central tip of their thumb. The subject then held a straw at arms-length. With the other hand, the subject held a toothpick and attempted to place the toothpick into the straw using his peripheral awareness. The participant had 3 attempts to place the toothpick in the straw at a given distance on the straw. After each attempt, the participant was required to touch the toothpick to their table or desk to remove any habitual factors. The participant performed this for 5 minutes and record his maximum distance.
2. **Peripheral Expansion Chart:** Electronic peripheral expansion charts were provided to the participant. The participant was asked to centrally fixate on the center target at 40 cm, sitting approximately 1 foot from the chart. The participant was then asked to see how many letters they could correctly identify when fixating on that center target (recording: number of letters seen). After the participants recorded how many letters he correctly identified, he will then be asked to look at the peripheral letters in the chart and repeat the task.
3. **Speed Memory:** This exercise required paper designs with 2-8 one inch letters on the outer edge. The participant was instructed to stare at a centrally located target at the center of the piece of paper. The participant would then flash the paper design with the centrally located target for 1-2 seconds. The participant, while staring at the centrally located target at 40 cm, would attempt to identify the letters in the periphery using his peripheral awareness. The participant was to do

this 12 times/workout. Participant was to record how many letters he successfully identified on each page.

4. Page Flip: This test required a computer. The researcher was given 100 pages and had one letter typed in the periphery on six of the pages. The participant was asked to fixate at an x in the center of each page. The participant then flipped through the pages (holding the down arrow) and attempted to identify the letters in the periphery. Assuming the participant would not identify all 7 letters the first time he performed the exercise, he was asked to repeat the exercise until he believe he had correctly identified all 7 letters.
5. Shapes: This test required a computer at 40 cm. The participant was to fixate at a specified target on the paper. In the periphery there were several shapes (square, circle, triangle, diamond, hexagon) drawn. The participant was asked to quickly identify each of the shapes in the periphery. This was a timed exercise and the time stopped when the participant identified 15 pages of shapes. Time and pages of misidentified shapes was recorded.
6. Juggling: This exercise required 2 or 3 tennis balls. The number of tennis balls used depended on the juggling skills of the participant. During this exercise the participant was asked to attempt to juggle while staring at a centrally located target.
7. Tennis Ball High Toss: This exercise required a tennis ball. The subject was to stare at a centrally located target located approximately 10 feet away that was slightly below eye level. The participant softly threw the ball over his head from

one hand to the other. The ball left the subject's peripheral awareness, then came back. This required the subject to track the ball with his peripheral awareness.

8. Color recognition: The participant was given cutouts of colors. The participant, while staring at a distant centrally located target, extended his arms and slowly, and at a steady pace, brought the colors inward (with his arms still extended) until he correctly identified the color.