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FOR BASEBALL PLAYERS

Visual Enhancement Training for Baseball Players

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Abstract

The purpose of this study was to determine if visual enhancement training is beneficial to a baseball player's hitting abilities. We found that the group of players who received the visual training sessions showed a statistically significant ($p<.05$) increase in their hitting abilities as compared to a group of players who did not receive the visual training sessions. This study shows that a generalized visual enhancement training program can help a baseball player improve his hitting abilities.

Visual Enhancement Training for Baseball Players

Introduction

Vision and baseball have always been interrelated. Expressions such as: "You can't hit what you can't see" , "Keep your eye on the ball", and "Where were you looking?", have been heard on many a baseball diamond. But how often has a coach told his players how to use their eyes? Athletes are coached in everything but their most important asset, vision. It has been said that an athlete can perform only as well as he can see and interpret what he sees. The purpose of this study was to see if visual enhancement training is beneficial to a baseball player's hitting abilities. It also tried to develop simple techniques which coaches and players could utilize in their training programs to increase a player's visual efficiency. The visual enhancement training emphasized accommodative tracking, accommodative facility, the interaction of accommodation and convergence, visual tracking and locating skills, stereopsis, and certain vision oriented baseball training techniques developed by Dr. William Harrison.

Harrison states that hitting a baseball has been called the most difficult single act performed by an athlete. It not only involves the tracking of a moving object but the player must judge its speed, trajectory, whether it is a fastball or curve, and whether it is a strike or ball. In 1950 Slater-Hammel and Stumpner measured the starting and moving reaction times of batters to a visual stimulus. Starting reaction time was defined as a measure of speed with which a subject could start a bat moving upon presentation of a visual stimulus. The average starting

reaction time was approximately .21 seconds. This means that for the average fastball which travels from the pitcher to homeplate in approximately .43 to .58 seconds the ball would be at least 22 to 30 feet from home to have sufficient time for a starting reaction to take place. Movement reaction time, which was defined as a measure of the speed with which a subject could change the direction of a moving bat upon the presentation of a visual stimulus, was approximately .27 seconds meaning the ball would have to be at least 28 to 38 feet from home if a movement reaction was to take place. The experiment tested simple reactions and actual batting situations may involve choice reaction, i.e., whether a pitch is high, low, inside or outside. Therefore in 1951 they conducted a choice batting reaction time experiment. In this experiment the batter responded only to certain stimuli. Choice starting reaction time was measured at .29 seconds therefore the ball would have to be a least 30 to 41 feet from home. Choice movement reaction time equaled .34 seconds meaning the ball would be at least 35 to 48 feet from home. These figures do not take into the effect of change in velocity of the ball due to air resistance and bringing the bat forward after the starting movement. They concluded that it appears that a batter must obtain information as to where the ball will be as it passes over home before the ball reaches the midpoint of its flight. After the ball has passed this point, there would no longer be time for a batter to react to any changes in the ball's direction of flight.

In 1975 Harrison stated that the average pitch in the major leagues travels at approximately 80 m.p.h., which means it takes .4 seconds for the ball to get from the pitcher's hand to home plate. It takes .2 seconds to get the bat from the shoulders to the point of impact. That leaves .2 seconds for the batter to decide whether or not to swing.

It is evident from both these sources that if the hitter loses anytime in processing the necessary visual information on the pitch he will not be able to get the bat around to make solid contact with the ball.

Hubbard and Seng in 1957 concluded that visual tracking of a pitched baseball is accomplished by pursuit movements with some compensatory eye movements while the head is held in a fixed position. Trachtman in 1973 found pursuits to have a significant correlation with batting averages of Little Leaguers. Therefore even a slight lag in a pursuit movement or a slight movement off the ball can turn the ball into a blur. A player must be able to center on a moving object in space and quickly judge and interpret the maximum amount of information he can in the short time he has before he has to start to swing the bat.

The idea of using visual training to improve athletic performance has existed for sometime. Koch in 1949 published a report on visual training and sports at Ohio State University. Their research group evolved several principles from their study. They are as follows: The capacity to see is affected by habits of seeing and may be changed by appropriate experience. The ability to see objects in a wider visual field can be increased by training. This training may also affect the depth of the visual field increasing this depth in both the vertical and horizontal meridians. Training may also improve the overall visual perception in a once widened form field. It will enable the trainee to more accurately discriminate the distances which separate himself from objects in a given visual field, as well as the size, shape, brightness and color of these objects. It will enable the observer to discriminate more accurately the relative positions of objects in a given visual field when the objects are introduced at variable periods of time. They concluded that the degree of performance of the observer's spatial relationship influences the observer's

spatial relationship influences the observer's ability to move and act in relationship to his performance, and in turn, that the best learning comes with an integration of optical, auditory, kinesthetic, motor, tactile, psychological and intellectual stimuli.

This same idea of integration of the different physical systems is the basis for Harrison and Lee's vision dynamics method for baseball. They were hired by the Kansas City Royals baseball team in 1972 to develop a visual training program. The Royals were the first major league club to initiate a diversified program in visualization. The program concentrated on eight physical systems: 1. Visual; 2. Motor Coordination; 3. Balance; 4. Hearing; 5. Energy; 6. Touch; 7. Body Awareness; and 8. Thinking (through visualization). The tests and exercises were designed to improve the players' discrimination, perception and decision making processes involved in what their eyes see. The training emphasizes visual efficiency while the person is processing information through the other system such as balance, hearing, and coordination.

A good visual system is essential if a player expects to hit a baseball sharply and consistently. Beside 20/20 visual acuity, the abilities to focus, converge, and control the eyes individually and together are equally important. Harrison and Lee feel that these functions combined with visual perception of depth, motion, form, direction, and the perception of time have to be functioning efficiently to bring a hitter to his maximum effectiveness. However, they feel that the key to their program is the development of concentration through a process called centering. The concentration process is broken down into four steps: 1. Defining what the job is; 2. Visualizing the desired performance; 3. Centering on the target; and 4. Execution of the task. There

are degrees of centering within a sensory system. An individual may want to soft center or prefer to fine center. Fine centering on a target is to be aware of as much detail as possible while as he softens his centering the degree of detail becomes less. In sports, it is essential that an athlete center in the proper system and to the proper degree of fineness or softness for best performance. Lee feels that in great athletic performances the athlete has a high degree of visual awareness (visual centering) and a low awareness of what his body, arms and legs are doing.

The visual dynamics method showed good success with the Royals. In the first year after the training the Royals lead the American League in team batting and had four players in the top ten hitters in the league. One other player raised his lifetime batting average of .224 to three successive seasons of .275.

Revien in an article published in 1977 worked with the New York Sandlot Baseball Club and increased batting averages .072 points for players who had visual training as compared to an increase of .029 for players with no visual training. Players who did not receive visual training had an average of one strike out per 4.5 times at bat in 1974 and one per 4.6 at bats in 1975. Visually trained players averaged one strike out per 5.8 at bats in 1974 and only one per 10.8 at bats in 1975. Visually trained players reported that the ball seemed to be moving slower and that it appeared clearer.

Falkowitz and Mendel's study in 1977 shows that there is a relationship between rotations, pursuits, saccades, near point of convergence, eye and hand dominance and the batting averages of Little Leaguers.

In this study the evaluation of regular season statistics was not

done due to the time limitations of the study. Testing was conducted during the off season (September-December) and was done in a handball court in the Pacific University Athletic Complex with batters hitting off a Granada II pitching machine. These controls were necessary to insure equal opportunities for each batter.

It was assumed that nine one hour visual training sessions with home training activities in between sessions would be sufficient to produce changes in the subjects' visual systems. Revien used three sessions per week each 30 to 40 minutes long through nine sessions to produce his results. It was also assumed that the test conditions sufficiently simulate regular game situations. The results obtained were also assumed to correlate with players' abilities during the regular season although more data would be necessary to prove this assumption.

A player's hitting abilities was calculated on four criteria in this study. First the number of solid contacts made per strikes thrown. Solid contacts will be defined as when a batter takes a full swing and hits what is judged by the experimenter as a hard hit line drive or hard hit ground ball. Data on the number of strikes swinging and missing, the number of called strikes a player takes, and the number of called balls taken will also used to evaluate the player's hitting abilities. The term strikes thrown is defined as the sum of the number of pitches swung at whether or not any type of contact is made, and the number of called strikes taken.

Research Design and Procedures

It was hypothesized that a group of baseball players given nine visual enhancement training sessions would show an equal change in their hitting abilities when compared to another group of baseball players

who are not given the visual enhancement sessions.

The subjects for this experiment were members of the Pacific University baseball team. The players were chosen randomly to be either in the experimental group (those receiving the visual training) or the control group (those not receiving the visual training). They are identified in the data according to their initials.

A Granada II pitching machine was used to throw pitches at the batters during the testing procedures. Regulation size bats as approved for college play were used. The machine threw perforated plastic balls, one ounce in weight. The machine was placed 26 feet from the batter. This distance was recommended by the manufacturer to simulate the speed of a pitch in an average college baseball game.

Optometric equipment used in the visual training sessions included Brewster stereoscopes, rotators, rotoscopes, telebinoculars, vectographic materials, Vodnoy aperature rules, Marsden balls, Brock strings, lens flippers, far and near acuity charts, various types of stereograms including the B.U. and A.N. series, balance boards and lenses and prisms of various powers.

The testing started with all the players hitting 108 pitches off the pitching machine in a handball court in the Pacific University Athletic Complex. Each player was given 18 practice pitches prior to the start of the testing procedures. The subjects were instructed that they were going to receive 108 pitches in sets of 18. They were to swing at pitches that they thought to be strikes and try to make solid contact with each attempt. They were told that failing to swing at a strike and missed swings would be counted against them, and failing to swing at a called ball would count towards their score. The experimenter served as the

judge of solid contacts and balls and strikes. Each hitter was given 108 pitches with pauses between each group of 18 pitches so that the batters could alternate turns. Players were allowed to hit in any arbitrary order. Data was kept on the total number of pitches thrown, the number of solid contacts, the number of missed swings, and the number of called balls and strikes. This procedure was repeated following the nine visual training sessions. The players were given nine one hour sessions during a 6 week period with home training activities in-between. The players were required to do two 15 minute sessions per day at home. Training was given in areas to improve accommodative tracking, accommodative facility, convergence amplitude, convergence and divergence facility, the interaction between accommodation and convergence, visual tracking and locating skills, stereopsis, and certain visually related baseball training techniques developed by Dr. William Harrison.

Visual Training Emphasis Areas

I. Visual Tracking and Locating Skills - Manipulatory Skills

1. Rotations training - monocularly and binocularly
   A. Rotators - Arneson or Elephant
   B. Rotoscope
   C. Dowel Sticks
   D. Marsden Ball with a balance board
   E. Fixation Light

   Vary speed and distance.
   Use prisms and head, body and pointing movements

2. Pursuits and Tracking - monocularly and binocularly
   A. Fixation Light
   B. Dowel Sticks
   C. Marsden Ball
   D. "Bug on the Wall" tracking
   E. Brock String

   Use prisms and body movements.

3. Saccadic Fixation Training - monocularly and binocularly
   A. Two Fixation Lights
   B. Two Dowel Sticks
   C. Jump Ductions - A.N. series
   D. Brock String
   E. Wall Corner Fixations
   F. Fixations with Star target

   Do in all merdians and vary distance.

II. Convergence Training

1. Development of Convergence Amplitude
   A. Development of NPC break and recovery points
      1)Pencil push-ups
      2)Stationary target and patient sways towards and away target
      3)Brock string
      4)All of the above with asymmetric target presentation
   B. Combined NPC training with other binocular V.T. procedures
      1)Rotations, binocular motor field training and stereodisplays
      2)Combine with stereopointing

2. Convergent Saccadic Training
   A. Symmetrical and asymmetrical presentation of fixation objects and target field at different distances
      1)Head in primary position
      2)Paired with body sway, locomotion, pointing and/or head movements
   B. Stereodisplays
      1)Stereoviews in a stereoscope
      2)Vectographic displays
   C. Brock string
   D. Distance rock procedures

3. Binocular Motor Field Training
   A. Target tracking with head stationary in primary position
   B. Target or fixation object stationary with head movements in different meridians
   C. Target stationary, head stationary in primary position and body rotating
   D. Stereoscopic pointing procedures
   E. Rotoscope
   F. Vectographs
   G. Brock string in all meridians

4. Forced Prism Vergence Training
   A. Split stereograms at varying distances
   B. Trombone procedures with stereoscope display stage
   C. Prism stereogram series including jump ductions
   D. Vodnoy training equipment

5. Prism Rock
   A. Prism rock techniques involve a constant visual display at a determinate distance with various magnitudes of BO and BI prisms inserted in and out before the eyes
   B. Training will be done with flipper equipment and loose prisms and balance boards with acuity material as the target

6. Combined Sphere and Prism Rock Training
   A. Same as prism rock procedures
   B. Lens schedules:
      1)BO prism (in MA) with plus spheres
      2)BI prism (in MA) with minus spheres

III. Accommodative Training

1. Accommodative Rocks
   A. Monocularly and binocularly
   B. Combined minus and plus lenses

2. Accommodative Tracking
   A. Trombone procedures in a stereoscope
   B. Body movements with fixed targets

3. Distance Rock
   A. Monocularly and binocularly
   B. Acuity chart at far and near used as targets

IV. Stereopsis Training

1. SILO awareness training
   A. On lens rocks
   B. With poloroid material

2. S.M. series of stereograms- Airplane series

3. A.N. series of stereograms

4. Stereopointing - pencil point into straw

5. Stereoscope tromboning

6. Rotoscope

V. Visually Related Baseball Training Techniques

1. Centering on the ball - concentrate and look at the middle third of the ball

2. Height judgement
   A. Point at different objects estimating their heights, then walk up to the object to see if you are right
   B. With a bat and a stick and five targets at 20 feet. Each target was placed at a different height. Player A tells Player B to look at one of the five targets and to estimate its height. Player A holds a six foot long stick upright in front of Player B. Player B swings the bat slowly and stops at the stick at the height he estimates the target is at. The stick is marked on the side away from the batter with the correct heights of the targets. Player A tells Player B whether he has swung too low or too high. Player A picks the next target and Player B swings again. This is repeated until Player B has swung at every target several times.

Visual Training Schedule - In Office

Session No. 1

1. Pursuits and Rotations - monocularly
2. Saccades - monocularly
3. Pencil Push-ups
4. Prism Rock - 6 P.D. base-in and base-out
5. Split stereograms - far setting
6. Distance Rock - monocularly
7. Stereopointing - pencil and straw
8. Accommodative Rock - monocularly with $\pm$1.50 D lenses

Session No. 2

1. Pursuits and Rotations - monocularly
2. Saccades - monocularly
3. Brock string - smooth tracking movements at near
4. Distance Rock - monocularly and binocularly
5. Prism Rock - 8 P.D. base-in and base-out
6. Accommodative Rock - monocularly and binocularly with $\pm$1.50 D lenses
7. Split stereograms - far and near settings

Session No. 3

1. Pursuits and Rotations - binocularly
   A. Elephant Rotator
   B. Marsden Ball
2. Saccades - binocularly in stereoscope
   A. 2° fusion target at far and near
   B. 3° fusion target at far and near
3. Prism Rock - 8 P.D. base-in and base-out
4. Vectograms - Clown
5. Accommodative Rock - binocularly with $\pm$1.75 D lenses
6. Brock String - smooth movements and jump ductions

Session No. 4

1. Pursuits and Rotations - binocularly
   A. Elephant Rotator while balancing on one foot
   B. Marsden Ball
2. Saccades - binocularly in stereoscope
   A. 2° fusion target at far and near
   B. 3° fusion target at far and near
3. Prism Rock - 10 P.D. base-in and base-out
4. Vectograms - Clown
5. Accommodative Rock - binocularly with $\pm$1.75 D lenses
6. Height Judgement
7. Split Stereograms

Session No. 5

1. Rotoscope - 3° fusion target
2. Marsden Ball tracking and balance board
3. Prism Rock - 10 P.D. base-in and base-out

4. Accommodative Rock - binocularly with ±2.00 D lenses
5. Vodnoy Rule
6. Jump Ductions - AN series
7. Height Judgement - Bat swinging
8. Stereoacuity - Airplane series

Session No. 6

1. Rotoscope - 3° fusion target
2. Marsden Ball tracking and balance board
3. Prism Rock - 10 P.D. base out with +1.50 D lenses
4. Accommodative Rock - binocularly with ±2.00 D lenses
5. Vodnoy Rule
6. Jump Ductions - AN series
7. Height Judgement - bat swinging
8. Stereoacuity - Airplane series
9. Stereoscope Tromboning

Session No. 7

1. Saccades - 3° fusion target in stereoscope
2. Brock String
   A. Short length - rotations
   B. Long length - smooth tracking movements and jump ductions
3. Prism Rock - 10 P.D. base-in with -1.50 D lenses
4. Jump Ductions - AN series
5. Vectograms - Clown and Spirangle
6. Accommodative Rock - binocularly with ±2.00 D lenses
7. Height Judgement - bat swinging
8. Balance Board and hand held loose prisms - 6 P.D. base-in and base-out

Session No. 8

1. Rotoscope - 3° fusion target
2. Saccades - binocularly in stereoscope
3. Prism Rock - 12 P.D. base-in with -1.25 D lenses
4. Accommodative Rock - binocularly with ±2.00 D lenses
5. Height Judgement - bat swinging
6. Jump Ductions-AN series
7. Stereofusion - AN series
8. Vectograms - Spirangle
9. Balance board and hand held loose prisms - 8 P.D. base-in and base-out

Session No. 9

1. Marsden Ball tracking and balance board
2. Saccades - binocularly in stereoscope with pointing
3. Prism Rock - 10 P.D. base in with -1.50 D lenses
4. Accommodative Rock - binocularly with ±2.00 D lenses
5. Stereoscope Tromboning
6. Jump Ductions - AN series
7. Vectograms - Spirangle
8. Stereoacuity - Airplane series

Eye Exercises for Home Training

Exercise No. 1 - Tracking Skills

1. The task here is to simply follow a moving object in space.
2. The target should be something small such as the tip of a pencil or pen. A small penlight can also be used.
3. It is important in this task and all other task to focus in on the target. This is best done by looking for detail such as small print or in this case the very tip of the pen or pencil.
4. Start off using one eye at a time and progress to using both eyes.
5. It is best to do the exercises with a partner but they can also be done alone.
6. With one eye covered slowly rotate the target in front of you in a circular manner at a distance of 16 to 18 inches.
7. Follow the target by moving your eyes only. Do not use any head movements. Have your partner observe if your eye movements are smooth or jerky. Strive for smooth and accurate movements.
8. Now move the target up and down and in a criss-crossing pattern.
9. Now move the target toward your eyes in a U-shaped pattern. Do it in varying meridians.
10. Now stare at a fixed object and turn your head to the right and to the left, up and down, and in a circular manner. Keep looking at the object at all times.
11. Staring at a fixed object again rock your body back and forth and to the side. Add head movements and maintain your fixation.
12. Pick out a picture on the wall and slowly trace its outside margins with your eyes. Imagine there is a bug walking along the edge and you are following it. Go around the picture in both directions. Remember to do it slowly.

Exercise No. 2 - Jump Fixations (Saccades)

1. The task here is to move your eyes quickly and accurately back and forth between two targets.
2. Use two pens or pencils as targets.
3. Start with one eye covered and remember to focus in on the targets. Alternate eyes. Progress to using both eyes.
4. Hold the targets about 12 inches apart and about 16 inches in front of you. These distances can be varied as the exercise becomes easier.
5. Look at one target and with your peripheral vision try to see the other target off to the side. Now quickly look at the other target.
6. Have your partner note if your eye movements are smooth and accurate or if you have to make compensatory movements once you are close to the target. Note if you are slightly undershooting or over-shooting the target.
7. Look back and forth between the targets remembering always to pause and to use your peripheral vision to see the other target before looking back at it.
8. Do these movements in varying meridians - horizontal, vertical and oblique.
9. Now do it with one target close to your eye and one at a farther distance.
10. Now use a picture on the wall as a target. Look quickly from corner to corner going around the picture in both directions.

11. Now pick out several small objects in the room they should be at various distances from you and in various locations in the room. Look at one object, call out another object and quickly and accurately look at the next. Go from object to object in any random order. Remember to look for detail in the objects you look at.

Exercise No. 3 - Pencil Push-ups

1. This is done like Exercise No.1 except always do this with both eyes open.
2. Using a pen or pencil slowly move it on your midline towards your nose.
3. Try to keep it single for as long as you can.
4. Note at what distance you first see the pencil tip double. Move the pencil all the way in to your forehead. Slowly move the pencil back away from your face and try to make it into one as soon as you can.
5. Note when you can make it back into one again.

Exercise No. 4 - Distance Rocks

1. This is done like Exercise No. 2 except we will use letters as the targets.
2. Pick out something that is printed on the wall. Try to find the smallest print you can see from across the room.
3. Hold a book or printed material just below eye level and about 16 inches in front of you. Again use the small print letters.
4. Read a letter at near then look out at far and read a letter. Look back at near and read the next letter. "Rock" back and forth between far and near.
5. Vary both the distance at which you hold the book and how far you are from the distant letters.
6. Start off using one eye only and progress to using both eyes.

Exercise No. 5 - Pencil and Straw (Depth Perception)

1. This exercise should be done with a partner.
2. Have your partner hold a straw upright in front of you.
3. You must place the pencil point right in the center of the straw in one quick and continuous motion.
4. Do not stop or slow down your motion as you approach the straw.
5. Keep both eyes open.
6. Vary the distance at which the straw is held.
7. Now use your other hand to do the pointing.

Exercise No. 6 - Height Judgement

1. The idea of this exercise is to judge the height of different fixed objects much like judging the height of a pitched ball.
2. Look out across the room and pick out an object; the door knob, light switch, a spot on the wall or a letter on a picture.
3. Judge its height, raise your finger to that height and walk across the room to see if your judgement is correct.
4. Start off at about 6 to 8 feet from the object and increase the

distance as the task gets easier.
5. Use various objects at different heights as targets.

Exercise No. 7 - Brock String

1. There are two tasks that can be done with the strings. The first involves doing smooth tracking movements and the second quick accurate movements.
2. Hold one end of the string up to your nose and stretch the string out to arm's length. One bead should be 4 to 6 inches from your nose, another midway down the string and the last at arm's length.
3. With both eyes open look down the length of the string at the last bead you should see a V formed with the strings meeting at the bead you are looking at.
4. Now look at the middle bead you should see an X formed with the bead at the center. In fact you should see the strings crossing at any point you look at.
5. Slowly follow the string all the way into the closest bead and then back out again. Keep following the string in and out.
6. Make the movements slowly and smoothly and always be aware that the point where the strings cross is where you are looking.
7. Now look at the farthest bead and slowly rotate the string in circular and random criss-crossing patterns. Keep the strings crossed at the point you are looking at.
8. Do the same for the other two beads.
9. Now tie one end of the string down to a nail or tack. The nail should be about chest high.
10. Stretch the string out to its full length and again place the beads at near, midway, and at the end of the string.
11. Repeat the smooth tracking movements up and down the string.
12. Now take your batting stance and do the tracking procedures.
13. The second exercise is to jump back and forth between the three beads.
14. Look quickly from bead to bead in any random order.
15. When you look at the bead the cross should go right through the bead and not in back or in front. If you see the cross in back or in front of the bead then you are undershooting or overshooting the target and having to make a second movement to get right on the bead. Strive to do it in one quick and accurate movement.
16. Do this exercise both at arms length and with the whole length of string.

Visual Training Schedule - Out of Office
Refer to Eye Exercises for Home Training for Exercise numbers.

Weeks No. 1 and 2

Exercise No. 1 Steps 1-8 monocularly
Exercise No. 2 Steps 1-8 monocularly
Exercise No. 3 Steps 1-5
Exercise No. 4 Steps 1-4 monocularly
Exercise No. 5 Steps 1-6

Week No. 3

Exercise No. 1 Steps 1-9 monocularly and binocularly
Exercise No. 2 Steps 1-9 monocularly and binocularly
Exercise No. 3 Steps 1-5
Exercise No. 4 Steps 1-6 monocularly and binocularly
Exercise No. 5 Steps 1-6
Exercise No. 7 Steps 1-6

Week No. 4

Exercise No. 1 Steps 1-9 binocularly
Exercise No. 2 Steps 1-9 binocularly
Exercise No. 4 Steps 1-6 binocularly
Exercise No. 5 Steps 1-7
Exercise No. 6 Steps 1-5
Exercise No. 7 Steps 1-8 & 13-15

Week No. 5

Exercise No. 1 Steps 1-11 binocularly
Exercise No. 2 Steps 1-10 binocularly
Exercise No. 4 Steps 1-6 binocularly
Exercise No. 6 Steps 1-5
Exercise No. 7 Steps 1-8 & 13-15

Week No. 6

Exercise No. 1 Steps 10-12 binocularly
Exercise No. 2 Steps 10-11 binocularly
Exercise No. 4 Steps 1-6 binocularly
Exercise No. 6 Steps 1-6
Exercise No. 7 Steps 7-16

Statistical Procedures

Four criteria were used to evaluate a player's hitting abilities. The first was the number of solid contacts made per number of strikes thrown (SC average). This was probably the most important average because it is a batter's job to try to make solid contact with the ball every time he goes up to bat. Next is the number of pitches called balls per number of pitches not swung at (BB average). It is to a hitter's advantage to be able to correctly judge which pitches are balls and which are strikes and thereby swing at only good pitches. The third criteria was the number of called strikes per number of pitches not swung at (KC average). A player's misjudgement of strikes as balls is to his disadvantage. The last criteria was the number of missed swings per number of strikes thrown (KS average). This was an important statistic because failing to hit the ball is exactly the opposite of what is demanded of a hitter.

The improvement between the pre-therapy and post-therapy averages in each catagory were compared between the experimental and control groups. Comparison was make by t-test statistics with a .05 significance level. The four criteria were then averaged together to get an over all average of a player's hitting abilities (BA average). The KC and KS averages were taken as one minus their value in order to make them positive attributes of a hitter's abilities. The two groups were again compared according to the t-test with a .05 significance level.

Data and Results

Four criteria were used to evaluate a player's hitting abilities. After the pre-therapy hitting session it appeared that three of the criteria, the BB, KC, and KS averages, would not be valid measurements of a player's hitting abilities. This was caused by the pitching machine's consistency in throwing strikes. The batters were making contact with over 96% of the pitches thrown. Table II shows the exact number of called balls and strikes and swinging strikes each subject had and converts the totals for each group into percentages of total pitches thrown. It is evident in both the pre and post-therapy hitting sessions that the sample size to determine the BB, KC, and KS averages were too small to show any significance. Therefore only the change in the SC averages for the experimental and control groups were compared.

Table I shows the pre and post-therapy SC averages, their differences and gives the student's t value for the differences between the two groups. The student's t value equals 1.800 with 12 degrees of freedom and is significant to $p < .05$ level. The null hypothesis was rejected.

Table I - SC Averages

Control Group

SUBJECTS	PRE	POST	DIFFERENCE
SA	.476	.565	.089
FB	.500	.638	.138
RB	.628	.653	.025
RCp	.589	.657	.068
LK	.713	.800	.087
JS	.587	.629	.042
RS	.570	.648	.078
HU	.565	.704	.139
TOTAL AVERAGES	.579	.662	.083

Experimental Group

SUBJECTS	PRE	POST	DIFFERENCE
BBf	.486	.714	.228
BBl	.611	.667	.056
RCn	.660	.755	.095
TD	.602	.741	.139
JM	.542	.663	.121
HS	.509	.648	.139
TOTAL AVERAGES	.568	.698	.130

$t = 1.800$ $p < .05$ $df = 12$

Table II - KC, KS, and BB data

Control Group

SUBJECTS	KC PRE	KC POST	KS PRE	KS POST	BB PRE	BB POST
SA	1	0	1	0	3	0
FB	1	0	2	2	6	3
RB	1	0	0	0	3	7
RCp	0	1	3	0	1	6
LK	0	0	0	0	0	3
JS	0	3	0	0	4	3
RS	1	1	1	0	1	0
HU	0	0	0	0	1	0
TOTALS	4	5	7	2	19	22
% of TOTAL PITCHES	0.5	0.6	0.8	0.7	2.2	2.5

Experimental Group

SUBJECTS	KC PRE	KC POST	KS PRE	KS POST	BB PRE	BB POST
BBf	0	2	3	0	1	3
BBl	0	0	0	1	0	0
RCn	0	1	1	0	2	2
TD	0	0	0	0	0	0
JM	1	1	0	0	1	7
HS	1	0	0	0	2	3
TOTALS	2	4	4	1	6	15
% of TOTAL PITCHES	0.3	0.6	0.6	0.2	0.9	2.3

Totals for both groups for both sessions:

Total pitches	3024
Total pitches not hit	91
% of Total pitches not hit	3.0%

Discussion

The statistical analysis of the data showed that the players in the experimental group improved their SC score on the average of .130 points while the control group improved only .083 points on the average. This difference was shown to be significant to $p < .05$, indicating that the visually trained group demonstrated a significant difference in their improvement in their hitting abilities over the control group.

Subjectively the players in the experimental group had a variety of comments on the visual training affects. Player BBf said the post-therapy hitting session was a lot easier. Player JM's comment was that the ball appeared larger and that he was seeing more of the ball. Player TD said he could feel his eyes more and felt like he was using them more. An interesting comment was that Player HS felt that the training had helped him improve his basketball shooting.

Hitting abilities were defined to be a combination of a player's SC, BB, KC and KS averages but because of the pitching machine's consistency in throwing strikes the number of called balls and strikes and the number of missed swings were too small to be compared with the SC average. Out of the 3024 pitches thrown only 3.0% of these pitches were not hit. In fact one player (TD) had no called balls or strikes or missed swings in both the pre and post therapy hitting sessions. Therefore the SC average alone was taken to be an indication of a player's hitting ability. This was probably the most important statistic because this measures the player's ability to make solid contact with the ball.

Since the training program emphasized five different areas (accommodation, convergence, visual tracking and locating skills, stereopsis and visually related baseball training techniques) it is not known whether each area

contributed equally to the improvement in the players' SC averages. One area may have contributed more than the others or may have even been the sole reason for the difference in the two groups. Further study is needed to determine which areas provide the most significant results or whether a wide pronged training schedule like the one undertaken here is necessary to show significant results.

Although the statistical evaluation showed a significant difference ($p < .05$) the student's t value was just within the .05 significance level. Therefore outside variables may have added to the differences in the two groups and caused a false conclusion from this study. It was assumed that these outside variables had an equal effect on both groups and therefore did not falsify the findings.

The first variable to be considered were the uncontrollable physiological factors such as a player's mental or physical fatigue factors. A player's concentration and his motivational factors can also be included here. Hitting a baseball is a very complicated and difficult task and therefore can be affected by these factors.

Another variable was that some players from both the control and experimental groups were participating in fall baseball workouts. Most of the players were probably in better physical shape for the post therapy hitting session because the start of regular baseball practice was nearing and because some of them had been participating in various intramural sports activities.

The pitching machine's consistency in throwing strikes altered the statistical evaluation and may have affected the players' judgements of pitches. The players were swinging at almost every pitch and may not have really been concentrating on whether the pitch was a strike or a

ball but just trying to make solid contact with it. The use of plastic balls with the machine may also have not really simulated a regular baseball.

A better way to evaluate hitting abilities would probably be to compare regular season statistics of the players in the study. This study did not do so because of time limitations involved in finishing the project. An addendum to this study could be added later to include this.

One of the purposes of this study was to develop a few simple techniques which coaches and players could use in their training programs to increase a player's visual efficiency. The visually related baseball training techniques and the eye exercises for home training help to meet this criteria. Although these two exercises alone may not help to increase a player's hitting abilities they can serve as a starting block for non-optometric personnel to gain better control of their visual systems and become more aware of its importance. These simple exercises are yet another avenue to pursue to see if visual training can contribute significantly to baseball hitting and other sports.

Conclusion

It has been shown that the players who under went visual enhancement training showed a significantly greater improvment in their hitting abilities as compared to the group of players who did not have the visual training sessions.

These findings go along with what others in the field have found. Harrison and Lee, Revien, Trachtman, and Falkowitz and Mendel all demonstrated that the visual system is an integral part of a baseball player's hitting capabilities. The need for a good, sound visual system is an important

factor in one's ability to hit a baseball. This study is another piece of evidence. It showed that accommodative, convergence, visual tracking and locating skills and stereopsis training along with a few visually related baseball training techniques can improve a player's hitting abilities. It points to the need for more qualitative studies in this field.

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