Article ▸ Stereopsis' Play on Baseball

Alison Jenerou, OD, Michigan College of Optometry at Ferris State University, Big Rapids, Michigan
Adeline Bauer, OD, Michigan College of Optometry at Ferris State University, Big Rapids, Michigan
Kimberly Reich, OD, Michigan College of Optometry at Ferris State University, Big Rapids, Michigan

ABSTRACT

Background: It is largely accepted that a superior binocular vision system is seen in collegiate and professional level athletes. Is their success based on innate above-average levels of depth perception, or are these high levels trained through years of playing sports? We sought to discover whether there is a correlation between stereopsis and batting average in young baseball players, 7-15 years old.

Methods: The following study assessed the visual acuity, heterophoria, and stereopsis of children who participated in organized Little League baseball teams. Those values were compared to their batting averages.

Results: Through the comparison of the patient data to their batting averages, we found that there was no correlation of the status of the binocular system and the batting averages.

Conclusion: The athletes screened had normal visual acuity and stereopsis, regardless of how many years they had been playing. Other research has shown a superior visual system in professional and collegiate athletes, and from this research, it may begin in childhood athletics. In comparison to the average population, athletes have superior stereopsis, but there is not a correlation between success in the sport and the value of the athlete's stereopsis. Athletic success seems to be multifactorial.

Keywords: baseball, sport performance, stereopsis

Introduction

Baseball is a fast-paced sport that requires skills such as eye-hand coordination and quick thinking. In the general population, those with better stereopsis perform better than those with reduced or no stereopsis at tasks involving visual motor skills.[1] Visual motor skills can include simple things such as copying a sentence from a chalkboard to more sophisticated skills such as playing tennis in a high-pressure competition. Most professional athletes are known to have superior vision when compared to the average person.[2] Specifically, studies done at the college and professional baseball levels have shown nearly uniform levels of depth perception that are better than the average population. However, it is unclear at this time whether these uniform, above-average levels are because the players who get to these high playing levels must have superior vision to compete at this level, or because these levels of visual acuity and stereopsis have been trained from years of playing the sport.

There have been some studies examining the ocular systems of novice and expert participants in certain sports. Fast-paced sports such as table tennis and clay target shooting have compared the visual systems of their novice and expert participants.[3,4] These studies show that it is not the stereopsis that separates the good athletes from the superior ones, but simply reaction time and experience. One author describes the difference in the athletes' hardware and software, acknowledging that the physical ocular characteristics (hardware) are at a higher level in athletes and are managed clinically by optometrists, but the software (perception) plays a large part in success.[5]

In this study, we examined the visual systems of relatively novice baseball players and assessed their visual acuity, heterophoria, and stereopsis in order to determine their level of binocularity. We compared it to their batting success during a 4-week indoor hitting league to determine whether better batting averages occurred in those with finer stereopsis.

Methods

Thirty-four athletes between the ages of seven and fifteen were randomly selected from a winter indoor hitting league. Subjects participated on different teams and were offered no compensation. They were told that they would undergo a short vision screening to determine their visual acuity and depth perception. The parents of the participants were required to sign an informed consent form and to complete a short questionnaire. The questionnaire inquired about the participant's age and previous participation in baseball. The research and testing protocol was reviewed and approved by the Ferris State University Institutional Review Board.

Athlete screenings took place during the baseball teams' regular practice time. All tests were administered indoors and with each player's normal optical correction. Participants' near local stereoacuity was measured with a Randot stereogram. Each subject held the test book at 40 cm and wore polarized glasses. The participant was asked to identify which of the Wirt circles in a set of three had crossed disparity, making

the circle appear to be coming towards the subject. The last correctly identified circle was recorded in seconds of arc. A supression check was also done using the R and L found in the test booklet. The subject's monocular visual acuity was tested with a Snellen chart placed at 20 feet. The participant was then instructed to cover one eye and to read the lowest line they could. If the subject got all the letters correct, he was asked to read the next line down. Visual acuity was recorded as the last line on which the athlete got over 50% of the letters correct. The results were recorded as a Snellen fraction and were later converted to LogMAR for analysis purposes. Eye alignment was assessed by having the athlete fixate on a distance letter on the Snellen acuity chart at 20 feet away, then performing a unilateral and alternating cover test. The results were recorded as orthophoric, esotropic, or exotropic.

A batting average was obtained from the director of the hitting league after the completion of the league. The hitting league consisted of four weeks, with one session per week. The participants received 50 pitches during each session, with ten pitches per at-bat before rotating with another player, for a total of 200 pitches during the course of the hitting league. The pitches were presented in a batting cage with a pitching simulator, which mimics an actual pitcher's wind up before the pitching machine delivers the pitch. The pitching machine was located 46 feet from the batter, which is the regulation distance for all Little League fields.

Batting averages were determined based on whether the ball would have been a hit or an out on an actual baseball field. In order to determine this, the batting cages were marked with different zones that corresponded to where the ball would land on a real Little League field. Foul balls were counted as outs, as were balls that landed within zones that a player should be able to field. Balls that would land in the outfield were counted as hits. If a player swung and missed, it was counted as an out. Not swinging at a pitch did not count against a batter and was not included in the total 50 pitches given to each player during a session. A neutral observer was charged with recording the hits and outs for each team. The final scores at the end of the four-week period were used to calculate a batting average. These averages were obtained from the league coordinator for this study.

Statistical analysis was done to determine whether any of the data yielded significant results. Descriptive and inferential statistics were accomplished using SPSS for Windows version 21. The mean and standard deviation were produced for all variables. Correlation coefficients were produced for all variable combinations. Stereopsis was divided into two groups, with one group having 20 seconds of arc or better and the other group having worse than 20 seconds of arc. Number of years playing was also divided into two groups, with one group having four years experience or less and the other group having more than four years experience. Participants were also grouped by age, with one group being 10 years old or younger and the other group being over 10 years old. A Levene's Test of Equality of Variance and an Independent Samples T-Test were used to analyze the Stereopsis Groups, Experience Groups, and Age Groups. Averages with standard deviations are provided for all data sets, as well as being broken down between groups.

Table 1. Number of Participants by Age

Age of Player	Number of Players
7	1
8	2
9	4
10	8
11	8
12	7
13	2
14	1
15	1
	34 (Total)

Results

The 34 participants in this study had a mean age of 10.8±1.7 years old (Table 1). These players had an average experience level of 4.97±1.56 years. On the Wirt ring stereogram, the participants had a mean stereopsis of 24.7±8.61 seconds of arc. The mean visual acuity for these players was 20/19.3 for the right eye and 20/18.8 for the left eye. Batting averages provided by the league coordinator showed an average of 0.543±0.175 for all participants.

From the data collected, 94% of the athletes had a visual acuity better than 20/30, and 97% had a stereopsis score better than 30 seconds of arc.

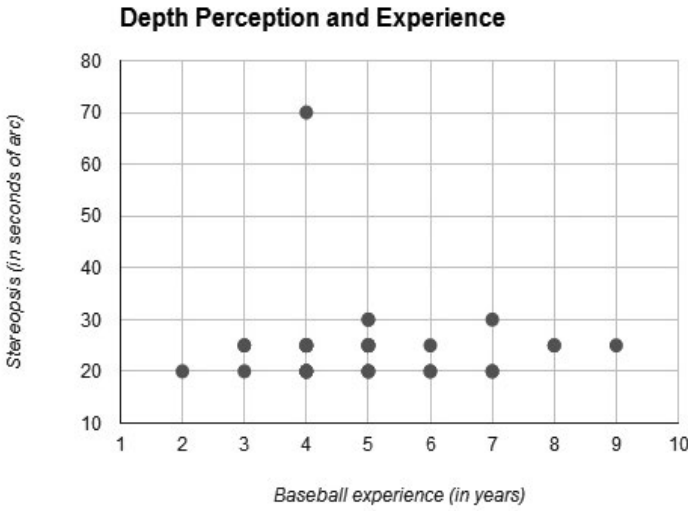

Figure 1. *A depiction of the relationship between the numbers of years each player has been playing baseball versus the stereopsis of the players that have been playing that specific year.*

After statistical analysis, it was concluded that there was no statistically significant correlation between stereopsis and batting average (p=0.518). In addition, there was no significance between years of experience and batting average (p=0.675). Finally, there was no correlation between years played and better stereopsis (p=0.847). Figure 1 illustrates the relationship between age and stereopsis. The only statistically significant finding was the correlation between age and the number of years of playing experience (p=0.000; Table 2).

In finding no correlation between the groups as a whole, the stereopsis, playing experience, and age categories were each divided into two groups and compared between these groups. Stereopsis was broken down into players who had 20

Table 2. Summary of Statistical Analysis

Comparison	Correlation	p value
Stereopsis vs. batting average	No correlation	p=0.518
Years of experience vs. batting average	No correlation	p=0.675
Years of experience vs. stereopsis	No correlation	p=0.847
Age vs. years of experience	Positive correlation	p=0.000

arc seconds or better versus those with worse than 20 seconds of arc. There was no statistically significant difference between age (t=-1.38, df 32, p=0.175), years of experience (t=-0.794, df 32, p=0.433), or batting average (t=1.53, df 32, p=0.136) in these groups. Playing experience was further broken down into two groups that consisted of those 10 years old or younger and those over 10 years old. Between these groups, there was no statistically significant difference between stereopsis levels as measured with the Wirt rings (t=0.572, df 32, p=0.571) and batting average (t=0.862, df 32, p=0.395). The population was also stratified into a group with four years or less experience versus those with more than four years of experience. There was no statistically significant difference between batting average (t=-0.069, df 32, p=0.945) or stereopsis (t=0.572, df 32, p=0.571) between these groups (Table 3).

Table 3. Summary of Relationships between Groups

>20 sec of arc vs. 20 seconds of arc	
age (no significant difference)	p=0.175
years of experience (no significant difference)	p=0.433
batting average (no significant difference)	p=0.136

<10 years old vs >10 years old	
stereopsis (no significant difference)	p=0.571
batting average (no significant difference)	p=0.395

<4 years of experience vs. >4 years of experience	
stereopsis (no significant difference)	p=0.571
batting average (no significant difference)	p=0.945

Table 4. Comparisons of the Athletes' Mean Stereopsis between the Current Study and those Previously Done[2,3,4]

Study	Age of Players	Mean Stereo ± std dev
Current study	Little League	24.7±8.4
Boden, et al.	Youth Ages 10-18	25.5±11.9
Molia, et al.	College	51.4±39.1
Laby, et al.	Major League Year 1993 Year 1994 Year 1995	 29±25 23±10 37±83

Discussion

From the data that was collected, the mean local stereopsis score was found to be 24 seconds of arc. A study by Boden et al. shows that the average, non-baseball playing individual has an average stereopsis of 56.2 seconds of arc.[2] A list of the stereopsis scores of each player can be found in Table 2.

Several studies have shown that those who participate in baseball have a higher level of depth perception than non-participants. A study by Boden et al. found that high school-age youth who participated in baseball or softball had better depth perception than people who did not participate in these sports.[2] Laby et al. also found a difference between stereoacuity of professional ball players and the general population.[6] These studies both show a statistically significant higher level of stereopsis than those found in the general population. Table 4 is a summary of previous studies' stereopsis findings for athletes.[2,6,7]

Instead of collecting players' statistics from actual game situations, batting cages were used for the setting of the present study in order to provide more consistent playing conditions, as suggested in Molia et al.[7] In this situation, batting average is a measure of pure hitting skill. Therefore, the data is not obscured by coaches calling for sacrifice plays, such as bunting, where the player hits the ball intentionally trying to get out so as to move other players around the bases. Having participants in the batting cages also eliminates increased batting averages due to fielding errors by the opposing team. Additionally, having a pitching machine deliver the pitches eliminates intentional walks and players getting on base by getting hit by a pitch. The scoring for the indoor hitting league attempts to make the batting averages as close to real field averages as possible by consistently scoring hits based on the location the ball hits the net in the batting cage.

Even with this more controlled environment, there was no appreciable correlation between stereopsis and batting average. Nor was stereopsis correlated with years of experience. These findings agree with the findings in the population of college players found in Molia et al.[7] Their conclusion from this information was that players with better stereopsis were "self-selecting." In other words, only players with exceptional stereopsis were successful in baseball and continued onto the next level. However, both their study and this study show no correlation between success as it relates to hitting and a higher level of stereopsis. There then are three different explanations for the high levels of stereopsis among all levels of baseball players.

First, it could be that self-selection occurs at a younger age than these studies examine. This self-selection could occur within the first year of participation in baseball, causing all players that make it past the first year to have excellent stereopsis. Yet this makes the assumption that self-selection only happens at a discrete point in time: within the first year of play. If there was a selective power behind stereopsis, it should be evident as a gradually increasing level of stereopsis over time. Therefore, higher levels of stereopsis would be apparent at higher levels of playing. For example, college players should have better stereopsis than high school players, and Major League players should have better stereopsis than college players. Players with the lowest levels of stereopsis amongst these groups (Little League, high school, college, and Major Leagues) would

theoretically not make it to the next level, because they could not compete amongst players with better depth perception. Yet all studies done up to this point show that stereopsis levels among these groups are not statistically different, leading to the conclusion that self-selection is not the mechanism behind the higher levels of stereopsis in baseball players.

Second, it is possible that stereopsis is behind a self-selection process that occurs between these groups, but that it is not associated with hitting. There are several different skills involved in being successful in baseball. Players have to field as well as hit the ball. While there is no correlation between hitting and stereopsis, it is possible that higher levels of stereopsis are required for fielding accurately. Yet the problem remains that there is no appreciable difference between the stereopsis of Little League players and Major League players. If stereopsis were important in advancement of skill level, there should be a difference of stereopsis measurements between these skill levels.

The third possibility can explain better stereopsis levels in baseball players versus the general population and the overall homogeneity of stereopsis levels among the baseball players. It is possible that playing a sport such as baseball can effectively act like vision therapy, causing an optimization in many different areas of visual function. This explains the excellent visual skills found among ball players like those noted in Laby et al. and also explains why no correlation has been found between these skills and success in the sport. Tracking activities, hand-eye coordination, and oculomotor skills are being constantly practiced at baseball practices all over the country. They are also a major component of most vision therapy sessions. It is likely that practicing these skills for hours a day, five days a week at baseball practice is even more effective at optimizing the visual system than once-a-week in-office vision therapy. If these excellent visual skills are trained through practice, we would expect an improvement of visual skills in a roughly sigmoid function, with major gains in stereopsis levels being made in early years of playing, then slowly tapering off after optimum levels have been achieved. This explains why Little League players have levels of depth perception similar to that of Major League players, yet better than the general population.

Baseball is not the only sport in which visual skills have been examined in relation to a successful athletic performance. One study by Abernethy and Neal compared the visual skills of novice and veteran clay target shooters. In their study, they found that visual skills such as stereopsis and acuity had no correlation to successes in hitting the moving targets. Instead, they cite experience and the ability to process visual information quickly as the biggest difference between the levels of participants.[3] Another study done by Hughes et al. found that the difference between elite and novice table tennis players was their level of psychomotor performance, or reaction time. Both these studies agree that the ability to process information quickly regarding target speed, direction, and spin and then reacting quickly are more important factors for success than visual function, which is a limitation of the present study.[4]

In order to determine more accurately the factors that determine success in baseball, future studies should focus on the area of why stereopsis is better in ball players, beyond hitting performance. Examining the difference between stereopsis before their first year of playing then subsequently after their first year of playing would lead to a better understanding of how depth perception changes as players gain experience. Comparing stereopsis of those who continued playing versus those who dropped out of the sport would lead to determining whether self-selection was occurring between the different levels of play. Another interesting area of study involves comparing the changes to the visual system of those who play baseball to a similar matched group of those who underwent vision therapy to determine whether playing a sport can function like in-office therapy. Reaction time and batting statistics should also be examined further, potentially leading to an effective regimen to improve players' chances of participating at elite levels.

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Correspondence regarding this article should be emailed to Alison Jenerou, OD, at jeneroa@ferris.edu.

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