



# Effects of Batting Practice and Visual Training Focused on Pitch Type and Speed on Batting Ability and Visual Function

by

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*This study aimed to examine the effects of batting practice and visual training focused on the pitch type and speed on batting ability and visual function. A total of 46 participants took part in 12 training sessions for 4 weeks. The participants were divided into six groups according to the training type as follows: Group 1, batting practice with a fastball at 100 km/h; Group 2, tracking (watching) a fastball at 100 km/h; Group 3, batting practice with a fastball at 115 km/h; Group 4, tracking a fastball at 115 km/h; Group 5, batting practice with a curve ball at 100 km/h; and Group 6, tracking a curve ball at 100 km/h. Dynamic visual acuity, depth perception, hand-eye coordination, and batting ability were measured before and after training. Group 1 showed significant improvement in batting ability in the tests with 100 km/h fastballs and curve balls, while Groups 3 and 5 showed significant improvement in batting ability with 100 km/h fastballs and curve balls, respectively. Group 6 also showed significant improvement in batting ability with 100 km/h fastballs. Moreover, Groups 2 and 4 showed significant improvement in Dynamic visual acuity and hand-eye coordination, respectively. The results of the present study suggest that batting practice and visual training improve batting ability for the same pitch types and speeds as those encountered in practice. Therefore, visual training may be an effective method for improving batting ability and visual function in coaching settings.*

**Key words:** tracking ball, dynamic visual acuity, fastball, curve ball.

## Introduction

Numerous studies have been conducted on batting in baseball to investigate swing mechanics (Dowling and Fleisig, 2016; Escamilla et al., 2009; Fleisig et al., 2013; Inkster et al., 2011). Studies have also been conducted on physical fitness, which is important in baseball, and on training and practice methods aimed at its improvement (Carda and Looney, 1994; Spaniol, 2009; Szymanski et al., 2009; Szymanski et al., 2007). On the other hand, few studies have focused on how batting practice actually affects batting ability.

Baseball players spend a proportionately large amount of their time in baseball practice focusing on batting. It is natural that batting

practice improves batting ability. However, the effects of batting practice may only be apparent when batters face the same type and speed of pitches in games that they encounter during practice. Clarifying whether the effects of practice are apparent only when facing the specific pitch type and speed encountered in practice, or whether these effects extend to other pitch types and speeds, is therefore important. Furthermore, the answer to this question could be expected to have an impact on batting practice planning and methods.

In addition, a variety of studies on dynamic visual acuity (DVA), which is the ability to track a moving visual target, and other aspects

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of vision in sports have recently been reported (Laby et al., 2011; Poltavski and Biberdorf, 2015; Quevedo et al., 2011; Zwierko, 2007). Studies have also been carried out on the importance of visual function, on methods for its measurement and evaluation, and on training methods aimed at its enhancement. However, few studies concerning practical training have been reported, and most of these have examined elaborate sets of programs consisting of numerous training methods (Abernethy and Wood, 2001; Clark et al., 2012; McLeod, 1991; Quevedo and Sole, 1995). Therefore, research that takes a simple approach to methods of visual training is needed. A training method in which players hit baseballs with stripes marking the seams has been reported (Osborne et al., 1990). Studies have also been carried out with a focus on methods in which players watch stickers on balls (Kohmura and Yoshigi, 2004). However, the extent to which such methods are effective compared with regular batting practice remains unclear.

Baseball is a sport in which visual function is clearly important, as professional baseball players must accurately make contact with incoming pitches delivered at speeds over 150 km/h. They must also be able to quickly distinguish these from a variety of off-speed pitches. Recently, some studies have reported the importance of visual information in striking a baseball (Gray, 2009, 2010; Müller and Abernethy, 2012; Müller et al., 2014). Even if their swing mechanics are correct and efficient, and they have all the necessary elements of physical fitness, batters will not be able to hit the ball if the visual information they receive is not accurate. In addition, as noted above, fundamental scientific data related to the effects of basic practice for batting, which is arguably the most important situation in baseball, are currently lacking. In baseball, all nine players on team bat in predetermined order, and successful hitting is one of the most important elements to scoring runs and ultimately winning the game. Clarifying the actual effects of batting practice would also be valuable scientific research from the coaching perspective.

Therefore, the present study conducted an experiment designed with two main objectives. The first was to examine the effects of batting practice on batting ability with a focus on whether

batting practice would be effective for only the same pitch types and speeds used during training, or whether these effects would be also evident under other conditions. The second was to clarify whether visual training had any effect on batting ability and visual function. Clarifying these issues should make it possible to provide guidance concerning efficient training methods aimed at improving batting ability in relation to the pitch type and speed in the coaching setting. It may also be possible to provide coaches with information concerning methods of visual training that are less costly and require less physical space than the types of batting practice currently conducted, but have comparable effectiveness.

## **Methods**

### *Participants*

This study was conducted after all participants had been informed of the details of the study and provided their consent to participate. The study was approved by the Research Ethics Committee of the Juntendo University School of Health and Sports Science. A total of 46 participants took part in the study (male,  $22.9 \pm 1.6$  years). The participants were individuals with either none ( $n = 35$ ) or little experience in playing baseball at a club level (1 year or more of baseball experience;  $n = 8$ , mean, 3.4 years). All participants had visual acuity of 1.0 or greater with uncorrected vision or with vision corrected by contact lenses (19 individuals used contact lenses). All individuals participated in three sessions per week for 4 weeks, that totaled 12 training sessions. In some cases, the same participant was assigned to two or more groups; in such a situation, an interval of around a year was set between training of the different groups to ensure a sufficient washout period. Thus, in these cases, data were analyzed as if they were from different individuals.

### *Procedures*

The participants were divided into six groups in accordance with different types of training as follows: Group 1, batting practice with fastballs pitched at 100 km/h; Group 2, tracking (watching) fastballs pitched at 100 km/h; Group 3, batting practice with fastballs pitched at 115 km/h; Group 4, tracking fastballs pitched at 115 km/h; Group 5, batting practice with curve balls pitched at 100 km/h; and Group 6, tracking curve balls

pitched at 100 km/h. For the batting practice groups, each session was divided into three sets of 20 balls, similar to regular batting practice. For the tracking groups, participants visually tracked pitched balls and then swung their bats using the same number of training balls. The tracking groups swung their bats to ensure that the amount of swinging practice was the same for both (tracking and batting) groups. To ensure that the study was carried out safely and efficiently, we used a rubber (soft) ball, which is comparatively less dangerous than a (regulation) baseball, and a pitching machine (SR-31; Sunaga Development Co., Ltd. Ashikaga, Japan).

### **Measures**

Before and after training, a test to evaluate batting ability was carried out, and various measurements of visual function were taken. The batting ability test had the following three conditions: 100 km/h fastball, 115 km/h fastball, and 100 km/h curve ball. Under each condition, batters were given 20 pitches to hit, and if a ball was struck, the direction was converted to a simple score. The sum of these scores represented the total score for the batting ability test. Each batting attempt was scored as follows: swing and a miss, 0 points; fouled back (the ball was “foul-tipped” off the bat and hit the protective net), 1 point; foul ball (the ball was struck, but settled in foul territory), 2 points; fly ball, 3 points; ground ball, 4 points; and hit/line drive, 5 points. These values were used to calculate total training scores.

In addition, the following measurements were taken concerning the aspects of visual function that are of primary importance in sports (Kohmura et al., 2013; Kohmura et al., 2015): DVA, which is the ability to accurately track a moving target horizontally; depth perception, which is a measurement of the sense of distance; and hand-eye coordination, which is the ability to react quickly and accurately to a visual target.

In the measurement of DVA, participants were asked to identify the direction that the gap in a Landolt ring was moving horizontally (from left to right) across a semicircular screen (HI-10; Kowa Company, Ltd., Nagoya, Japan). The rotational speed of the Landolt ring was incrementally decreased from 49.5 rpm. Two sizes of the Landolt ring, equivalent to decimal visual acuity values of 0.025 and 0.1, were used. The speed until the direction of the gap in the Landolt

ring was accurately distinguished was recorded, and the trials were repeated until five measurement results were obtained. The mean speed was then calculated. The gap in the Landolt ring moved in four randomly-selected directions (up, down, left, right).

To measure depth perception, three rods were displayed in a testing device (AS-7JS1; Kowa Company, Ltd.). Two outside rods (one on each side) were fixed, and a center rod was moved backward or forward at 50 mm/s. The participants were asked to immediately press a switch when they thought the three rods were aligned laterally, and the difference (mm) between their actual and perceived alignment was measured. All measurements were taken three times, and then the absolute values of the differences were averaged. The distance between the participants and the device was set at 2.5 m.

To measure hand-eye coordination, participants were asked to press lamps on a device (AS-24; Kowa Company, Ltd.) as quickly and accurately as possible as soon as they were lit. A total of 120 lamps on the measurement device were randomly lit one at a time. Once a lamp was pressed, the next one was lit. If a participant failed to press the lamp that was lit after 1.3 s, that lamp would turn off and the next lamp would light. We measured the score (the number of successful attempts: max 120) and the time (s) until 120 lamps were pressed or had gone out.

### **Statistical Analysis**

Means and standard deviations of measurement results were calculated. First, baseline measurement results were assessed using the Kolmogorov-Smirnov test. Then a paired t-test was applied to test for differences in means of measurement results from before and after practice/training if normal distribution data were obtained. In other cases a Wilcoxon signed rank sum test was used to compare baseline measurements and those obtained post practice/training. The level of significance was set at  $p < 0.05$ . Moreover correlation coefficients were calculated between the batting ability tests before practice/training to evaluate test reliability.

## **Results**

The normal distribution data were obtained by the Kolmogorov-Smirnov test in the batting ability tests at 100 and 115 km/h fastball, DVA,

and E/H score. The Wilcoxon signed rank sum tests were applied in the batting ability test at 100 km/h curve ball, DP, and E/H time and a moderate correlation coefficient ( $r = 0.65$ ) was obtained between the fastball tests. Moreover, low correlation coefficients were shown between fastball and curve ball batting tests (100 km/h fastball vs. curve ball:  $r = 0.25$ , 115km/h fastball vs. curve ball:  $r = 0.32$ ).

The results of the batting test are as follows. The group that participated in batting practice with 100 km/h fastballs showed significant improvement in batting ability in the tests with 100 km/h fastballs and 100 km/h curve balls (100 km/h fastballs,  $p < 0.05$ ; curve balls,  $p < 0.05$ ). No

significant improvement was seen with 115 km/h fastballs. In addition, the group that tracked 100 km/h fastballs showed no significant improvement in batting ability (Table 1).

The group that followed batting practice with 115 km/h fastballs showed significant improvement in batting ability with 100 km/h fastballs ( $p < 0.05$ ); however, no significant improvement was observed in the batting test under other conditions. In addition, the group that tracked 115 km/h fastballs showed no significant improvement in batting ability (Table 1).

**Table 1**  
Comparison of batting ability between pre- and post-training

			Pre			Post			F100		F115		C100		
			F 100	F 115	C 100	F 100	F 115	C 100	t	p	t	p	p		
Fast ball 100 km/h	Batting Practice	M	56.3	58.3	55.0	71.7	*	67.6	64.1	*	3.887	0.008	2.131	0.077	0.028
	Group 1, N:7	SD	16.5	15.8	25.5	7.1	13.7	19.5							
	Visual Training	M	47.8	46.6	51.6	51.6	59.3	60.3	0.434	0.676	1.435	0.189	0.374		
	Group 2, N:9	SD	22.7	23.2	24.0	24.8	17.9	11.8							
Fast ball 115 km/h	Batting Practice	M	52.4	54.8	51.5	73.0	*	57.6	59.1	2.744	0.029	0.648	0.537	0.233	
	Group 3, N:8	SD	24.2	15.3	25.2	8.0	13.6	23.0							
	Visual Training	M	60.2	52.5	36.5	62.5	59.8	53.3	0.413	0.697	0.948	0.386	0.075		
	Group 4, N:6	SD	6.5	14.4	23.1	16.2	8.1	26.3							
Curve ball 100 km/h	Batting Practice	M	62.8	54.6	63.4	59.0	58.5	70.3	*	0.627	0.550	0.808	0.445	0.036	
	Group 5, N:8	SD	12.8	16.2	7.9	15.9	14.4	10.1							
	Visual Training	M	48.6	47.5	56.3	67.3	*	57.4	55.4	3.417	0.011	1.782	0.118	0.944	
	Group 6, N:8	SD	18.4	18.8	16.4	6.9	10.4	18.7							

F 100: Fast ball 100 km/h, F 115: Fast ball 115 km/h, C 100: Curve ball 100 km/h,

\*: compared with Pre-training ( $p < 0.05$ )

Pared t-test was used in F100 and F115: Signed rank sum test was used in C100. t: t-value, p: p-value, Degree of freedom (t-test) : N-1

**Table 2**  
*Comparison of visual function between pre- and post-training*

				Pre				Post					
		DVA	dva	DP	E/H		DVA	dva	DP	E/H			
				time		score			time		score		
Fast ball 100 km/h	Batting Practice	M	39.8	32.5	9.8	81.1	106.6	42.3	34.2	12.1	79.9	108.1	
	Group 1, N:7	SD	4.5	5.5	6.8	5.6	7.7	2.6	4.3	7.1	6.1	5.5	
	Visual Training	M	40.6	35.1	9.0	77.3	110.4	44.1	*	37.5	11.6	75.7	113.0
	Group 2, N:9	SD	3.6	8.0	4.6	3.3	3.6	2.4	6.2	4.6	4.3	3.4	
Fast ball 115 km/h	Batting Practice	M	42.8	37.8	13.8	74.8	113.0	44.3	38.5	14.0	74.0	113.5	
	Group 3, N:8	SD	3.0	3.2	12.3	4.7	2.8	2.6	5.2	8.8	4.0	4.3	
	Visual Training	M	44.0	36.3	11.9	75.8	109.8	45.3	39.6	13.0	74.2	113.7	*
	Group 4, N:6	SD	3.4	5.0	8.0	4.8	3.2	1.8	3.9	6.3	5.0	2.9	
Curve ball 100 km/h	Batting Practice	M	43.0	36.1	11.0	78.5	110.4	43.6	37.8	18.4	*	76.4	113.1
	Group 5, N:8	SD	4.0	8.9	9.3	5.3	8.3	5.7	8.2	20.4	3.1	2.8	
	Visual Training	M	42.4	36.6	18.1	74.9	112.4	43.1	37.9	20.8	74.9	111.1	
	Group 6, N:8	SD	4.0	6.8	15.6	5.7	5.5	4.5	6.0	23.2	5.8	4.7	
Statistical value													
		DVA		dva		DP		E/H (Time)		E/H (Score)			
		t	p	t	p	p	t	p	p				
Group 1		1.379	0.217	0.864	0.421	0.271	1.046	0.336	0.233				
Group 2		4.081	0.004	1.598	0.149	0.362	1.690	0.129	0.068				
Group 3		2.255	0.059	0.560	0.593	0.889	0.614	0.559	0.932				
Group 4		1.159	0.299	1.577	0.176	0.917	1.685	0.153	0.044				
Group 5		0.493	0.637	1.626	0.148	0.012	1.056	0.326	0.360				
Group 6		0.630	0.549	1.444	0.192	0.674	0.000	1.000	0.302				

*DVA: Dynamic Visual Acuity (Visual target size: 0.025),*

*dva: Dynamic Visual Acuity (Visual target size: 0.1),*

*DP: Depth Perception, E/H: Hand-Eye Coordination,*

*\*: compared with Pre-training ( $p < 0.05$ )*

*Paired t-test was used in DVA, dva, and E/H Time: Signed rank sum test was used in DP and E/H Score. t: t-value, p: p-value, Degree of freedom (t-test) : N-1*

The group that completed batting practice with 100 km/h curve balls showed significant improvement in batting ability with 100 km/h curve balls ( $p < 0.05$ ); yet, no significant improvement was found in the batting test under other conditions. On the other hand, a significant decrease was shown in DP ( $p < 0.05$ ).

Furthermore, the group that participated in visual training with 100 km/h curve balls improved significantly in batting ability with 100 km/h fastballs ( $p < 0.05$ ) (Table 1).

With regard to the effects of training on visual function, the group that followed visual training with 100 km/h fastballs showed significant

improvement in DVA (visual target size, 0.025;  $p < 0.05$ ). The group that completed visual training with 115 km/h fastballs improved significantly in hand-eye coordination ( $p < 0.05$ ). No other significant improvement in visual function was found with any batting practice or visual training group (Table 2).

## Discussion

The main objective of the present study was to clarify the effects of batting practice and visual training on batting ability by determining whether results from batting practice or visual training were dependent only upon the pitch type and speed encountered in batting practice and visual training, or other conditions. Furthermore, the present study also aimed to verify whether visual training had any effect on batting ability or visual function. A possible study method would be to use baseball players as participants; however, in some cases, players may not necessarily be appropriate participants as they already have considerable experience, and their participation in regular baseball practice would inevitably influence their results. In the present study, the participants were individuals who did not participate in batting practice as part of their regular lifestyle; therefore, priority could be directly placed on clarifying the effects of batting practice or visual training. In addition, individuals in the groups that participated in actual batting practice swung at every pitch, which could also be expected to have an effect. The visual training groups were therefore required to make the same number of practice swings as the batting practice groups in order to eliminate the effects of swing training. Moreover, batting ability tests in this study were conducted experimentally as measurement of human performance. It was considered to have certain test reliability because a moderate correlation coefficient between fastball tests was obtained. However, a curve-ball test evaluates different ability compared with fastball tests, which was considered in this discussion.

According to the results, all groups demonstrated improved batting ability. Furthermore, a basic trend toward improved batting ability was apparent in the batting test under the same conditions as those in batting practice. However, no significant improvement in

batting ability was observed in those training with 115 km/h fastballs. Hitting fast pitches requires training with greater frequency or over a longer period of time. The groups that practiced under conditions other than 115 km/h fastballs did not reach a significant level of improvement with 115 km/h fastballs, but neither did the group that trained with 115 km/h fastballs. The group that completed batting training with 100 km/h fastballs showed significant improvement in batting ability with both the 100 km/h fastballs and the 100 km/h curve balls, which suggests that the effects of batting practice are more dependent on the pitch speed than on the pitch type. Additionally, although not a batting practice group, the group that followed visual training with 100 km/h curve balls showed significant improvement in batting ability in the test with 100 km/h fastballs; this could support the notion of dependence on the pitch speed. However, the group that practiced batting with 100 km/h curve balls did not improve significantly in batting ability in the batting test with 100 km/h fastballs; this issue therefore requires further investigation in future studies.

It should be noted that that significant improvement in batting ability was observed in the group that carried out visual training with 100 km/h curve balls. This suggests that, in the design of this study, visual training alone had some effect on actual batting ability. Further study is needed to investigate why significant improvement was found in the 100 km/h fastball visual training group. The results suggest that visual training is effective for improving batting in baseball, even for pitch types that differ from those used during training. A number of studies on visual training have been reported; in many of them, the participants were actual baseball players (Clark et al., 2012; Kohmura and Yoshigi, 2004). Our experiment was conducted from a different perspective. The participants were individuals who did not play baseball regularly, and the visual training group was allowed to practice batting in the batting tests before and after the training period of approximately 1 month. If visual training were carried out in tandem with regular baseball training, the effects of batting practice during regular practice would allow the effects of visual training to be more apparent. Also, in the present study, some cases were seen

in which participants were unable to successfully grasp the timing of the pitches through visual training alone; this suggests that a greater effect could be obtained from baseball players with adequate levels of experience. In other words, it is likely that experienced baseball players would have a greater ability to apply the effects of visual training to actual batting. Further studies employing a wider variety of training conditions and participants are therefore needed.

In relation to visual training, no effect was found in any of the groups that participated in batting practice. However, the group that carried out visual training with 100 km/h fastballs showed significant improvement in a portion of the DVA variables. Also, the group that participated in visual training with 115 km/h fastballs improved significantly in hand-eye coordination. DVA and hand-eye coordination are considered important visual functions in sports (Ishigaki and Miyao, 1993; Kohmura et al., 2013; Stine et al., 1982). In the visual training group, the training pattern involved concentrating on and being conscious of tracking (watching) without actually batting, which may perhaps be why the effects on visual function were greater in this group than in the batting practice group. On the other hand, results of DP decreased. DP in this study was not normal distribution data for a small number of participants and absolute value of error. DP may not be suitable as an evaluation indicator of training effect, however, it is necessary to study further this variable.

From the above, it appears that while overall batting ability tended to improve as a result of batting practice and visual training, the batting practice groups improved only their batting ability, whereas the visual training groups show improvement in visual function. It seems likely that while practice with slow pitches cannot help players prepare to hit fast pitches, it is effective the other way around. Moreover, the study protocol in this experiment was similar to the motor learning field. Future studies are needed to clarify the mechanism of training effect. There have been some studies using brain imaging of motor learning processes (Deiber et al., 1997; Volkman et al., 1998); however, they applied relatively simple tasks with small muscle groups involved. It seems thus necessary to conduct experiments simulating dynamic tasks as

in this study.

These results suggest the possibility that visual training, which requires little physical space and can be carried out during the off-season, may be an effective method for improving batting ability and visual function in coaching settings. Training involving tracking (watching) pitches from the batter's box may not amount to batting practice from the perspective of improving the batting ability of players who play baseball regularly, but it could be expected to be an efficient training method for batting when the environment for batting practice is inadequate, or when batting practice is not possible because of inclement weather or injury. With regard to experienced baseball players, visual training could be combined with regular training or batting practice to achieve a synergistic effect. However, ongoing experimentation and verification with a wider range of pitch types and speeds is needed.

The results of the present study suggest that batting practice and visual training greatly improve batting ability against the same pitch types and speeds as those encountered in practice. In the coaching setting, using these methods as training for specific pitch types or speeds that require improvement could be efficient. For batting against fast pitches in particular, batting practice with fast pitches for a sufficient length of time is needed; training with only slow pitches appears to be inadequate. However, the amount of training sessions in this study was rather small. Future studies could apply retention tests and include a control group without training and practice. These limitations need to be addressed in future experimental training studies. Moreover, it is possible that batting ability at a given pitch speed improves with batting practice at that speed, even if the pitch type that the batter faces differs from that encountered during practice. Thus, batting practice focused on the pitch speed could be expected to be effective in reducing practice time. It is also possible that visual training alone can help improve batting ability, and the introduction of this type of training into coaching settings could be proposed as a way to train visual function and enable players to become more conscious of their own vision. Visual training could also be recommended in coaching settings as an economical option during the off-

season or for injured players. Although further research is needed, a combination of regular batting practice and visual training may lead to improved batting ability for experienced baseball players. Therefore, additional research regarding implementation of these methods in coaching settings is needed. Additionally, although this research dealt with batting ability in baseball, our

results could be applied to visual training in ball games such as volleyball, table tennis, cricket, tennis and so on. To improve the ability to hit or catch the target, the athletes will need to take into consideration the speed and trajectory of the flying target.

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