



Sphere Passing Through Indicating Fence Applied In Senior High School Baseball Player Batting Test: An Exploratory Two-Case Pilot Study

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Abstract

Purpose: A fence to indicate sphere passing through (id-f) was designed to let baseball players transit between fixate on the baseball and initiating their swing clearly. In addition, the acute effects of this id-f on player's batting performance were studied.

Method: A non-elite player (NEP) with no experience in the national senior high school baseball competition and an elite player (EP) with best batting average (0.324) in competitions were recruited as the subjects. In the experiment, a pitching machine was used to throw 130 km/hr fastballs, and the subjects underwent Test A, Test B, and Test C in sequence. The Swing Analyzer was used to analyze the bat speeds and peak hand speeds during the swings, and the number of effective strikes were also recorded.

Result: Compared to Test A, which did not involve the use of id-f during baseball fixation exercises and batting testing, Test B incorporated id-f. In Test B, NEP demonstrated higher bat speed and a greater number of effective strikes than in Test A. However, EP exhibited only a greater number of effective strikes compared to Test A. In Test C, baseball fixation exercises were omitted, and batting testing was conducted directly without id-f. In this test, NEP again demonstrated higher bat speed and a greater number of effective strikes than in Test A. Nevertheless, EP exhibited only a greater number of effective strikes compared to Test A.

Conclusion: This study examined the acute effects of the id-f system on batting performance in novice (NEP) and experienced (EP) high school baseball players. Under consistent pitching conditions, id-f significantly improved bat speed in NEP, likely due to earlier swing initiation via visual feedback. EP, while showing no bat speed gains, achieved more effective strikes later in testing. Peak hand speed remained unchanged, suggesting id-f's influence was specific to the bat's distal end. However, potential practice effects from repeated testing may have confounded the results. Future research should use randomized test orders, control groups, and larger samples to better isolate id-f's effects.

Keywords: Baseball, Hitting, Practice, Skill, Indicating Fence

Introduction

Baseball is a sport that relies on batting to score points. Only by successfully hitting or hitting a home run can a team score points and ultimately win the game [1]. In the actual pitcher-batter confrontation, the batter first fixates on the ball in flight, makes decisions after the pitcher throws the baseball, and then swings to bat [2, 3]. In response to this demand, coaches must have effective methods to develop players' batting techniques.

Athletes often require stability in their movements and performance, and this is also a skill that high-level players are expected to demonstrate [4]. Regarding batting, if a clear indication can be given during the batter's swing practice, helping them understand exactly when to start the swing after continuously fixating on the ball in flight and then maintaining a stable pitching speed and time to batting to let them perform swing practice, develop the stability of their movements and performance, this approach is undoubtedly more appropriate for the needs of youth baseball players to develop the stability of their batting movements and ensuring solid contact with the ball comparing with blindly pursuing extreme bat speed [5].

During the flight of the baseball, the batter fixates on the ball, and although there are visual cues such as changes in the ball's location, speed, and trajectory [6, 7], providing more concurrent visual feedback can help the batter clearly understand when to start the swing after fixating on the ball. In fact, Yamamoto et al. [8] found that low skill level learners exhibited improved performance when provided with concurrent visual feedback, whereas high skill level learners did not demonstrate significant improvements under similar conditions. For youth baseball players who are developing their batting technique, this should assist them in mastering the critical timing between fixating on the ball and initiating the swing, ultimately improving their batting performance and stability if a method similar to that of Yamamoto et al. [8] is applied.

If athletes are categorized dichotomously, they can be classified into two types: non-elite and elite athletes. Gustafsson [9] pointed out that adopting a single-subject research design focusing on both non-elite and elite athletes not only allows for a detailed depiction of individual performance outcomes but also provides a way to examine perspectives such as those proposed by Yamamoto et al. [8] regarding the impact of concurrent visual feedback on the performance of athletes with high and low skill levels. Additionally, Gustafsson [9] suggested that this approach may lead to new findings and insights.

Based on this, a non-elite and an elite baseball player from the same high school served as subjects to conduct exploratory two-case pilot studies. In the experiment, a fence capable of instantaneously indicating the sphere passing through (id-f, Figure 1, Figure 2) was designed, and a pitching machine was utilized to maintain stable pitching speed to allow the subjects to clearly transition between fixating on the ball and initiating the swing. The goal was to examine the acute effects of id-f on these two subjects' batting performance and discuss potential directions for future research.

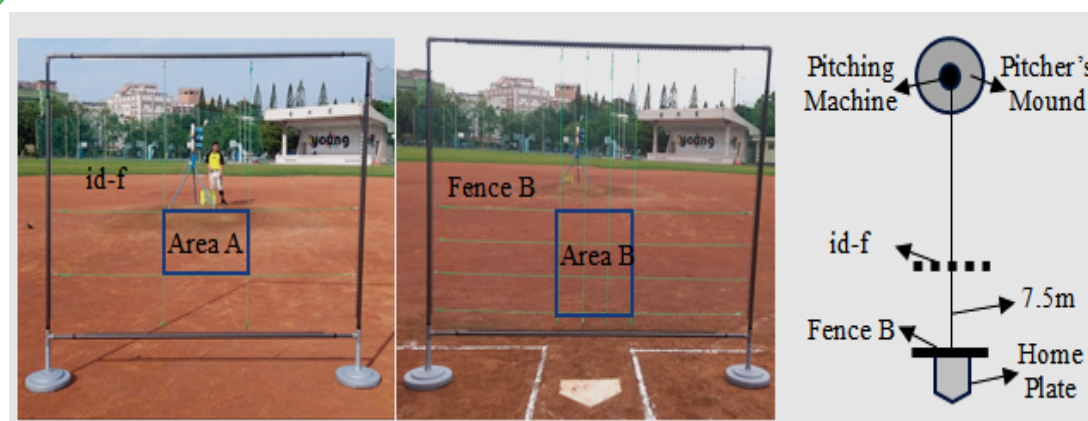


Figure 1: Placement of id-f and Fence B

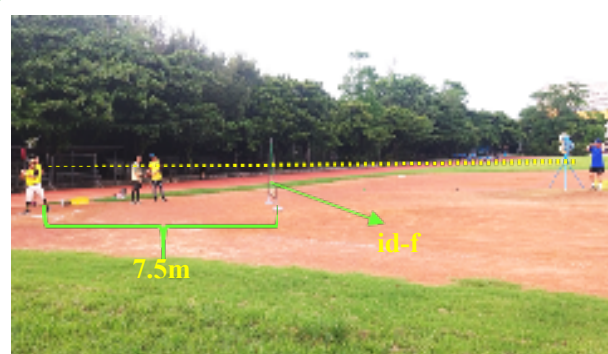


Figure 2: Placement of id-f

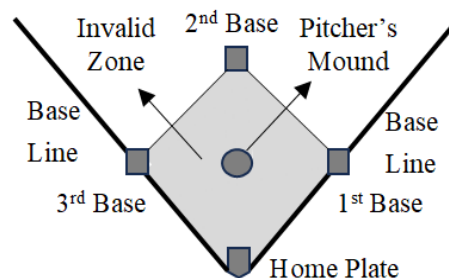


Figure 3: Invalid Zone definition

Materials and Methods

Subjects

Non-elite player (NEP): A 15-year-old senior high school baseball player with a height of 170 cm and a weight of 60 kg was the subject in this study. The subject was not considered one of the top players on the team and had not participated in any annual games preceding the experiment.

Elite player (EP): A 16-year-old senior high school baseball player with a height of 174 cm and a weight of 68 kg was recruited for this study. This player was identified as the team's most proficient batter. Based on performance statistics from all annual games preceding the experiment, his cumulative batting average was 0.324.

Additionally, these two players maintained a training schedule of 5 days per week and had not experienced any sports injuries over the past six months.

Explanation of id-f and Fence B

As shown in Figure 1, both id-f and Fence B were custom-made. Area B represented the subject's strike zone, which could be adjusted according to the subject's height.

Before the experiment, id-f was placed 7.5 meters directly in front of home plate, and Fence B was positioned above the home plate.

Then, a pitching machine was utilized to project a fastball at a speed of 130 km/h to confirm that the projected baseball could pass through both Area A and Area B. If it did not, the position of the pitching machine, Area A, and Area B was adjusted.

During the experiment, Fence B was removed. id-f was left to allow the subject to perceive that the pitched baseball had reached 7.5 meters directly in front of home plate, at which point they were required to begin their swing.

Explanation of Test A, Test B and Test C

The subjects (NEP and EP) were required to complete Test A, Test B, and Test C in sequence. A 5-minute break was provided between each test.

Test A: Before the test, the subject was asked to stand next to home plate, with only Fence B left on the field. Then, the pitching machine consecutively launched 30 baseballs, and each was required to pass through Area B of Fence B. During this phase, the subject did not swing, but only observed the baseballs projected by the machine. During the test, the pitching machine consecutively projected 15 baseballs, and the subject was required to swing at each pitch.

Test B: Before the test, the subject was asked to stand next to home plate. Both id-f and Fence B were left on the field. Then, the pitching machine consecutively launched 30 baseballs, and each launched

baseball had to pass through Area A of id-f and Area B of Fence B. During this phase, the subject did not swing but only observed the baseballs projected by the machine (the subject had to fixate on the ball from the moment it was launched by the pitching machine until it passed through Area A of id-f). During the test, the pitching machine consecutively projected 15 baseballs. Each time a ball was projected, the subject was required to similarly fixate on the ball from release until it passed through Area A of id-f. When the ball passed through Area A, the subject began the swing.

Test C: In this test, the subject no longer observed the pitching machine's projection and proceeded directly to the batting test. The procedure was the same as in Test A.

Measurement and analysis

The Swing Analyzer (Blast Baseball, Blast Motion Company, California, USA) was used to analyze the bat speed and peak hand speed in the subject's swing, and its sensor had to be securely attached to the knob at the end of the bat handle during use. Compared to the VICON Motion Analysis System, the Swing Analyzer exhibited a swing speed measurement error within 3 m/s. This made the Swing Analyzer an effective and useful instrument for analyzing swing speed [10].

The Handheld Radar Gun (Stalker Sport 2, Stalker Sport Company, Texas, USA) was used to monitor the speed of the ball when it was projected by the pitching machine in Test A, Test B, and Test C to prevent excessively high speeds from affecting the subject's batting performance. This radar gun had a speed measurement range of 8–241 km/h and an accuracy of $\pm 3\%$ of the reading. It has been widely used in related research and is regarded as the gold standard for reliability and validity studies of various handheld radar guns [11].

In addition to measuring bat speed and peak hand speed, the effectiveness of each strike during these tests was recorded in this study. For a strike to be considered effective (effective strike), the subject needed to hit the ball within the Base Line and beyond the Invalid Zone (Figure 3).

In terms of statistics, a repeated-measures one-way ANOVA and LSD post hoc test were performed to compare the speed of balls projected by the pitching machine (PM speed), as well as the subject's bat speed and peak hand speed in Tests A, B, and C. The significance level was set at $\alpha = .05$.

	Test A (NEP)	Test B (NEP)	Test C (NEP)	Test A (EP)	Test B (EP)	Test C (EP)	C	P
PM speed (Average)	131.27	132.67	131.13	132.33	132.27	132.47	2.02	0.09
PM speed (SD)	1.58	2.19	2.00	1.54	1.62	1.30		

Table 1: The statistics of the six PM speeds in tests A, B, and C for both NEP and EP (km/hr)

	Test A	Test B	Test C	F	P	post hoc test
bat speed (NEP)	90.18 $\pm$ 2.05	93.61 $\pm$ 2.92	93.24 $\pm$ 4.17	5.66	0.01*	Test B>Test A Test C>Test A
peak hand speed (NEP)	28.35 $\pm$ 0.92	28.63 $\pm$ 0.88	29.26 $\pm$ 1.19	3.28	0.05	
bat speed (EP)	94.07 $\pm$ 2.59	94.74 $\pm$ 4.76	94.51 $\pm$ 3.72	0.11	0.90	
peak hand speed (EP)	29.11 $\pm$ 0.73	29.02 $\pm$ 0.78	29.57 $\pm$ 1.03	1.41	0.26	

Table 2: The statistics of bat speed, and peak hand speed in the three tests (km/hr)

* $P < .05$

	Test A	Test B	Test C
Numbers (NEP)	4	6	7
Numbers (EP)	4	10	13

Table 3: The number of effective strikes by NEP and EP in the three tests

Results and Discussion

PM speeds

Table 1 shows that there are no significant differences among the six PM speeds in tests A, B, and C for both NEP and EP. These results indicate that NEP and EP can be tested at the same PM speeds, thereby avoiding the influence of varying PM speeds on their test outcomes.

The PM speed tested in this study was approximately between 131 km/hr and 132 km/hr. Based on this, the estimated time for the ball to travel from id-f to home plate was about 0.20 to 0.21 seconds, meaning the subject had 0.20 to 0.21 seconds to swing and strike the ball. Studies that used similar Swing Analyzer devices found that junior high school players took 0.17 to 0.19 seconds to swing and strike, while elementary school players took 0.19 to 0.22 seconds [12, 13, 14]. In comparison, the time available for the subject in this study to swing and strike the ball was sufficient. From this comparison, it can be concluded that the distance between id-f and home plate could be adjusted to accommodate changes in the speed of the ball projected by the pitching machine during the experiment.

Additionally, altering the distance between id-f and home plate could potentially affect the difficulty level of the test for the subject.

Acute effects of id-f

In this study, the acute effects of using id-f on the batting performance of NEP and EP were of particular interest to the team's coaching staff. Accordingly, the researchers collaborated with the coaches to design the relevant training and testing protocols implemented in Test A, Test B, and Test C.

Following the above discussion, this study utilized a pitching machine that consistently projected baseballs from a fixed position at speeds with no statistically significant variation. Under such controlled conditions, a longer swing time implies an earlier initiation of the swing. NEP was first-year senior high school students who had not participated in any official high school competitions and, thus, could be considered to possess a skill level comparable to that of junior high school players. According to the experimental setup, the time it took for a pitched ball to travel from the id-f to home plate was approximately 0.20 to 0.21 seconds. In contrast, the typical swing-to-contact time for junior high school players ranges from 0.17 to 0.19

seconds. This indicates that NEP had a relatively longer swing duration. This discrepancy helps explain the results observed in Table 2, where NEP bat speed in Test A was significantly lower than that in Test B and Test C. It is likely that in Tests B and C, the presence of the id-f visual cue prompted NEP participants to initiate their swings earlier. Furthermore, based on physical principles, bat speed is not only influenced by the batter's muscular effort (i.e., acceleration) but is also proportional to the duration of the swing. In other words, a longer swing duration generally results in greater bat speed. Therefore, the significantly higher bat speed observed for NEP in Tests B and C, as compared to Test A, can be attributed to the earlier swing initiation induced by the visual feedback provided by id-f. Similarly, in both Test B and Test C, the swing duration was approximately 0.20 to 0.21 seconds. However, no significant differences in bat speed were observed for EP across Test A, Test B, and Test C. This suggests that EP participants had already acquired the skill of initiating their swings earlier, even in Test A where no visual feedback from id-f was provided.

As previously reported, Yamamoto et al. [8] found that learners with lower skill levels demonstrated performance improvements when provided with concurrent visual feedback, whereas individuals with higher skill levels did not show significant improvements under the same conditions. The bat speed results from NEP and EP across the three tests in this study appear to support this finding. That is, the real-time visual feedback provided by id-f had a significant acute effect on enhancing bat speed for NEP. In contrast, no such effect was observed in EP, likely due to their more advanced technical proficiency.

In the results shown in Table 2, no significant differences in peak hand speed were observed across tests A, B, and C for both NEP and EP. This indicates that the influence of id-f is limited to the bat speed at the distal end of the bat. Since peak hand speed pertains to the part of the bat gripped by the player's hands, it appears that id-f does not exert any notable effect on this segment.

As shown in Table 3, the number of effective strikes increased progressively across tests A, B, and C for both NEP and EP. This trend was especially pronounced among EP, who exhibited a greater increase in effective strikes during tests B and C compared to NEP.

Taken together, the above results suggest that the acute effects of id-f on the batting performance of both NEP and EP align with the expectations of coaching objectives. Specifically, id-f led to a significant increase in bat speed for NEP during the testing sessions. Although no improvement in bat speed was observed for EP, they exhibited a greater increase in the number of effective strikes during tests B and C compared to NEP.

Practice effect

The design of tests A, B, and C in this study aimed to simulate a competitive scenario in which players receive id-f training (test B) between two at-bats (tests A and C), in order to examine whether such training could enhance performance in the subsequent at-bat (test C). However, due to the short interval between the tests (only 5 minutes), the identical structure of tests A and C, and the high number of repetitions (up to 15 trials), a practice effect [15] may have been introduced. This could explain why NEP demonstrated improved bat speed and a higher number of effective strikes in tests B and C compared to test A. A similar trend was observed in the EP group's effective strikes.

This potential practice effect presents a discrepancy between experimental findings and practical coaching perspectives. From a research standpoint, it becomes difficult to determine whether improvements in performance were the result of visual information provided by id-f or simply due to repeated exposure to the test conditions. To address this issue, future studies should consider both increasing the sample size and revising the experimental design. Possible approaches include randomizing the test order or incorporating a control group to better isolate the effects of id-f.

Conclusion

This study investigated the acute effects of the id-f system on the batting performance of novice (NEP) and experienced (EP) high school baseball players. Under controlled testing conditions, no significant differences were observed in pitching machine (PM) speeds, ensuring a consistent experimental environment. The findings demonstrated that id-f significantly enhanced bat speed in NEP, likely by prompting earlier swing initiation through real-time visual feedback. In contrast, EP already exhibited advanced technical skills, did not show significant improvements in bat speed, though they recorded a greater increase in effective strikes during the later testing sessions.

Furthermore, peak hand speed remained unchanged across tests for both groups, indicating that id-f primarily influenced bat speed at the distal end of the bat rather than at the grip segment. While these findings suggest that id-f can be an effective training tool, particularly for less experienced players, the design of the testing protocol may have introduced a practice effect due to the short time interval between tests, repeated test structure, and high trial frequency.

This potential confounding factor limits the ability to definitively attribute performance gains solely to the id-f intervention. Future studies should consider adopting randomized test orders, including control groups, and expanding the sample size to better isolate the effects of id-f and minimize practice-related improvements. These refinements would contribute to a more accurate evaluation of the id-f system's efficacy in enhancing real-time batting performance.

Competing interests: All authors have no competing interests when completing this article.

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