Seeing or Doing?
Pitch Recognition of Batters versus Pitchers: A Preliminary Report

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Keywords: Baseball, Pitch Recognition, Action Anticipation, Pitcher, Batter.

Abstract: In this study we tackled the question: between the experience of seeing or doing the movement, which one is more important in understanding the observed movement? We thus asked batters and pitchers, in high and intermediate skill levels, to identify the type of pitch that was edited in difference lengths. In general, we found that advanced players showed significant higher accuracy and lower uncertain rate than the intermediate players, particularly in viewing short pitch sequences. These results reflected the requirement of fast sports such as baseball, in which players have to make a correct decision quickly rather than staying uncertain. Moreover, advanced batters showed the tendency of being more accurate than advanced pitchers, though the difference did not reach statistical significance possibly due to small sample size. In consistency with the previous studies, all players showed higher accuracy in identifying the strike pitches when they could see longer sequence of the pitch motion and the baseball trajectory (Paull & Glencross, 1997). In sum, our results supported the notion that when understanding an observed movement, the perceptuo-motor experience reacting to it is more important than the actual motor experience of the observed movement.

1 INTRODUCTION

In anticipating the action of the opponent in sports, it has been shown that the experience plays an important role (review see Williams, Davids, & Williams, 1999). That is, due to the accumulated experience, a skilled athlete knows where to view in the opponent and then makes the best use of the information extracted to act or react to the opponent (e.g., Farrow & Abernethy, 2003; Aglioti et al., 2008). For example, advanced baseball batters pay close attention to the pitcher's motion particularly in the pitcher's shoulder, elbow and wrist, and then switch the focus to the ball trajectory with fewer fixations than the intermediate batters for making the batting decision (e.g., Hubbard & Seng, 1954; Shank & Haywood, 1987; Takeuchi & Inomata, 2009).

In a recent study, it was investigated the ability to predict the fate of actual or fake soccer penalty kicks between goalkeepers, kickers and novices (Tomeo et al., 2012). Goalkeepers showed higher accuracy for fake actions as compared to kickers and novices. Kickers were even more confused by the fake actions than goalkeepers and novices. The authors concluded that goalkeepers could outperform kickers and novices due to their visual rather than motor expertise. However, we thought that goalkeepers should be considered as "visuo-motor" experts since they are trained to "perceive and react" to the penalty kicks. Kickers, instead, don't have to intercept the penalty kick even though they are capable of doing a fool action.

In fact, baseball and football can be considered very special sports because the players have two very distinctive roles. Take baseball player for example: the pitcher is responsible for throwing the pitch and the batter has to bat and run. The two roles of players have developed very specialized perceptual and motor expertise depending on the task required in the match. Thus, we would like to investigate whether the pitcher (who possesses the expertise of performing the pitch motion) or the batter (who possesses the perceptuo-motor expertise of intercepting the pitch) could better recognize whether the pitch is a strike or a ball. We thus asked elite pitchers and batters to identify whether a pitch is a strike or a ball and compared their performance with intermediate players. The pitch sequence was edited in different lengths to see whether different amount of the information of the baseball trajectory could differently influence the pitch identification

Chen Y., Lee P., Lu Y. and Yen N..
Seeing or Doing? - Pitch Recognition of Batters versus Pitchers: A Preliminary Report.
DOI: 10.5220/0005144700170024
In *Proceedings of the 2nd International Congress on Sports Sciences Research and Technology Support* (icSPORTS-2014), pages 17-24
ISBN: 978-989-758-057-4

for pitchers and batters with high and low expertise levels.

We expected that advanced players, both pitchers and batters, would be more accurate than intermediate players due to their much more experience in pitch identification in general. Furthermore, batters would be more accurate than pitchers, particularly in advanced group, because they were the so-called perceptuo-motor experts in this task in the match.

2 METHODS

2.1 Participants

We recruited 9 high-level pitchers (hereafter HP; mean age=21; training years=12.52; hours per week=16.19) and 18 high-level batters (hereafter HB; mean age=20; training years=10.22; hours per week=23.94) from highly ranked Taiwanese university baseball team in this study. Most of them had the experience of participating in international competition. Moreover, a group of intermediate pitchers (n=7; hereafter IP; mean age=23; training years=5.43; hours per week=4.14) and intermediate batters (n=12; hereafter IB; mean age=24; training years=5.79; hours per week=6.63) were recruited as control groups. All participants were right-handed males, and with the height about 180 cm to have similar strike zone. This study was approved by the Research ethics committee of National Taiwan University and was in accordance with the Declaration of Helsinki; participants gave written informed consent.

2.2 Stimuli

The stimulus sequences were colour video clips (wmv format) of baseball pitches of 2 skilled pitchers. The 2 skilled pitchers were asked to throw four-seam fastballs to the strike zone of a 180-cm right-handed batter from the pitcher's mound toward the catcher, given a draw situation of full count (2 strikes & 3 balls), 2 out, and full base at the last inning. The video sequences were taken from the right-handed batter's perspective using video camera (SONY HDR-XR150; 30 frames/s; setting see Figure 1). 9 strikes and 9 balls thrown by each pitcher were recorded, making a total of 36 (2 pitchers x 2 types of pitch x 9 throws) different throws. Whether the pitch was a strike or a ball was judged by a skilled catcher on site. The criterion of recruiting the 2 skilled pitchers and catcher was the same as the criterion of recruiting the advanced skill-level batters. The average speed of the throws was controlled at around 115 km/hr by a speed gun. We then edited each video in 12 different lengths, which include the windup preparation phase and the pitching phase till the moment of the baseball released from the pitcher, or 33, 67, 100, 133, 167, 200, 233, 267, 300, 333, and 367 ms after the baseball released from the pitcher, respectively.

2.3 Task

The task is twofold. Right after viewing the pitch, participant had to decide whether he would swing the bat or not (to bat, not to bat, or uncertain) by pressing the response key 1, 2, or 3 with index, middle or ring finger. Immediately after this batting decision, he had to recognize the pitch type (strike, ball, or uncertain) again by pressing one response key with its corresponding finger. The response key (1, 2, or 3) assigned to the answer of batting decision (to bat, not to bat, or uncertain) were counterbalanced between participants. The response key of the answer of batting decision (to bat, not to bat, or uncertain) was always combined with the response key of answer of pitch recognition (strike, ball, or uncertain) following the nature of batting a strike and not batting a ball. All of the responses had to be made in 2.5 s, or the trial would be skipped. We reminded participants to respond as quickly as possible, but we emphasised accuracy over speed.

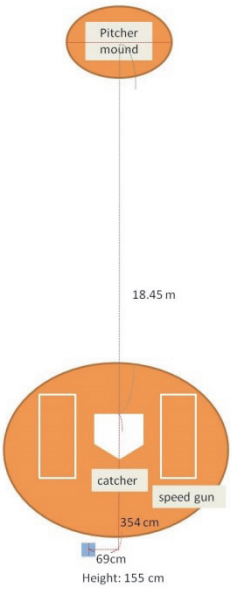

Figure 1: The display of experimental apparatuses: the blue filled box indicates the position of video camera.

2.4 Procedure

Before testing, we demonstrated the video sequences of the 9 strike and 9 ball pitches of each pitcher to the participant. The video sequences were longer than the testing stimuli because they were terminated at the moment of 200 ms before the baseball was caught by the catcher. This procedure was applied to let the participants familiar with the strike zone judged by the catcher and to let participants adapted to the scene filmed by the video camera. We then explained the task to the participant and the participant could practice at least 10 trials to make sure that the task is fully understood.

In each trial, the participant was presented with a fixation cross displayed on a white background and located in the centre of the screen (1024x768, 60Hz) for 1 s. Next, the video clip of the pitch was played. When the video clip terminated, participant had to decide whether to bat or not and to recognize the pitch type. The inter-stimuli interval (ISI) was 1 s (See Figure 2). There were 432 (2 pitchers x 2 types x 9 pitches x 12 video lengths) trials, randomly divided into 8 runs, to be completed. Between each runs, participant could have a short break of 3-5 minutes. The entire experiment took approximately 1.5 hr. The experimental protocol was written using Eprime 2.0. The response and response time of participants were registered for data analysis.

2.5 Data Analysis

We calculated the correct, incorrect, and uncertain response in percentage of each participant in each experimental condition. The data was then entered into 3 separate repeated-measures mixed-model 3-way (4 groups x 2 types of pitch x 12 lengths of video) ANOVAs for the correct, incorrect and uncertain response**,** respectively. For all ANOVAs, group was the between-subject factor, and type of pitch and length of video were within- subject factors. The threshold for significance was set at $p < .05$. A Bonferroni adjustment was used for multiple comparisons. SPSS 20.0 was used for statistical analysis.

3 RESULTS

In Figure 3, we demonstrated the percentage of "correct", "incorrect" and "uncertain" response of pitch identification of four groups for strikes and for balls, in different lengths of video sequence of the pitch. The statistics were reported in Table 1.

3.1 Correct Response

The ANOVA detected a significant main effect of group, with advanced players showing higher accuracy than intermediate players (mean value of 60%, 62%, 55%, and 55% for HP, HB, IP, and IB, respectively). Post-hoc analyses indicated that HB showed significantly higher accuracy than IB. There was also a significant main effect of pitch type, with higher accuracy in strikes than in balls. Moreover, we found a significant pitch type-by-group interaction, with HB being more accurate than IB particularly for strikes. And, all groups except for IB showed higher accuracy in strikes than in balls (see Figure 4 top panel). The main effect of length of video was also significant, showing that all players were more accurate when they could see longer pitch sequence. Video length-by-group interaction was also significant, for that HB showed significantly higher accuracy than intermediate players (both HP and HB) especially for short videos (length 1~4; see Figure 4 middle panel). The video length-by-pitch type interaction was also significant, with higher accuracy in strikes than in balls particularly for long videos (length4, and 6~12). The 3-way interaction was not significant.

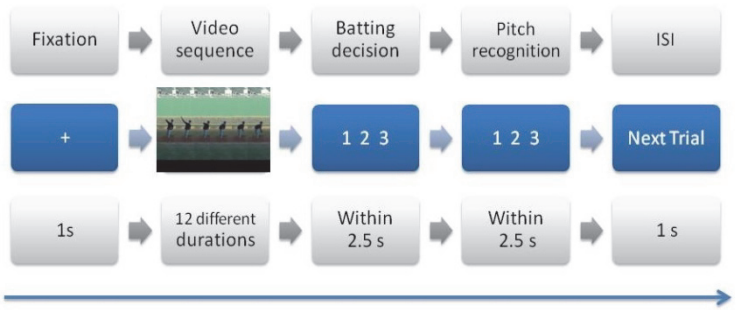

Figure 2: The procedure of a trial.

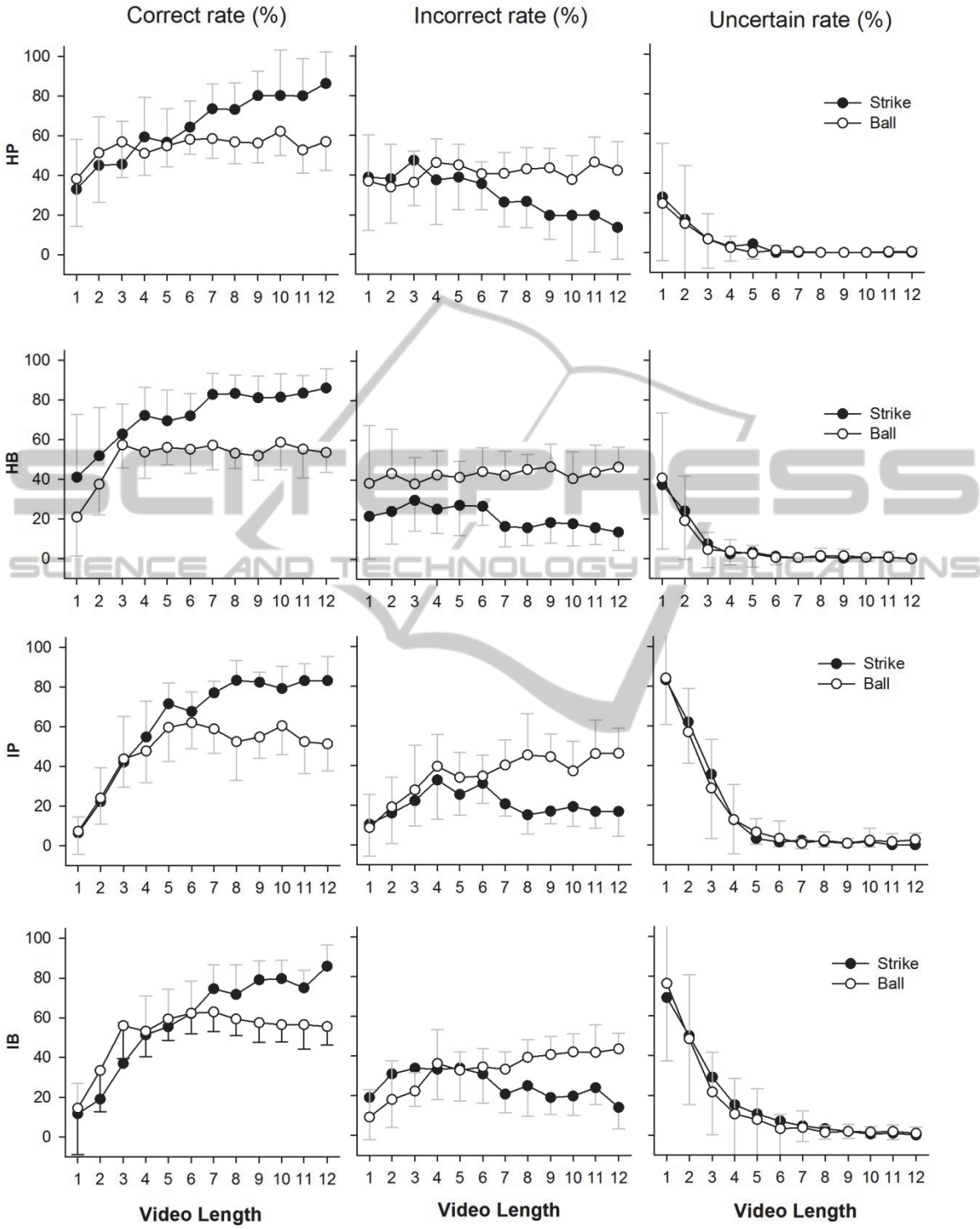

Figure 3: The percentage of "correct", "incorrect" and "uncertain" response of pitch identification for strikes and for balls of four groups (HP: high-level pitcher, HB: high-level batter, IP: intermediate pitcher, IB: intermediate batter) after viewing different lengths of video sequence of the pitch. The 12 different video lengths showed the windup preparation phase and the pitching phase until the moment of the baseball released from the pitcher, or 33, 67, 100, 133, 167, 200, 233, 267, 300, 333, and 367 ms after the baseball released from the pitcher, respectively.

Table1: Statistic s of all main effects and interaction effects for correct rate, incorrect rate, and uncertain rate.

Index	Effect	F value	*p* value	Pairwise comparisons
Correct rate (%)	Group	$F_{(3,42)} = 3.67$	$p < .05$	HB > IB
	Pitch type	$F_{(1, 42)} = 38.55$	$p < .001$	Strike > ball
	Pitch type-by-group interaction	$F_{(3,42)} = 3.29$	$p < .05$	HB > IB for strikes; pitch type effect for all groups expect for IB
	Video length	$F_{(11, 462)} = 136.61$	$p < .001$	Long > short
	Video length-by-group interaction	$F_{(33,462)} = 4.58$	$p < .001$	H > I, in length1&2; HB > I, in length3 & 4
	Video length-by-pitch type interaction	$F_{(11, 462)} = 18.54$	$p < .001$	Strike > ball, in long videos (length 4, and 6~12)
Incorrect rate (%)	Group	$F_{(3,42)} = 3.60$	$p < .05$	HP > IP
	Pitch type	$F_{(1, 42)} = 42.35$	$p < .001$	Ball > strike
	Pitch type-by-group interaction	$F_{(3, 42)} = 3.00$	$p < .05$	HB > IB, for balls
	Video length	$F_{(11, 473)} = 5.89$	$p < .001$	
	Video length-by-group interaction	$F_{(33, 462)} = 2.77$	$p < .001$	H > I, in length1; HP > I, in length3; HP > IP, in length5
	Video length-by-pitch type interaction	$F_{(11, 462)} = 16.26$	$p < .001$	Ball > strike, in long videos (length 4~12)
Uncertain rate (%)	Group	$F_{(3, 42)} = 5.90$	$p < .005$	I > H
	Video length	$F_{(11, 473)} = 89.01$	$p < .001$	Short > long
	Video length-by-group interaction	$F_{(33, 462)} = 5.85$	$p < .001$	I > H, in length1&2; I > HB, in length3
	Video length-by-pitch type interaction	$F_{(11, 462)} = 2.65$	$p < .005$	Strike > ball, in length3; ball > strike, in length11&12

H = high-level pitcher and batter; I = intermediate pitcher and batter; HP = high-level pitcher; HB = high-level batter; IP = intermediate pitcher; IB = intermediate batter.

3.2 Incorrect Response

The ANOVA detected a significant main effect of type of pitch, in which balls were identified with more mistakes than strikes. The main effect of group was also significant, with HP showing higher inaccuracy than IP (mean value of 36%, 32%, 28%, and 29% for HP, HB, IP, and IB, respectively). A significant pitch type-by-group interaction was detected. Post-hoc analyses indicated that HB showed higher inaccuracy than IB particularly for balls. And, all groups except for IB had higher inaccuracy for balls than for strikes (see Figure 5 top panel). The main effect of length of video was also significant. Moreover, video length-by-group interaction was also significant, with advanced players selectively showing higher rate than the intermediate players in length 1, 3, and 5 (see Figure 5 middle panel). The interaction between the main effect of pitch type and video length was also significant. This interaction was due that the inaccuracy for the strikes decreased as the video became longer, while the tendency was opposite for the balls (see Figure 5 bottom panel). The 3-way interaction was not significant.

3.3 Uncertain Response

We found a significant main effect of group was also significant, with advanced players, both pitchers and batters, showing lower uncertain rate than the intermediate players (mean value of 5%, 7%, 17%, and 16% for HP, HB, IP, and IB, respectively). The main effect of length of video was also found significant, with higher rate for the short videos. The interaction between the main effect of type of pitch and the length of video was also found significant. This interaction was due to a higher rate for strikes than balls only in length 3 (see Figure 6 bottom panel). Video length-by-group interaction was also

significant, for advanced players, no matter pitchers or batters, showed lower rate than intermediate players especially for short videos (length 1~3; see Figure 6 bottom panel). The other two-way or three-way interactions were not found significant, and their *p* values were far from significant level.

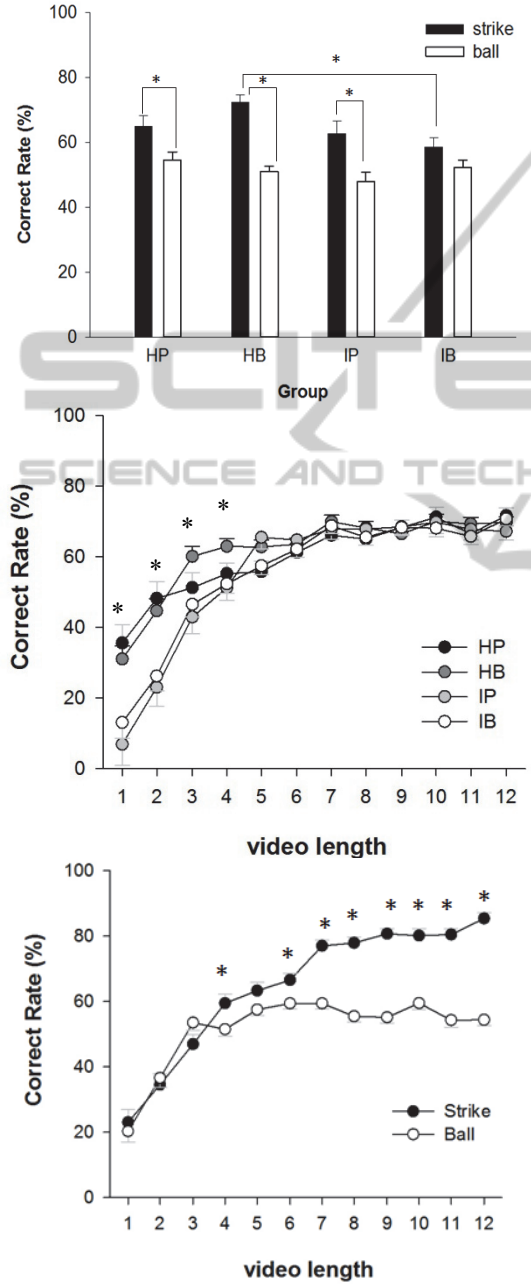

Figure 4: Four groups' average correct response for two types of pitch (top panel) and for viewing different lengths of pitch sequence (middle panel); all players average correct response for strikes and for balls in different video lengths (the bottom panel). *p < .05. Error bars indicate standard errors.

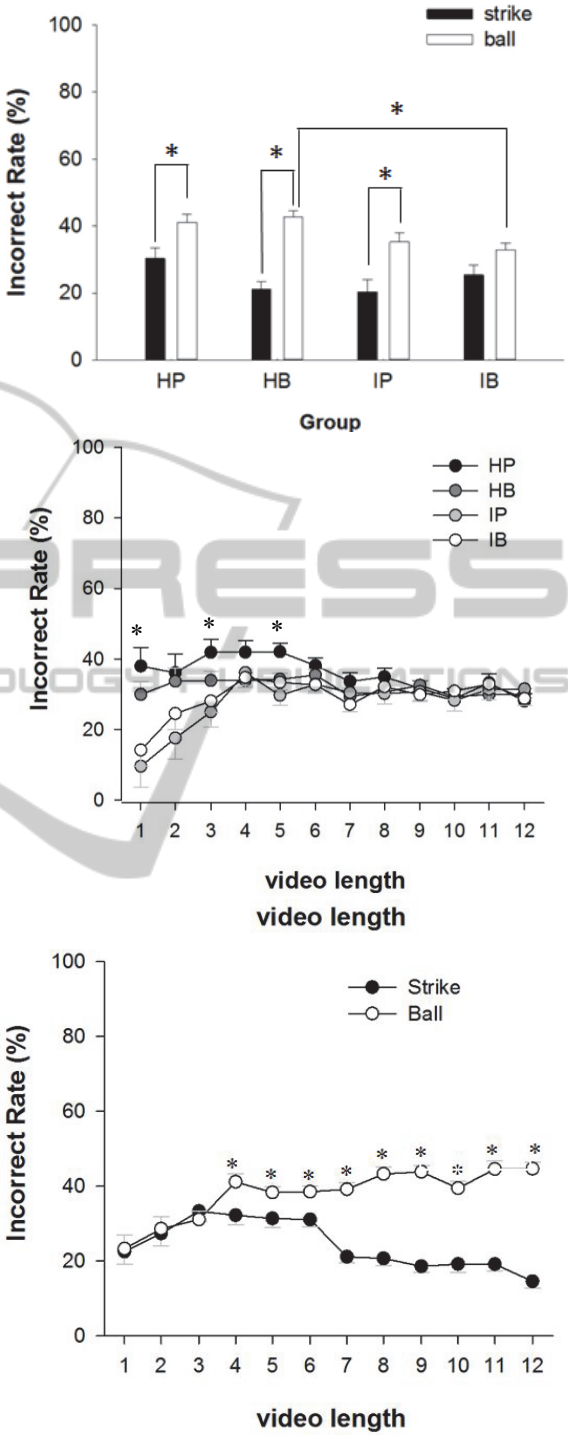

Figure 5: Four groups' average incorrect response for two types of pitch (top panel) and for viewing different lengths of pitch sequence (middle panel); and all players average incorrect response for strikes and for balls in different video lengths (the bottom panel). *p < .05. Error bars indicate standard errors.

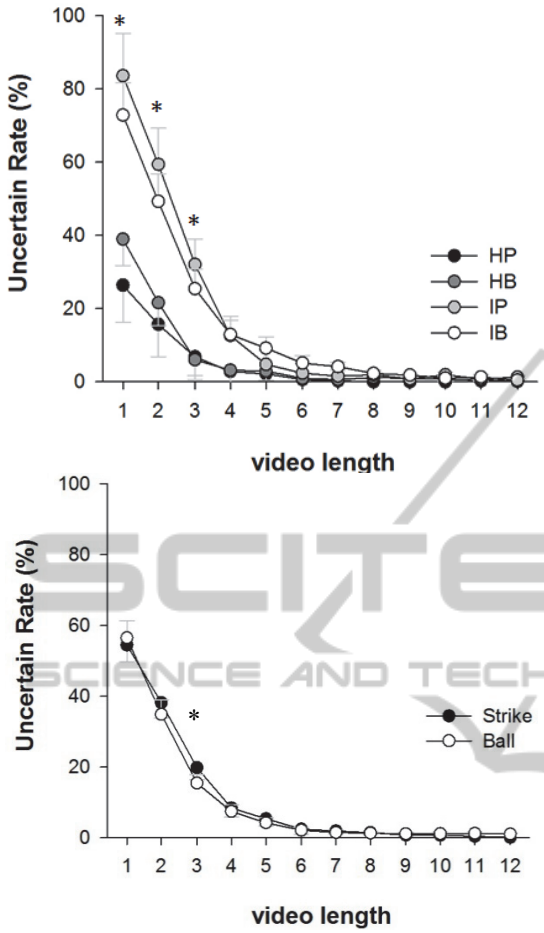

Figure 6: Four groups' average uncertain response after viewing different lengths of pitch sequence (top panel); and all players average uncertain response for strikes and for balls in different video lengths (the bottom panel). *p < .05. Error bars indicate standard errors.

4 DISCUSSION

In this study we tackled the question: in terms of understanding an observed movement, is the perceptuo-motor experience reacting to it more important than the actual motor experience of the observed movement? Baseball pitchers and players could be considered as the best candidates to study this topic since pitchers are trained to throw the pitch, and batters are trained to intercept it. When they are required to identify the type of the pitch, who can show the higher accuracy? We recruited pitchers and batters, with advanced and intermediate skill levels, to study this topic.

We found that advanced batters showed the highest accuracy among the four groups, particularly when only very short pitching sequence was presented to them for pitch identification. They were significantly more accurate than the intermediate players (both pitchers and batters). Advanced pitchers were slightly less accurate than the advanced batters (even though without reaching statistical significance), and intermediate players were the worst. Between intermediate pitchers and batters, there was no significant difference. This result was consistent with previous finding that video-motor experts (goalkeepers) were more accurate than the motor experts (kickers) (Tomeo et al., 2012) and high level players were more accurate and faster in their response than intermediate players (Williams et al., 1999). However, the lack of significant difference between the 18 advanced batters and the 9 advanced pitchers could be due to the unbalanced sample size. We expect to find a statistical difference when we will recruit more advanced pitchers in the future. As the indifference between intermediate pitchers and intermediate batters, we thought it is reasonable because they have not developed such great difference since their training experience was not so different as compared to advanced players.

In addition, in consistency with the previous studies, we found that our players generally showed higher accuracy in identifying the strike pitches when they could see longer sequence of the pitch motion and the baseball's trajectory (Paull & Glencross, 1997). However, no such difference was found for ball pitches. For explaining this result, we would like to note that the final position where the balls passed were not always very far from the striking zone (in the perspective of the catcher). For several balls, the difference to the striking zone was only the size of half or one baseball. In this case, these balls were easily to be identified as the strikes, especially because we set experiment situation as in a full count (2 strikes & 3 balls), 2 out, and full base at the last inning.

Furthermore, intermediate players showed the higher uncertain rate than the advanced players particularly for short videos. This finding was of importance because it revealed the requirement of fast sports such as baseball, in which players have to make a quick decision rather than staying uncertain. Last, we found that advanced pitchers showed the higher inaccuracy rate than the intermediate players. However, we would not take it as they were more erroneous than the intermediate players. Instead, we interpreted it as the result of identifying a pitch as a strike or a ball, rather than giving an uncertain response.

In sum, at this moment our results suggested that advanced players were generally more accurate than intermediate players. Moreover, there seemed to the difference between pitchers and batters, particularly in high levels. Whether the difference is significant or not has to be confirmed by recruiting more pitchers and comparing their performance with batters. This difference could be important because it supports the notion that athletes (batters) can better perform the task that they train better than the athletes (pitchers) that acquire the actual motor experience in doing the movement (Newell, 1986). A further analysis of the players' response time will be done to better understand their ability in pitch identification.

ACKNOWLEDGEMENTS

We would like to thank coach Shih-Kuei Huang from Chinese Culture University, coach Wen-Nan Liao from University of Taipei, coach Jung-Tang Kung from National Taiwan Sports University, and coach Po-Hsiu Lin from National Taiwan Normal University for their help in recruiting baseball players and their useful insights in experiment setup and discussion.

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