To Bat or Not to Bat?
Batting Eye of Elite Batters: A Preliminary Report

Yin-Hua Chen, Yu-Wen Lu, Pei-Hong Lee and Nai-Shing Yen
Research Center for Mind, Brain and Learning, National Chengchi University,
No. 64, Sec. 2, Zhi-Nan Rd., Wen-Shan District, Taipei 11605, Taiwan

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Abstract: In this study, we investigated the difference of the batting decision in advanced (n=18) and intermediate baseball batters (n=12) by asking them to make a swing judgement and then to recognize the pitch after they viewed it, given a draw situation of full count (2 strikes and 3 balls), 2 out, and full base at the last inning in a match. We also manipulated the length of the video sequence of the pitch that was presented to the batters to investigate the group difference when batters could see only fraction of pitch motion and the baseball trajectory. Advanced players showed higher batting rate than the intermediate players, particularly when they could see very limited sequence of the strikes pitches. This result reflected their more accurate and quicker response for strikes as compared to intermediate players. Interestingly, a similar tendency was also found for ball pitches. This result could be explained by that advanced players considered those balls as potential strikes subjectively; or that they were intended to make a foul ball, for getting a further pitch count as a positive strategy. Intermediate players instead, in this situation were not sure whether to bat or not, resulting a higher percentage of uncertain decision. We concluded that to make a batting decision correctly and strategically could be important elements in achieving high level batting.

1 INTRODUCTION

In baseball, the batter has only a fraction of a second to decide whether the pitch will be a strike or a ball and whether he will swing the bat or not. It is of great interest to understand whether these two questions are considered as one question to batters depending on different skill levels. Therefore, we asked batters at different skill levels to make a swing judgement and then to recognize the pitch after they viewed it. We focused our attention in the batting decision of the batters since the final goal of a batter is to make a correct and successful attack by swinging the bat rather than to make correct pitch recognition.

It has been shown that both the motion of the pitcher and the trajectory of the baseball are important cues for batters in recognising the pitch as well as in making the batting decision (e.g., Hubbard and Seng, 1954; Shank and Haywood, 1987; Takeuchi and Inomata, 2009). Therefore, we filmed the pitcher's motion from his preparatory phase until the baseball reached the plate, from a right-handed batter's perspective. In order to see whether the amount of the information of baseball trajectory could influence the batting decision differently, we then edited each pitch to show different lengths of the baseball trajectory.

Previous studies have reported that expert batters show significantly shorter decision time and higher accuracy in recognizing the pitch and predicting where the baseball will pass through the strike zone (Paull and Glencross, 1997). Thus, we expected that advanced batters would show the same tendency in their batting decision as compared to intermediate batters. Particularly, we investigated whether advanced batters would be more aggressive in attack (i.e., choosing to swing the bat anyway) even when the forthcoming pitch was ambiguous in recognition.

2 METHODS

2.1 Participants

We recruited 18 advanced players (mean age=20; training years=10.22; hours per week=23.94) from highly ranked Taiwanese university baseball team

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(advanced skill-level group) and 12 intermediate players (mean age=23; training years=6.84; hours per week=9.42) in this study. Two third of the advanced skill-level group had the experience of participating in international competition. To qualify for the intermediate skill-level group, participants had to have played on their university faculty baseball team. 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 and 3 balls), 2 out, and full base at the last inning. The video sequences were taken from the batter's perspective using video camera (SONY HDR-XR150; 30 frames/s; setting see Figure 1). 9 strikes in a nine-cell strike zone and 9 balls out of the strike zone 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 that we used to recruit the 2 skilled pitchers and the 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 included 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 I don't know) 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 I don't know) again by pressing one of the 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 I don't know) were counterbalanced between participants.

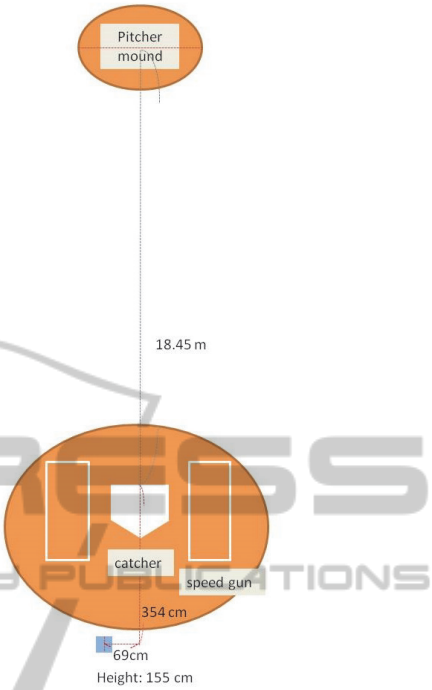


Figure 1: The display of experimental apparatuses: the blue filled box indicates the position of video camera.

The response key of the answer of batting decision (to bat, not to bat, or I don't know) was always combined with the response key of answer of pitch recognition (strike, ball, or I don't know) 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.

2.4 Procedure

Before testing, we demonstrated the video sequences of the pitch of the 9 strikes and 9 balls of each pitcher to the participant. The video sequences demonstrated in this phase 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. 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 percentage of the response (i.e., to bat, not to bat, uncertain) of each participant in each experimental condition. A correct batting decision included 2 situations: batting for strikes and not batting for balls. An incorrect batting decision could be "batting for balls" and "not batting for strikes". The data was then entered into 3 separate repeated-measures mixed-model 3 way (2 groups x 2 types of pitch x 12 lengths of video) ANOVAs for the correct, incorrect, and uncertain batting decision, 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 $p < .05$. Furthermore, we picked up 6 pitches that were considered the most ambiguous pitches while batters were asked to identify the type of the pitch. We then computed again the percentage of decision of "to bat" between 2 groups and compared the group difference in different lengths of video sequence using a 2 way (2 groups x 12 lengths of video) repeated measures ANOVA. A Bonferroni adjustment was used for multiple comparisons. SPSS 20.0 was used for statistical analysis.

3 RESULTS

In Figure 3 we demonstrated the average percentage of correct, incorrect, and uncertain batting decision made by advanced and intermediate players for strikes and for balls, after they viewed 12 different lengths of video sequence of the pitch. All of the statistics were reported in Table 1.

3.1 Correct Decision

The ANOVA (2 groups x 2 types of pitch x 12 lengths of video) detected a significant main effect of type of pitch, with higher percentage observed for the strikes than for the balls. We also found a significant main effect of length of video, for the percentage was higher when batters could see longer videos. There was also a significant main effect of group, with advanced batters showing higher accuracy than the intermediate batters. Moreover, we found a significant video length-by-group interaction. It was due to the group difference was significant when the video was short (from length 2 to length 5) but not when the video was longer (see Figure 4 top panel). A video length-by-pitch type interaction was also detected. This interaction effect was due to the higher accuracy for the strikes than for the balls was found particularly for long videos (from length 6 to 12; see Figure 4 bottom panel). The 3 way interaction effect was also significant, for that advanced batters showed higher accuracy than the intermediate batters, particularly when they viewed the very short strikes videos (length 1 to 3).

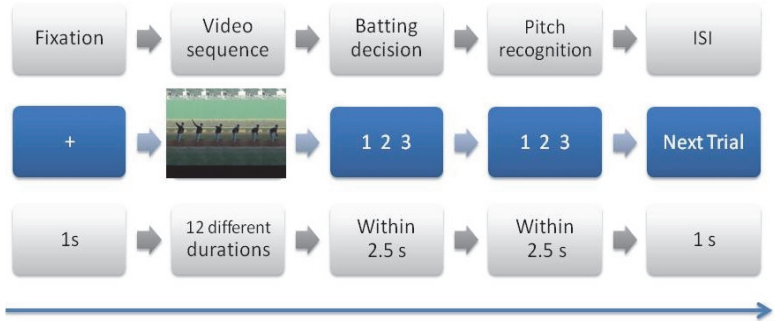


Figure 2: The procedure of a trial.

Table 1: Statistics of all main effects and interaction effects for correct rate, incorrect rate, and uncertain rate for all pitches, and batting rate for ambiguous pitch.

Index	Effect	F value	*p* value	Pairwise comparisons
Correct rate (%)	Group	$F_{(1, 28)} = 7.28$	$p < .05$	Advanced > intermediate batters
	Pitch type	$F_{(1, 28)} = 29.43$	$p < .001$	Strike > ball
	Video length	$F_{(11, 308)} = 78.89$	$p < .001$	Long > short
	Video length-by-group interaction	$F_{(11, 308)} = 4.03$	$p < .001$	Group difference particularly in short videos (length 2~5)
	Video length-by-pitch type interaction	$F_{(11, 308)} = 15.86$	$p < .001$	Type difference particularly in long videos (length 6~12)
	3 way interaction	$F_{(11, 308)} = 3.71$	$p < .001$	Group difference particularly in very short strikes videos (length 1~3)
Incorrect rate (%)	Pitch type	$F_{(1, 28)} = 30.54$	$p < .001$	Ball > strike
	Video length	$F_{(11, 308)} = 6.11$	$p < .001$	Short > long
	Video length-by-pitch type interaction	$F_{(11, 308)} = 13.54$	$p < .001$	Type difference particularly in not-short videos (from length 4~12)
	3 way interaction	$F_{(11, 308)} = 3.45$	$p < .001$	Advanced > intermediate batters, particularly in short balls videos (length 1~2)
Uncertain rate (%)	Group	$F_{(1, 28)} = 6.89$	$p < .05$	Intermediate > advanced batters
	Video length	$F_{(11, 308)} = 53.26$	$p < .001$	Short > long
	Video length-by-group interaction	$F_{(11, 308)} = 4.83$	$p < .001$	Group difference particularly in short videos (length1~4)
	Video length-by-pitch type interaction	$F_{(11, 308)} = 15.87$	$p < .001$	Higher rate for the balls in extremely short videos (length 1)
Batting rate for Ambiguous pitch (%)	Group	$F_{(1, 28)} = 3.47$	$p = .073$	Advanced > intermediate batters
	Video length	$F_{(11, 308)} = 17.56$	$p < .001$	Long > short
	Video length-by-group interaction	$F_{(11, 308)} = 4.62$	$p < .001$	Advanced > intermediate batters, particularly in short balls videos (length 1~3)

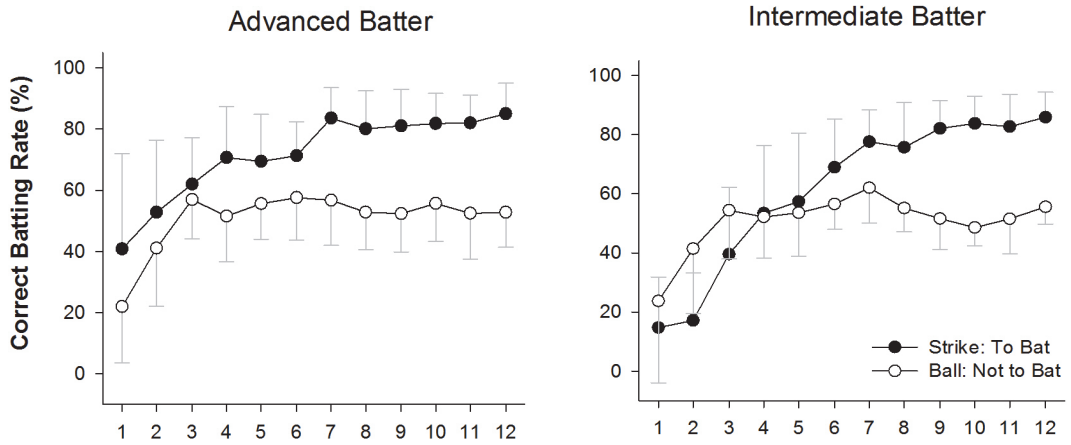
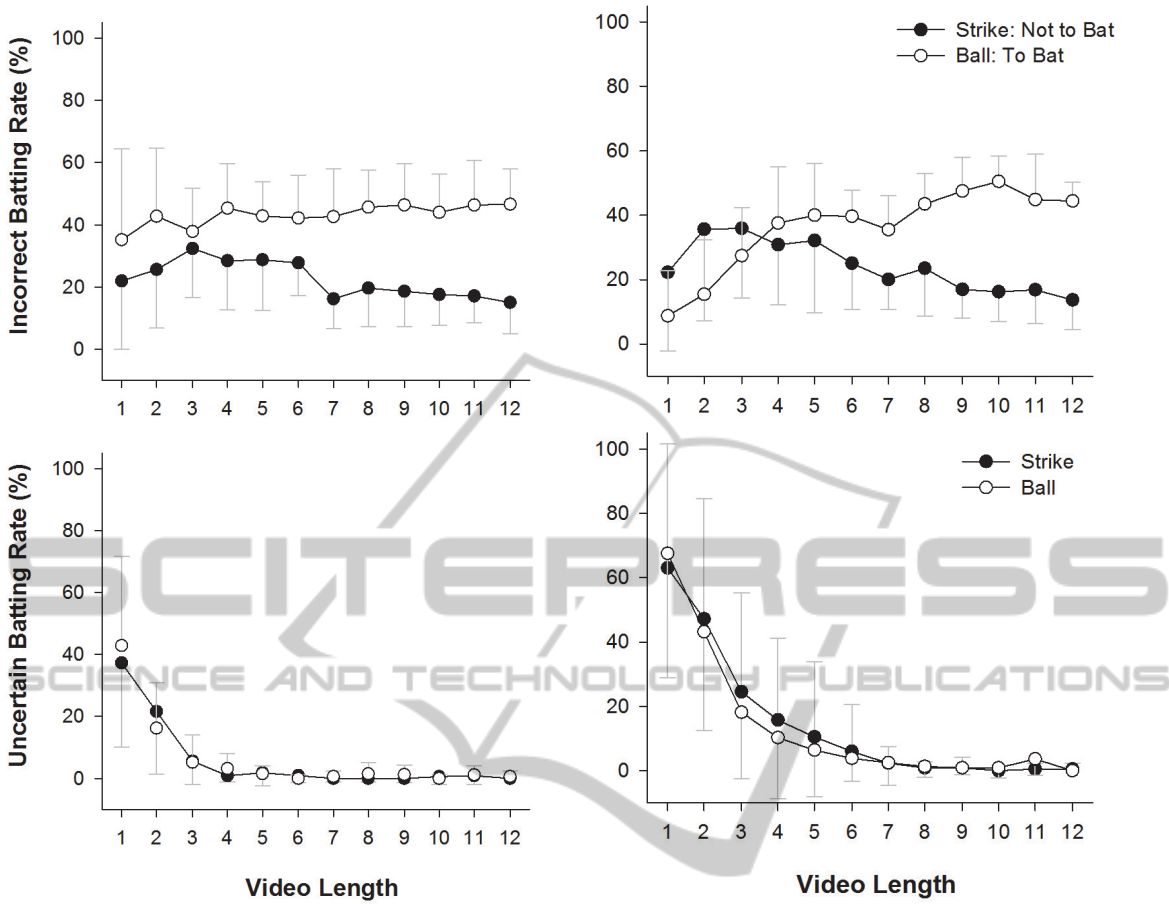


Figure 3: Average rate of correct, incorrect, and uncertain batting decision made by the advanced and intermediate batters after viewing 12 different video lengths. The 12 different video lengths showed the windup preparation phase and the pitching phase until the moment of the baseball released from the pitcher, or 33, 67, 100, 133, 167, 200, 233, 267, 300, 333, and 367 ms after the baseball released from the pitcher, respectively.



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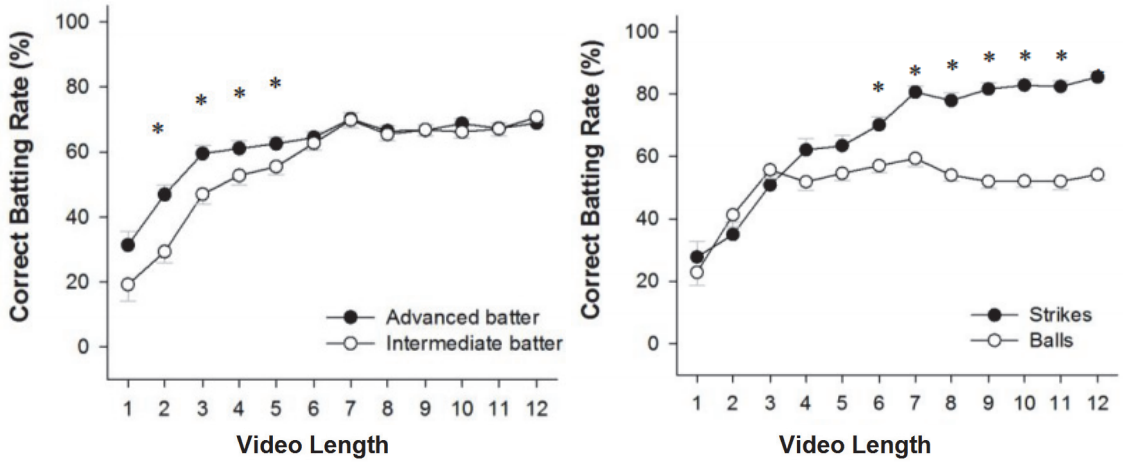

Figure 4: The average correct batting rate of 2 groups (advanced vs. intermediate batters; top panel) for 2 types of pitch (strike vs. ball; bottom panel) as a function of the length of video sequence of the pitch. *p < .05. Error bars indicate standard errors.

3.2 Incorrect Decision

In the 3 way (2 groups x 2 types of pitch x 12 lengths of video) ANOVA, we found a significant main effect of pitch type, with higher percentage observed for the balls than for the strikes. There was also a significant main effect of video length, for batters showing the lowest inaccuracy in the shortest video (length 1) compared to other videos. The main effect of pitch type interacted significantly with the main effect of video length, for the difference between the pitch types was not significant for the short videos (see Figure 5). We also found the 3 way interaction effect significant. The post-hoc analyses indicated that advanced batters showed higher inaccuracy than the intermediate batters, particularly when they viewed the very short balls videos (length 1 to 2). The main effect of group and other interaction effects were not significant.

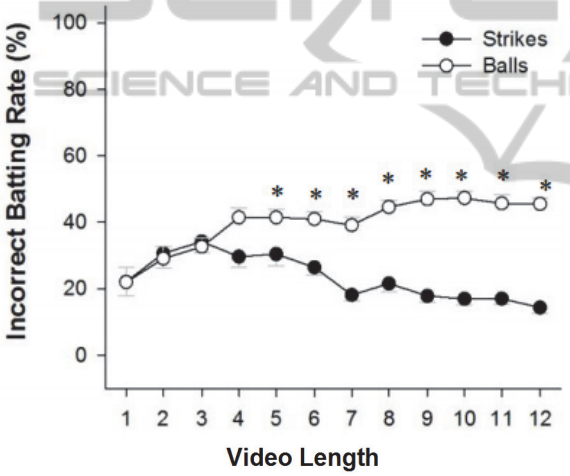

Figure 5: The percentage of the decision of "Not to bat" when batters saw different lengths of video of strikes (shown in blue) and balls (in green). *$p < .05$. Error bars indicate standard errors.

3.3 Uncertain Decision

The ANOVA for the decision of "I don't know" detected a significant main effect of video length, showing that the longer the video the less uncertain the batters. The main effect of group was also significant, with intermediate batters showing higher uncertain rate than the advanced batters. There was also a significant video length-by-group interaction. It was due to that the group difference was significant only for the short videos (from length 1~length 4; see Figure 6 top panel). Moreover, we found a significant interaction between the main effect of length of video and the main effect of type of pitch, $F(11, 308) = 3.63$, $p < .001$. It was based on the fact that batters showed higher uncertain rate for the balls when the video was extremely short (in length 1) but not when the videos were longer (see Figure 6 bottom panel).

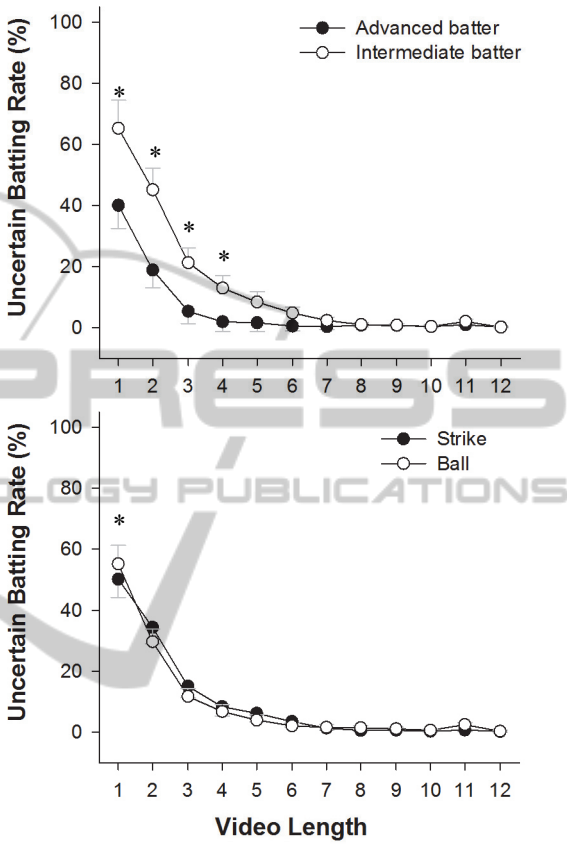

Figure 6: The percentage of decision of "I don't know" of 2 groups (advanced vs. intermediate batters; top panel) for 2 types of pitch (strike vs. ball; bottom panel) as a function of the length of video sequence of the pitch. *$p < .05$. Error bars indicate standard errors.

4 DISCUSSION

In this study, we investigated the difference of the batting decision in expert and non-expert baseball batters. A correct batting decision is "to bat" for the strike and "not to bat" for the ball pitch. We also manipulated the length of the video sequence of the pitch that was presented to the batters to investigate the difference between the 2 groups when they could only see fraction of the pitch motion and the baseball trajectory. It is worthy to note that the pitching videos were obtained by 2 different pitchers. It provided more varieties as compared to previous study that used pitch motion of only one pitcher.

We found that advanced players made batting decision with higher accuracy than the intermediate players, particularly when they could see very limited amount of strike trajectory. This result indeed reflected the fact that advanced players were more accurate and quicker in batting decision, due to their more accumulated experience, as compared to intermediate players. Interestingly, we also found that advanced players chose to swing the bat after viewing the very short ball pitches. This result could be explained by that advanced players considered those balls as "potential" strikes subjectively since they only saw very limited sequence of the ball pitches. It could be also possible that they were intended to make a foul ball, for getting a further pitch count as a positive strategy.

Intermediate players instead, while viewing short pitch sequence (not matter for balls or for strikes) was not sure whether to bat or not, resulting in a higher percentage of uncertain response. In sum, we found that advanced batters decided whether to swing the bat or not even when they could see very short pitching sequence. Intermediate players could not make such decision if they could not see enough baseball trajectories. When the pitch sequence could reveal enough information for batters to decide whether to bat or not, both advanced and intermediate players could make more accurate decision. This result was consistent with the previous studies that players could better recognize the type of the pitch when they saw the longer trajectory of the baseball (Paull and Glencross, 1997).

The limitation of this study could be that we did not consider the eye and head movement strategy (Mann et al., 2013). However, our results provided the evidence that to make a batting decision correctly and strategically could be important elements in achieving high level batting. We will perform a further analysis of the batters' decision time to understand more deeply their batting decision.

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