TRIAL-BY-TRIAL ERROR CORRECTION FOR ACCURATE BASEBALL PITCHING

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Introduction

In various motor skills in sports, such as throwing, kicking, and hitting, accurately controlling a ball to a target position in high-speed is one of the important skills. The final arrival position of the ball is approximately determined by its physical state at the release or impact. In high-speed baseball pitching, reducing the variability of the ball's release angle is particularly necessary to reduce the variability of arrival position (Kusafuka et al., 2022). However, as there is always variability in human movements and it increases as the speed increases (Faisal et al., 2008; Fitts, 1954), how to decrease the variability is one issue. This study focused on one strategy; trial-by-trial error correction, which is to correct movements in the following trials facing an undesirable outcome. The intertrial change of ball's release angle in baseball pitching was analyzed by autocorrelation analysis to clarify the error correction.

Methods

Two high-speed cameras (960 fps) were used to capture the baseball pitching of 14 skilled pitchers (sex: male; age: 20.7 ± 1.9 years; height: 177.0 ± 5.6 cm; weight: 76.5 ± 7.7 kg; 13 right-handed and 1 left-handed). The 3D positions of the ball during each pitching of 30 fast balls were obtained using an automatic image recognition technique based on deep learning (DeepLabCut). Therefore, no markers were placed on the ball. Pitchers were instructed to aim at the catcher's mitt and throw as fast and accurately as possible.

The release angle was defined as the elevation angle θ1 (−90◦ to 90◦) and the azimuth angle θ2 (−90◦ to 90◦) of velocity vector at the ball release in polar coordinates. The autocorrelation analysis was performed on the intertrial change of release angle and its coefficient in lag-1: ACF1 was calculated as an error correction index. The correlation between this index and the variability (standard deviation: SD) of release angle was examined.

Results

Figure 1 shows the intertrial change of θ1 and its ACF1 in typical pitchers. If no corrections are made, each value of release angle is close to the previous (ACF1>0). If over correction are made, values of release angle of consecutive trials tend to be on opposite sides of the mean (ACF1<0). For correction that lead to a small variability, each value of release angle is statistically independent of the previous, thus ACF1 is close to zero (van Beers et al., 2013). Figure 2a shows the correlation between ACF1 and SD in θ1, and Figure 2b shows that in θ2. ACF1 in the pitchers who have small SD of release angle were close to zero. On the other hand, ACF1 in the pitchers who have large SD of release angle tended to be negative in θ1, but be positive in θ2.

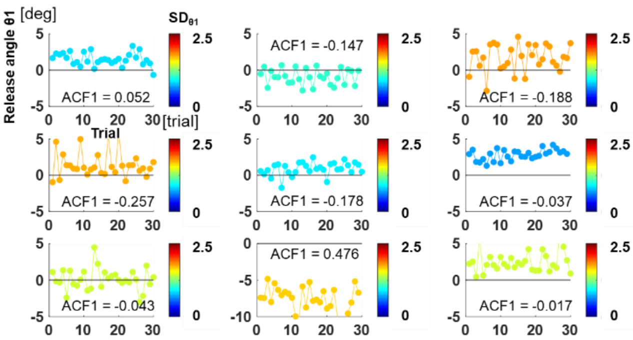

Figure 1: The intertrial change of θ1 and its ACF1 in typical pitchers.

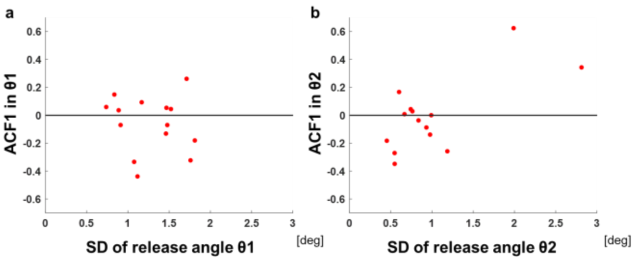

Figure 2: The correlation between ACF1 and SD of release angle.

Discussion

The results suggest that the pitchers who have small variability of release angle made correction that lead to a small variability. On the other hand, it suggests that the pitchers who have large variability of release angle made over correction in θ1, but made no correction in θ2. These findings indicate that trial-by-trial error correction can be one strategy to decrease the variability, but there are different reasons that the correction goes wrong depending on the direction of errors.

References

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