CHANGES IN THE THROWING TECHNIQUE OF COLLEGE MALE JAVELIN THROWERS BY AN IMMEDIATE FEEDBACK TRAINING.

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The purpose of this study was to present effects of the immediate feedback training on techniques in college male javelin throwers. The participants were five college male javelin throwers. The technical problems revealed by the preliminary motion analysis were explained to the participants for this experiment. In the immediate feedback training, an iPad displaying the motion pattern of the ELITE throwers (Notomo et al., 1998) was set up, and a delayed playback device was used to allow the participants to visually compare their own movements with the model after throwing. Three trials were performed in each of before and after the training sessions. The best recorded trials in each of the training sessions were selected for analysis. Three of five throwers improved their deceleration of center of gravity and trunk rotation, although improvement in the record and the release speed of all participants was not observed.

KEYWORDS: javelin throw, coaching, immediate feedback.

INTRODUCTION: The javelin throw is one of the throwing events in athletics. It has been stated that the speed of the run-up and the angle of the knee of the front leg are important factor for gaining large throwing distance (Bartlett et al., 1996; Murakami et al., 2006). In coaching, the motion consciousness plays an important role to correctly improve techniques. Kase et al. (2020) reported that the improvement in sprint running technique and changes in the consciousness of sprint motion closely related to each other in the immediate feedback training. The purpose of this study was to present effects of the immediate feedback training on techniques and consciousness of throwing in college male javelin throwers. The hypothesis of this study was that the immediate feedback training would be able to change the thrower's motion, but there would be no immediate improvements in the performance.

METHODS: (1) Identification of the technical problems
The participants were five college male javelin throwers (height, 1.72 ± 0.05 m; weight, 84.0 ± 9.38 kg; age, 19.8 ± 1.17; personal record, 62.41 ± 4.61 m). All participants were the right-handed throwers. In this study, we set elite javelin thrower's motion patten (shortly, ELITE; Notomo et al.,1998) as a model to identify the college thrower's technical faults in the immediate feedback training. The averaged motion of twenty-four college male throwers created by the method of Ae et al. (2007), were compared with the ELITE model (Figure 1). The comparison revealed that the torso rotation at the left foot touchdown (L-on) for college throwers was delayed and slow. Tauchi et al. (2012) reported that the angular displacement of the hip rotation in the preparatory phase (from R-on to L-on) was positively correlated with the record, and the torso rotation was considered to be a factor determining the record. The position of the right foot at the R-on was also more forward in the college throwers, compared with the ELITE. This seemed to be a factor to reduce the deceleration of the run-up speed. Therefore, two critical points were considered as technical faults for the five throwers as well as other twenty-four throwers; (1) The delayed hip rotation and (2) the decrease in the speed of the center of mass in the preparation phase. These technical faults were explained to the participants prior to the immediate feedback training.

(2) Immediate feedback training
The setup for the immediate feedback training consisted of a digital video camera on the

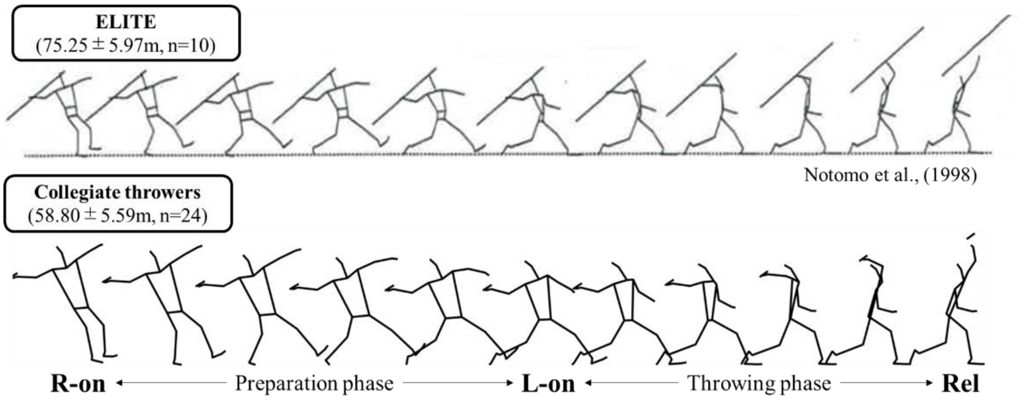

Figure 1: The averaged motions of the ELITE and the college male throwers.

right side of the runway to capture and show images on a display via a delay playback device, so the participants were able to observe the throwing motion immediately after trials. An iPad displayed the averaged motion of the ELITE as a model for the participants to compare their own motion with ELITE. The duration of the training was one hour, and the number of throws for training was from five to seven. Three trials were carried out in each of before and after the training. The best recorded trials in each of the training sessions were selected for analysis.

(3) Data collection and processing
The throwing motion was videotaped with two high-speed cameras (AX-700, SONY) which were synchronized by the event method. The camera speed was 120 frames/s and the exposure time was 1/1000 second. Twenty-three points on the body and two points on the javelin (top and rear ends of the grip) were manually digitised by an experienced digitiser with using Frame-DIAS V (DKH, Co., Japan). Three-dimensional coordinate data of the digitised points were obtained using the three-dimensional DLT method. The three-dimensional coordinate data were smoothed by a Butterworth low-pass digital filter at the optimum cut-off frequencies from 3.6 to 9.6 Hz which were determined by the residual method (Winter, 2009). The right-handed coordinate system was set with the throwing direction being the Y axis, the X axis being the right direction to the Y axis, and Z axis being the vertical direction. The averaged errors were 0.008 m in the X direction, 0.011 m in the Y direction and 0.006 m in the Z direction. After completing the entire process, we collected the consciousness of motion from each player by a questionnaire.
The deceleration ratio of the center of gravity (CG) speed was calculated as the ratio of the R-on to the L-on of the CG speed. The hip angle was defined as the angle between the line connecting the left and right hips and the X-axis on the horizontal plane. The hip rotation angle in the preparatory phase was defined as the angular displacement of the hip angle between R-on and L-on.

Table 1: Change in parameters due to immediate feedback training.

Subj	Record [m]			Release Vel [m/s]			Deceleration ratio [%]			Hip rotation angle [deg]		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
A	59.8	56.4	↓	24.4	23.7	↓	7.5	11.6	↑	8.4	14.6	↑
B	56.4	52.7	↓	23.9	22.6	↓	4.2	2.7	↓	11.4	17.1	↑
C	53.7	49.7	↓	22.9	22.2	↓	7.6	6.9	↓	4.2	9.6	↑
D	54.1	51.2	↓	22.2	20.8	↓	13.4	4.7	↓	17.5	13.0	↓
E	50.5	48.5	↓	21.8	21.3	↓	13.8	16.4	↑	13.2	13.2	-

RESULTS: Table 1 shows changes in the trial record, release velocity, deceleration ratio of CG speed and the angular displacement of the hip rotation for the participants before and after the training. There was no increase in the record and the release velocity of the participants before and after the training. Subject A increased the deceleration ratio of CG speed and the hip rotation angle. Subject B decreased the deceleration ratio of CG speed and increased the hip rotation angle. Subject C decreased the deceleration ratio of CG speed and increased the hip rotation angle. Subject D decreased the deceleration ratio of CG speed and the hip rotation angle. Subject E increased the deceleration ratio of CG speed but did not alter the hip rotation angle.

DISCUSSION: As shown in Table 1, the one-hour technical training with the immediate feedback showed no positive changes in the record and release speed. The purpose of this study was to observe how participant's movements changed by the immediate feedback training rather than improvement in records. Therefore, changes in two technical factors identified in Method (1) will be discussed as a case study: i.e., subject A showing increase in hip rotation angle, and subject D with deceleration rate decreased.

(1) Subject A

He showed the increase in the hip rotation angle from 8.4 deg to 14.6 deg. Subject A (Figure 2 (1)) showed a slight rotation of the trunk at L-on in the post trial, indicating that he was able to improve his hip rotation. The hip rotation angle in the post trial was about 1.7 times larger than the pre trial. However, his deceleration ratio of the CG speed was larger in the post trial. The deceleration of CG speed may have caused the prolonged phase time and as a result helped to larger increase the hip rotation angle. Therefore, the improvement in hip rotation angle was thought to reflect one of effects of the immediate feedback.

(2) Subject D

He greatly reduced the deceleration ratio and was able to maintain the run-up speed (Table 1). The stick pictures (Figure 3 (2)) showed that the position of the right foot at the R-on was closer to the CG of the body as the ELITE movement described above. His consciousness collected after the post trial was that ''I was conscious of doing touchdown my right and left foot at same time at R-on and L-on''. Based on this, it is thought that subject D intended to change deceleration of the CG speed in the preparation phase. The similar consciousness was introspected by other subjects like subject C. From these results, it can be inferred that ''a simultaneous touchdown of the left and right foot'' as a consciousness is effective to reduce the deceleration of the CG speed in the preparatory phase of javelin throwing. However, the stick pictures of subject D (Figure 3 (3)) revealed that the left knee was largely flexed at Rel. Since it is said to be desirable that the left knee should be extended for transferring the speed gained in the run-up to the javelin, subject D may have failed to transfer the run-up speed to the javelin due to the lack of the technique.

In the coaching, it would be no doubt that an individual athlete's consciousness influences

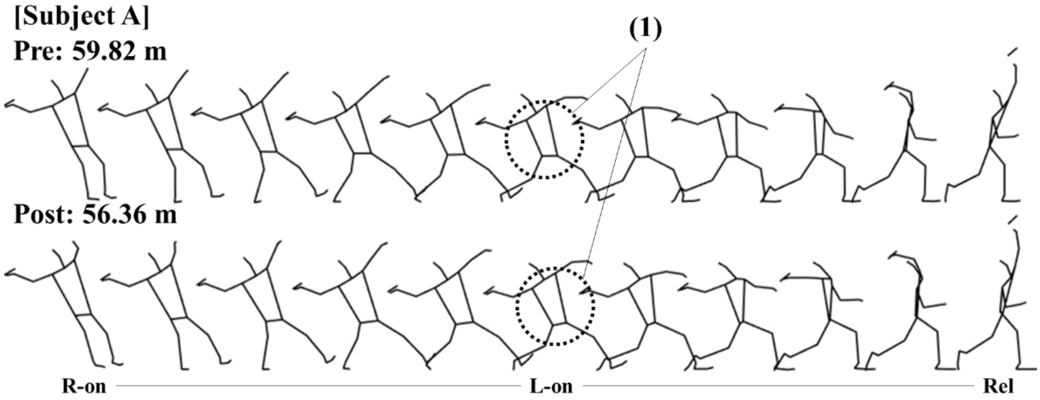

Figure 2: The stick pictures of the subject A pre and post the training.

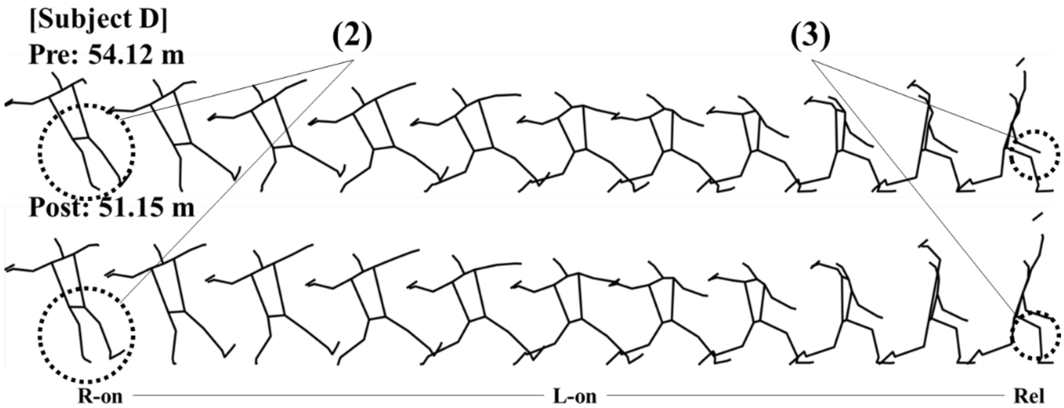

Figure 3: The stick pictures of the subject D pre and post the training.

his/her technique. However, few studies have reported changes in throwing movements and the consciousness of javelin throwers. In this study, the immediate feedback training was carried out on five college male javelin throwers, and changes in their movements and consciousness were investigated as case studies. Although the participant's movements partially tended to change and become closer to the model, their throwing distance did not increase. One of the reasons might be fatigue become they threw five to seven times in both sessions. Another might be a non-intentional inhibition of the output of mechanical energy due to over-emphasis or over-consciousness on segmental movements. The immediate feedback training would be more effective if more detailed information of each thrower's technique was collected and analysed prior to the training.

CONCLUSION: In the present study, we conducted one-hour immediate feedback training on five college javelin throwers, and investigated changes in performance - related parameters and techniques. The deceleration ratio of CG speed and the hip rotation angle improved in three of five participants, although improvement in the record and the release speed of all participants were not observed. ''A simultaneous touchdown of the left and right foot'' would be effective to reduce the deceleration of the CG speed in the preparatory phase.

REFERENCES

Ae, M., Muraki, Y., Koyama, H. & Fujii, N. (2007) A Biomechanical Method to Establish a Standard Motion and Identify Critical Motion by Motion Variability: With Example of High Jump and Sprint Running. *Bull. Inst. Health & Sport Sci., Univ. of Tsukuba, 30: 5-12*.

Bartlett, R., Muller, E., Lindinger, S., Brunner, F. & Morriss, C. (1996) Three-dimensional evaluation of the kinematic release parameter for javelin thrower of different skill levels. *Journal of Appl. Biomech,* 12: 58-71.

Kase, H., Mizuno, M., Nagashima, M., Hatakeyama, S. & Ae, M. (2020) A case study on changes in the sprint running motion and awareness for student sprinters due to the improvement program of sprint techniques. *Bull. Of Nippon Sport Sci. Univ*, 49, 3001-3011.

Murakami, M., Tanabe, S., Ishikawa, M., Isolehto, J., Komi, P. V. & Ito, A. (2006) Biomechanical analysis of the javelin at the 2005 IAAF World Championships in Athletics. *New Studies in Athletics,* 21: 67-80.

Notomo, H., Togashi, T. & Ae, M. (1998). Kinematic analysis of javelin throwing motions for athletes in different performance levels. *Research quarterly for athletics*, 32: 32-39.

Tauchi, K., Fujita, Z. & Endo, T. (2012). Development of evaluation standards for throwing motion of male javelin throwers. *Japan. J. Biomech. Sports. Exerc*, 16: 2-11.

Winter, D. A. (2009) *Biomechanics and motor control of human movement (4th ed.)*. John Wiley & Sons: New Jersey, pp. 70-73.