


The Difference Between Movement and Self-Recognition in Children Performing the Standing Long Jump

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Abstract

This study examined the relationship between the recognition of movement and actual movement during the standing long jump. A total of 11 healthy elementary school children from 10 to 11 years of age participated in this study. Participants conducted standing long jumps (the target movement) after receiving video instruction. They were then tested on their recognition of the target movement according to an image. A total of 12 markers were then attached to each participant to measure the actual movements taken during subsequent performances of the target movement. They were then tested on the recognition of their own movements (a self-evaluation). The results were as follows: maximum shoulder angle was observed prior to each jump; this became successively lower in the image review, actual movement, and self-evaluation procedures. Knee flexion angle successively decreased in the actual, target, self-evaluation, and image movements during the railway crossing procedure. While jumping, the maximum shoulder angle was significantly larger in the target movement than the actual ($P < .01$) movement, but the actual movement was significantly lower than the image ($P < .001$) and self-evaluation ($P < .001$) movements. The angle between the perpendicular from the acromion and the line segment connecting the acromion to the lateral malleolus successively decreased in the target, image, self-evaluation, and actual movements. Thus, there were obvious points at which it was either easier or more difficult for subjects to recognize movements. Points of relative ease and difficulty were also identified during performance of the target movement.

Keywords

standing long jump, acquisition of motor skills, recognition of movement, self-image

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Introduction

Physical education teachers often present examples of exercise tasks during class. Students then repeatedly practice and correct their movements in order to acquire the necessary skills to perform these tasks. However, it is often necessary to confirm the exercise task and become conscious of defects¹ to correct these movements. An exercise task can be interpreted as a series of movements or a movement structure. As such, motion analysis and video delay technologies can be used to present exercise tasks and provide feedback to promote consciousness of these movements. However, it is difficult to determine whether a student properly recognizes the exercise task and/or their own movements.

Harada² distinguished between one's understanding of movements and actual body movements. Objective understanding of the movement is classified as knowledge, while the actual movement is perceived as a sensation. Horie³ reported that understanding of the target movement involved technical structure. Osedo et al⁴ reported that primary school students with high motor skills could correctly perform self-assessment regarding

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the neck spring skill. Shimizu et al⁵ showed that skilled college students had better observational abilities than unskilled beginners regarding the front hip circle. In addition, top athletes typically have a better kinesthetic sense. Individuals who are able to move properly are therefore considered to understand their own movement.

The relationship between understanding and performing the movement can be classified into 4 combinations: (1) the subject can perform the movement through understanding, (2) the subject cannot perform the movement through understanding, (3) the subject can perform the movement without understanding, and (4) the subject cannot perform the movement without understanding. In practical motor learning, proper instruction was not effective unless the learner understood the movements and tasks. Motor learning can be conducted without requiring learners to understand their movements or having them understand ideal movements. However, it is difficult to accurately determine the learner's degree of understanding under these circumstances. Self-evaluation methods have therefore been used in many previous studies and actual physical education classes. It is difficult for teachers to determine the degree of student understanding since children themselves are not typically able to grasp detailed information between movements. For example, the ability to self-evaluate pulling the elbow behind the shoulder to perform a throwing motion may be differently ascertained according to skill level. It is possible that such measuring criteria are unclear and different for each child. In addition, few studies have determined whether target movements were performed correctly.⁶ It was therefore necessary to evaluate the extent to which students were able to recognize the target movement in addition to their own movements for effective exercise instruction.

This study set the standing long jump as the basic movement. The standing long jump is an important physical fitness test used to determine power and jumping ability among the lower limbs. Its development process is well-researched.⁷⁻¹¹ Previous studies have revealed that the standing long jump nearly becomes an adult-like behavior at approximately 9 years of age.⁷⁻¹¹ This is based on movement patterns, the movement range of joints, and motion analysis. However, there is an increasing number of children who are uncoordinated, obese/lean, and with low physical strength. It is thus necessary to provide effective instruction on basic motor skills through movements such as the standing long jump. Therefore, this study examined the relationship between movement

recognition and actual movement as well as how accurately students were able to recognize their movements when performing the standing long jump.

Methods

Subjects

A total of 11 (ie, 4 boys and 7 girls) healthy elementary school children from 10 to 11 years of age participated in this study. Male subjects were 144.8 ± 6.8 cm in height, 34.0 ± 4.6 kg in weight, and 164.5 ± 21.1 cm in the standing long jump, while female subjects were 138.0 ± 10.3 cm in height, 31.7 ± 4.9 kg in weight, and 150.7 ± 12.2 cm in the standing long jump.

Procedures

This study's movement task was standing long jump. Subjects were first provided with instruction by viewing a video displaying the target movement. The reference points for movement were referred to from a study by Hiruma and Ueya¹² as follows: (1) shake the arms wide and recoil, (2) jump with the knees tightly bent, and (3) put the feet in front of the body while holding the knees.

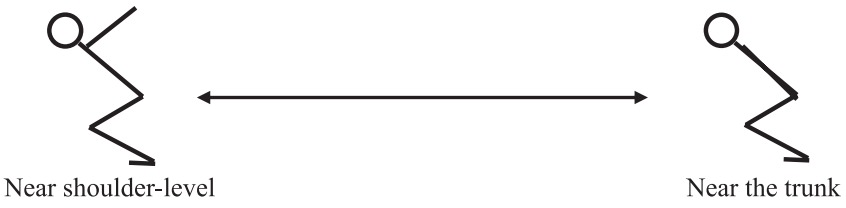
After watching the video, participants were asked about their recognition of the target movement according to the images. Each participant then performed an appropriate physical warm-up before the researchers attached a total of 12 markers: the left and right side ulnar styloid processes, humeral medial epicondylar, acromion, greater trochanter, and femoral lateral epicondyle and lateral malleolus, respectively. They then performed one trial jump. These events were used to calculate their actual movements using a 3-dimensional real-time motion analysis system (VENUS 3D-100A, Nobbytech, Tokyo, Japan). After the trial, subjects answered a questionnaire about recognition of their own movements as a self-evaluation.

Measurements

Measurements were taken as follows: (1) the maximum shoulder angle when the arm swings backward before the railroad crossing (hereafter referred to as the maximum shoulder angle before jumping), (2) the knee flexion angle at the time of railway crossing, (3) the maximum shoulder angle when jumping, and (4) the angle between the perpendicular from the acromion and the line segment connecting the acromion to the lateral malleolus. Recognition of the target movement and students' own movements were investigated using a visual

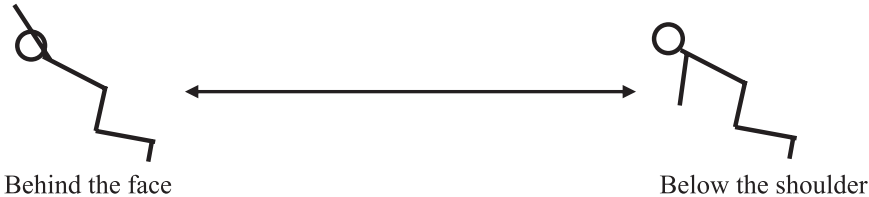
Points 1 Shake the arm sufficiently and recoil

Q1. How far backward did the arm swing?



Near shoulder-level Near the trunk

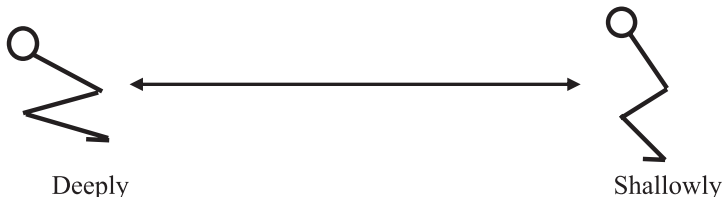
Q2. How far backward did the arm swing after the jump?



Behind the face Below the shoulder

Point 2 Jump with the knees tightly bent

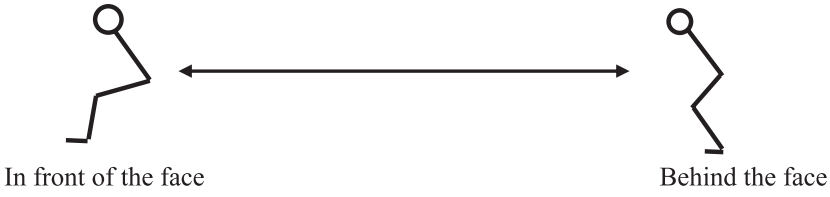
Q3 How far did you bend your knees just before jumping?



Deeply Shallowly

Point 3 Put the feet out front while holding the knees

Q4 How far did you get on your feet?



In front of the face Behind the face

Figure 1. Questionnaires.

analog scale. The questionnaire is available in Figure 1. Visual analog scale has previously been used as an index to assess pain.¹³ In recent years, it has also been used to evaluate the sense of motion (eg, the appearance

of 1-dimensional sport movement angles)¹⁴⁻¹⁶ Reports have indicated that reproducibility within the individual subject is high and that similar evaluations can thus be performed as relative measurements among them.¹⁷

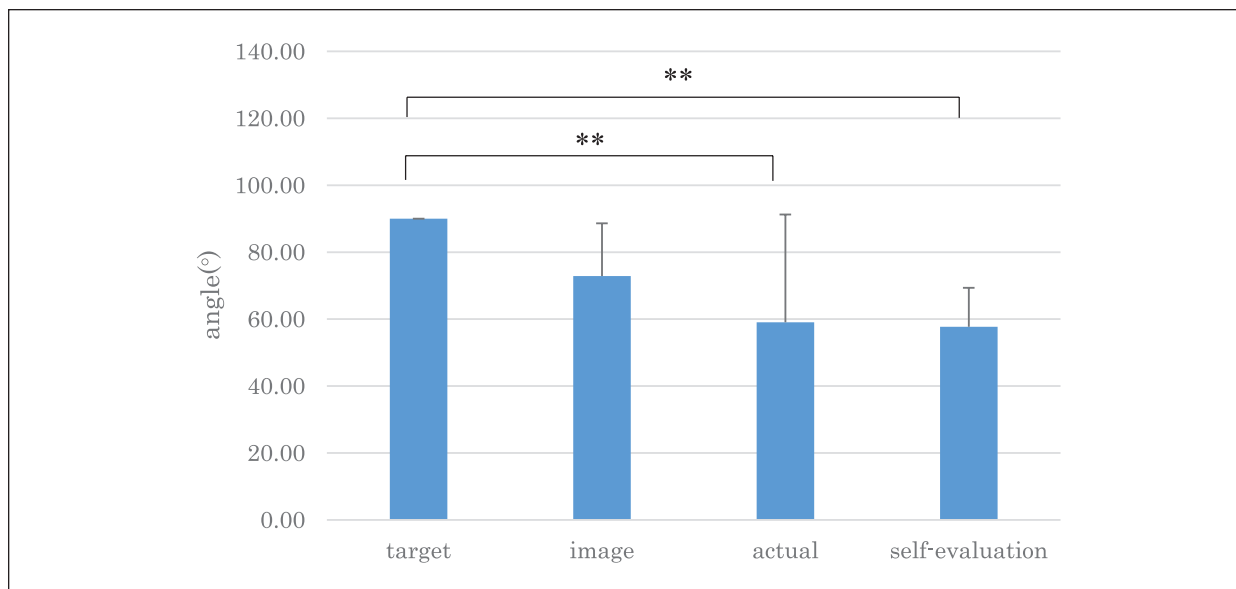


Figure 2. Maximum shoulder angle before jumping.
** $p < .01$.

Statistics

All data shown are mean \pm standard deviation. Ideal movement values, ideal movement recognition, actual movement, and recognition of one's own movements were calculated. A 1-way analysis of variance (ANOVA) was performed for the statistical treatments. If the F value was significant, a multiple comparison test was conducted. The level of significance was less than 5%.

Ethical Approval and Informed Consent

We explained the intents and methods of this study to subjects and their parents before measurements were taken. Informed consent was obtained before proceeding. This research was also approved by the Research Ethics Committee of the Graduate School of Education, Hiroshima University, on October 10, 2017. We were not granted an institutional review board/reference number. Informed consent was implied voluntary participation of parents and children.

Results

Difference Between Self-Recognition and Actual Movement

Figure 2 shows the maximum shoulder angle before jumping. The results of the 1-way ANOVA showed significant differences among the target, image, actual, and self-evaluation procedures ($F[3, 40] = 7.003$,

$P < .001$, partial $\eta^2 = 0.344$). The target movement (hereafter referred to as the target), recognition of the target movement (hereafter referred to as the image), actual movement (hereafter referred to as the actual), and the recognition of one's own movements (hereafter referred to as self-evaluation) are also shown in Figure 2. The maximum shoulder angle before jumping was largest in the target and successively decreased for the image, actual, and self-evaluation. The target angle was significantly larger than that of the image ($P < .01$) and self-evaluation ($P < .01$), respectively.

Figure 3 shows the knee flexion angle at the time of railway crossing. The results of the 1-way ANOVA showed significant differences among the target, image, actual, and self-evaluation procedures ($F[3, 40] = 22.509$, $P < .000$, partial $\eta^2 = 0.628$). The knee flexion angle successively decreased for the actual, target, self-evaluation, and image. The target angle was significantly larger than that of the image ($P < .001$) and self-evaluation ($P < .01$), while the image was significantly lower than that of the actual ($P < .001$).

Figure 4 shows the maximum shoulder angle during jumping. The results of the 1-way ANOVA showed significant differences among the target, image, actual, and self-evaluation procedures ($F[3, 40] = 22.523$, $P < .000$, partial $\eta^2 = .628$). Here, the target angle was significantly larger than that of the actual ($P < .001$), while the actual angle was significantly lower than that of the image ($P < .001$) and self-evaluation ($P < .01$), respectively.

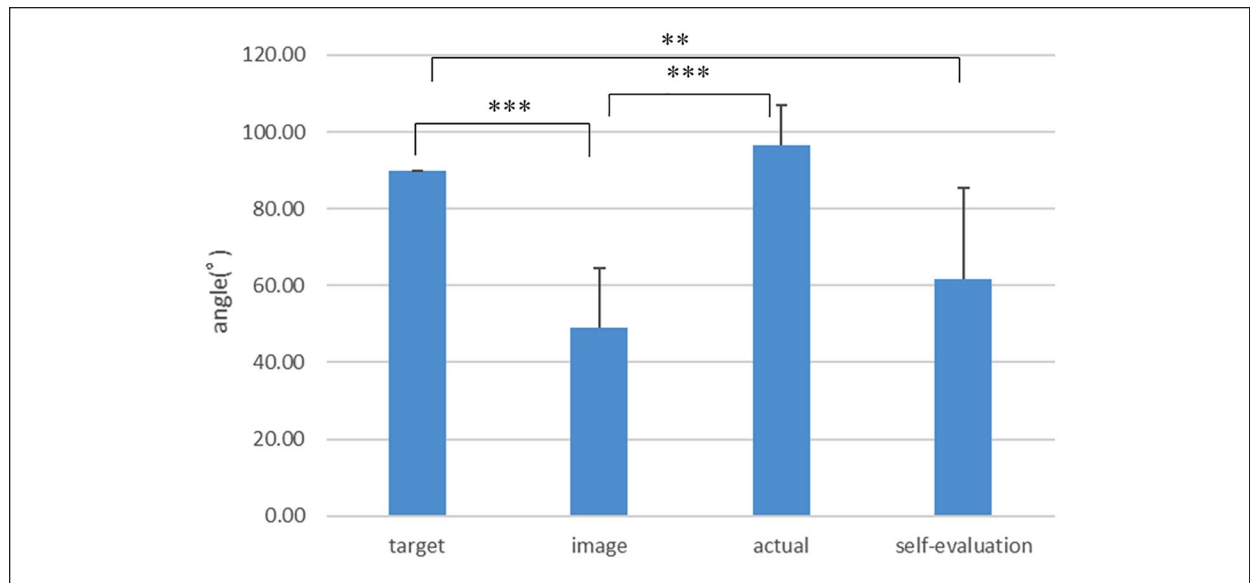


Figure 3. Knee flexion angle at the time of railway crossing.
 $**P < .01$, $***P < .001$.

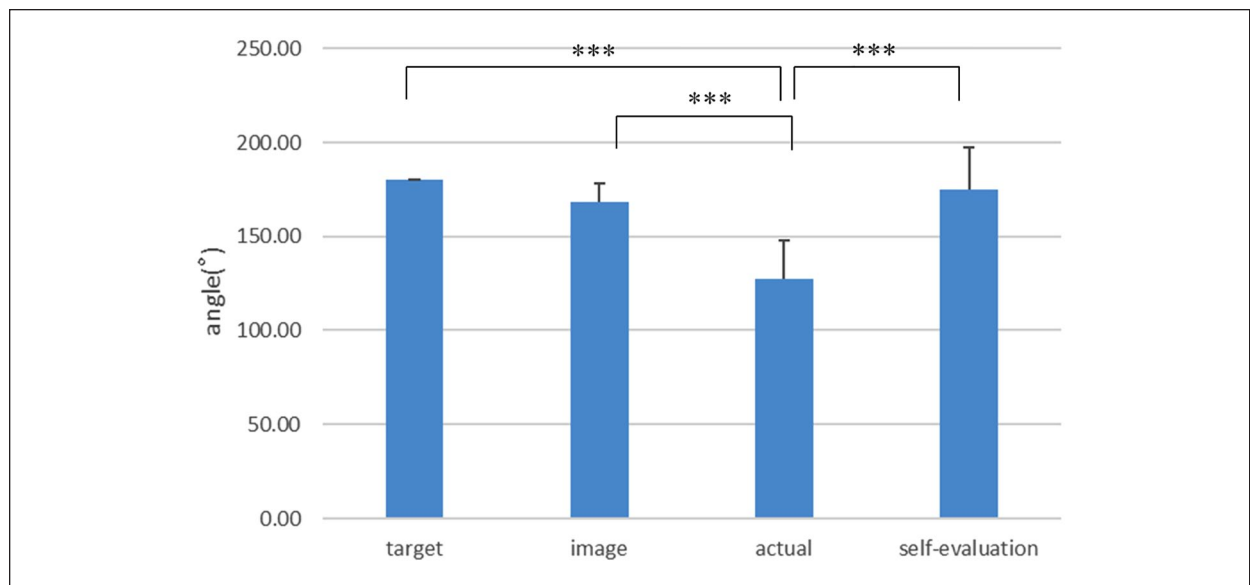


Figure 4. Maximum shoulder angle while jumping.
 $***P < .001$.

Figure 5 shows the angle between the perpendicular from the acromion and the line segment connecting the acromion to the lateral malleolus. The results of the 1-way ANOVA showed significant differences among the target, image, actual, and self-evaluation procedures ($F[3, 40] = 6.395$, $P < .001$, partial $\eta^2 = 0.324$). This angle successively decreased for the target, image, self-evaluation, and actual. The target angle was significantly

larger than that of the actual and self-evaluation, respectively ($P < .05$).

Relationship Between Self-Evaluation and Performance

Tables 1 through 4 show the correlation coefficients among the performance, target, image, actual, and

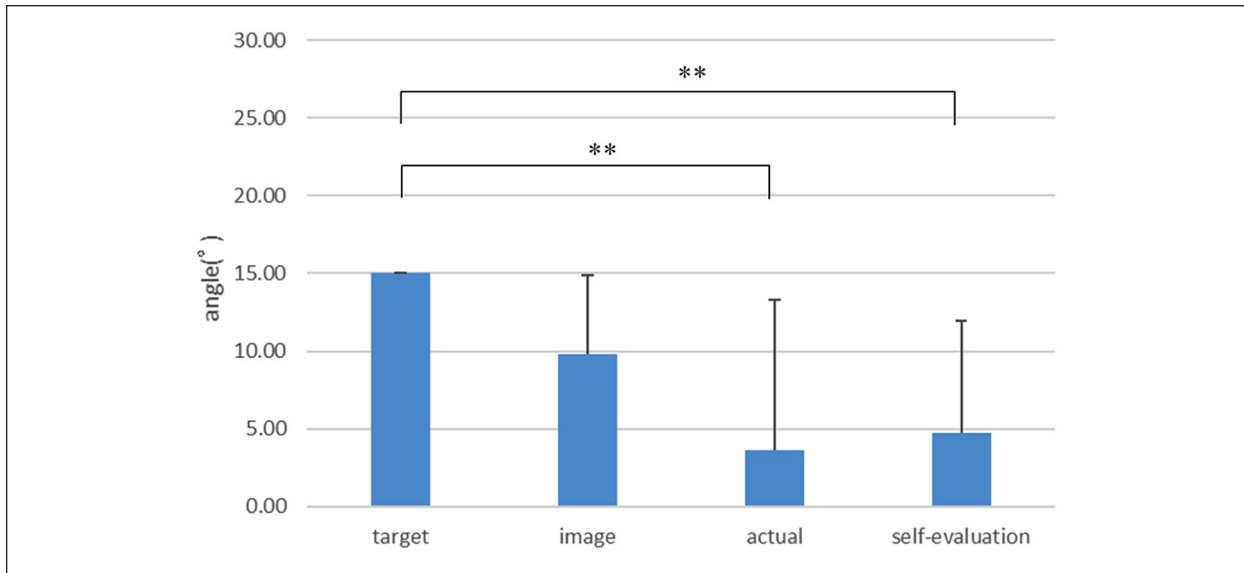


Figure 5. Landing angle.

** $P < .01$.

Table 1. Correlation Coefficients Among Performance, Image, Actual, and Self-Evaluation Regarding Maximum Shoulder Angle Before Jumping.

	Performance	Image	Actual	Self-Evaluation
Image	-0.166			
Actual	0.120	0.076		
Self-evaluation	-0.220	0.553	-0.119	

self-evaluation for the maximum shoulder angle before jumping (Table 1), at the time of railway crossing (Table 2), at the maximum shoulder angle during jumping (Table 3), and at the angle when throwing the legs forward (Table 4). The image had a relatively high correlation with self-evaluation in relation to both the knee flexion and landing angles.

Discussion

The basic movements of the long jump are running, jumping, and throwing the legs forward. The standing long jump also consists of preliminary crouching, a subsequent swinging up of the arms, and extension of the hip, knee, and ankle. The difference between a vertical jump and a standing long jump is that the jump involves a kick to produce horizontal speed while jumping.¹⁸ Kim and Matsuura¹⁹ reported that the level of coordination greatly affected the standing long jump; a high correlation was found between performance and movement. Although the standing long jump is a simple movement,

Table 2. Correlation Coefficients Among Performance, Image, Actual, and Self-Evaluation Regarding the Knee Flexion Angle at the Time of Railway Crossing.

	Performance	Image	Actual	Self-Evaluation
Image	-0.172			
Actual	0.313	0.046		
Self-evaluation	0.230	0.728*	0.477	

* $P < .05$.

Table 3. Correlation Coefficients Among Performance, Image, Actual, and Self-Evaluation Regarding the Maximum Shoulder Angle During Jumping.

	Performance	Image	Actual	Self-Evaluation
Image	-0.064			
Actual	-0.117	0.157		
Self-evaluation	-0.237	0.516	0.225	

Table 4. Correlation Coefficients Among Performance, Image, Actual, and Self-Evaluation Regarding the Angle When Throwing Legs Forward.

	Performance	Image	Actual	Self-Evaluation
Image	0.236			
Actual	0.552	0.587		
Self-evaluation	0.398	0.718*	0.255	

* $P < .05$.

it is necessary to link the upper limbs, lower limbs, and trunk. The movement has been widely used in previous studies on child motor development.

Recorded standing long jumps and joint angles among this study's participants were nearly the same as those in other studies among subjects of the same age.^{7,8} This study compared the target movement (target), recognition of the target movement (image), actual movement (actual), and recognition of one's own movements (self-evaluation) during the standing jump. Current results indicated that the image was consistently lower than the target. In particular, the target knee flexion angle was significantly lower than that of the image; they were underestimated with regard to the target. There was no significant difference between the actual and self-evaluation except for maximum shoulder angle during jumping. That is, except for the maximum shoulder angle during jumping, the subjects could recognize their movements with relative accuracy. However, other items that participants self-evaluated were lower than the actual movements. Subjects consistently underestimated the image in relation to the target, but there was a tendency to self-evaluate movements as being identical to those in the image. This is most likely because images were presented to students by a teacher or model during physical education classes, thus making it difficult to understand without emphasizing the teaching points.

This study classified the relationship between understanding a movement and performing it through examination of the relationships between the target, image, actual, and self-evaluation during the standing long jump. The results revealed 2 points. One is that there was no difference between the target and image (the only exception being the knee flexion angle). The other is that there was no difference between the actual and the self-evaluation (the exception being the maximal shoulder angle during jumping). On the other hand, there was a gap between either the target and image or the actual and self-evaluation in cases where students did not understand their own movements. Participants also tended to self-evaluate that their movements were close to those in the image. It was thus considered necessary to firmly and exaggeratedly indicate the target to help determine whether the actual movements could be performed correctly.

There was a close relationship between the target and image when subjects were able to perform the movement. Conversely, subjects were not able to perform the movement when there was a large gap between the target and actual. Considering each point of the standing long jump in this study's framework, it was thought that subjects who were unable to perform the movement had

trouble with either (1) the maximum shoulder angle before jumping, (3) the maximum shoulder angle during jumping, or (4) the landing angle. Since there was no significant difference between the target and image, but significant differences were detected between the target movements and actual movements involved in them, it is thought that subjects were able to correctly identify movements in the image even though they had difficulty performing them.

In relation to (2), the maximum knee flexion angle, there were significant differences between the target and image. However, since there was no significant difference between the target and actual, it was thought that this movement was imaged in a difficult manner, but was easily performed. Subjects did not correctly recognize the target movement in this study. This is because each child's timing may have been different. It is inferred that subjects created an angle deeper than the target by focusing on the maximum sinking angle, but did not focus on the angle while jumping. It was necessary to provide subjects with verbal instruction on this point for them to correctly recognize the target.

There were significant differences between the target and image, the image and actual, as well as between the actual and self-evaluation, for (3) the maximum shoulder angle during jumping. It was thought that subjects could perform this movement without correctly understanding the target and actual. A significant difference was seen for (3) the maximum shoulder angle during jumping; the angle of the actual and was 50° lower than that of the self-evaluation. Because there was no significant difference between the image and self-evaluation, subjects self-evaluated incorrectly. It was therefore unnecessary to objectively observe subjects' movements to understand that there was a gap not only between the target and actual, but also between the image and self-evaluation.

There were obvious points of ease and difficulty for subjects when imagining the movements as well as easy and difficult portions of the movement itself. The easier points to image were the target of (1) maximum shoulder angle before jumping, (3) maximum shoulder angle during jumping, and (4) the landing movement (these were also easier points to evaluate regarding their own movements). Combined, these provided an easier target to achieve. These results are similar to those from Fukuda's study,²⁰ which presented the difference between self-evaluation and actual movement when throwing. It is thought that fewer points of instruction are better when teaching physical activity because children do not typically understand the multiple actual movements required to complete the full movement at the same time.²⁰ Moreover, it became clear that there was a point at which it was difficult for subjects to

correctly imagine the target in addition to a point at which it was difficult to correctly evaluate the movements performed in this study.

This study examined correlations among the 4 indices of the standing long jump. There was no significant correlation between performance and image or actual and self-evaluation at any of the 4 points. This may indicate that subjects did not understand their own movements at current skill levels, even when their performance levels were high. That is, the image of the target task is an important condition and index for properly modifying their movements during physical education lessons. Elementary school students should have similar abilities to understand movements even with variable levels of physical fitness and motor skill. Therefore, demonstrating exercise tasks appears to provide sufficient guidance. However, it was considered necessary for the instructor to demonstrate and emphasize the movements to ensure accurate teaching points.

However, there was also a high correlation between image and self-evaluation regarding the knee flexion and landing angles. This indicates that participants did not move correctly as a result of guidance that only pointed out incorrect movements in cases where the actual deviated from the target or image. A moderate correlation was found between performance and landing angle. It was thought that the landing angle was easy to understand but difficult to perform.

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 Validation: Misako Yasue, Takeshi Ueda, Tomohiro Fukuda, Tatsuya Adachi, Yusuke Ozaki.
 Visualization: Misako Yasue.
 Writing – original draft: Misako Yasue.
 Writing – review & editing: Takeshi Ueda.

Declaration of Conflicting Interests

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