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Original Article

Effects of an external foci of attention at different distances on standing long jump in non-athletes

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Abstract. [Purpose] External focus (EF) instructions demonstrate a learning effect on motor performance enhancement. However, the effective EF distance during standing long jump performance of non-athletes has not been clarified. This study aimed to determine the effects of EF at different distances on jumping performance. [Participants and Methods] A total of 40 non-athlete participants were randomly divided among four groups. The no attention line group performed a standing long jump without the attention line on the floor; those in the −20-cm EF group, the ± 0-cm EF group, and +20-cm EF group performed the jump attention line with an attention line 20-cm posterior, at ± 0 cm, and 20-cm anterior as the reference jump distances, respectively. [Results] The mean rate of increase between the first to second jump distances in the +20-cm EF group was higher than that in the no attention line group. The rates at which the jumpers reached the attention line in the ± 0-cm EF group and the +20-cm EF group were lower than the rate in the −20-cm EF group. [Conclusion] Instructions are more effective when the distance to the attention line exceeds jumping performance.
Key words: Attentional focus, External focus, Standing long jump

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INTRODUCTION

In motor learning, attention focus instructions affect motor performance improvements[1, 2)]. Attention foci include internal focus (IF) and external focus (EF); the focus of attention is directed to the movement of own body part or the body in the former, while it is directed to the equipment used during exercise or the external environment remote from the body in the latter.

In an exercise different from jump, Chiviacowsky et al.[3)] have reported that gravimetric fluctuation is smaller when attention is focused on a marker placed on a horizontal table compared with when attention is focused on the participant's feet; moreover, fluctuation is smaller when attention is focused on a marker placed outside, rather than inside, the left and right feet[4)]. These results indicate that EF is more effective than IF regardless of whether the equipment is in direct contact with the player.

In a motor task of hitting a tennis ball, thrown by a tennis ball machine, with a tennis racket toward a target, a higher score can be achieved when the focus of attention is placed on the ball trajectory from where it is hit by the racket to the target rather than from where it comes out of the machine to where it is hit by the racket[5)]. In this example, both attention foci correspond to EF; therefore, this finding demonstrates that different EF methods produce different motor learning effects.

Meanwhile, in a study using the standing long jump task, Coker[6)] reported that the jump distance increased when the participant focused on jumping as close as possible to a cone placed 3-m anterior compared to when the participant focused

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on extension motions of arms and knees during the jump. Lotfi[7] reported that the jumping distance of standing long jump in athletes was the longest when the attention line was pulled to a distance of 4 m, which is equivalent to the distance that athletes cannot jump. These results indicate that EF is more effective than IF for improving performance in standing long jump; however, the individual effective distance between the attention focus and the participant remains unclear.

In previous studies on attention foci, EF has been shown to produce a better motor learning effect than IF through their simple comparisons. However, these studies did not include comparisons between appropriate and inappropriate EF and, thus, did not specify how far the individual attention focus should be for effective EF in non-athletes. Therefore, for the maximum improvement of motor performance, it is essential to clarify effects of different distances to the target used in EF on motor learning. Therefore, this study aimed to clarify effects of EF of attention at individual different distances on jump performance of non-athletes.

PARTICIPANTS AND METHODS

All participants agreed to participate in this research after receiving an explanation of its purpose and content and all the risks involved. The study was conducted in accordance with the principles of the Declaration of Helsinki for experimentation with humans, and was approved by the Ethics Committee for Human Experiments of the Nittazuka Medical Welfare Center (No. 201958).

A total of 40 participants who are non-athletes were included in this study (20 males and 20 females; age, 20.5 ± 1.5 years; height, 166.6 ± 9.0 cm; and weight, 61.1 ± 11.0 kg).

The participants were randomly divided into four groups (five males and five females each): no attention line group, −20-cm EF group, ± 0-cm line group, and +20-cm EF group. A standing long jump was performed as follows: the participants stood barefoot, with their feet being shoulder-width apart and toes aligned to the balkline, and jumped forward using both feet simultaneously without a running start. The jump distance was measured as the length of straight line connecting a point of balkline at the center of the left and right feet to the landing position of the heel closer to the balkline.

The participants performed a reference jump without a target object whenever they were ready, and this jump distance was used as the reference jump distance for the attention line. Then, the participants in the no attention line group performed the standing long jump with no attention line; the participants in the −20-cm EF group, ± 0-cm line group and +20-cm EF group performed the standing long jump with an attention line placed at −20 cm (posteriorly), ± 0 cm, and +20 cm (anteriorly) to the reference jump distance. Immediately before each attempt, all participants were instructed verbally to jump with all of their strength. The attention to the attention line was left to the participant's discretion. The interval between the jumps was 3 minutes. The participants performed two sets of reference jump and jump with EF or jump without attention line (Fig. 1).

After the experiment, the following parameters were calculated: mean distance of reference jump, mean increase rate of reference jump distance from the first set to the second set, each mean increase rate of jump distances with EF and without attention line from the first set to the second set, and the rate of jump distance reaching the attention line. In order to analyze whether the EF line of attention that we originally created is related to the jump distance, except for the no attention line group without attention line, the correlation between the attention line position and the jump distance with EF was examined.

Data are shown as mean and standard deviation. One-way analysis of variance was used to compare physical parameters and pre-jump distances of the participants between the groups; the Bonferroni method was used for parameters with significant differences. Dunnett's multiple comparison test was used to assess rates of increases in the post-jump distance. Pearson's correlation coefficient was used to identify any correlation between the attention line position and the post-jump distance. The significance levels used were <5% and <1%.

RESULTS

There were no significant intergroup differences in height, body weight, and body mass index as physical characteristics of the participants (Table 1).

There were no significant differences distances of reference jumps performed under the common condition with no attention line among the groups (Table 2).

There were no significant differences in the mean increase rate of reference jump distance from the first set to the second set among the groups (Table 2).

For jumps after the reference jump, which the participants in the respective groups performed under different conditions, the each mean increase rate of jump distances with EF and without attention line from the first to second set was significantly higher in the +20-cm EF group than in the no attention line group ($p<0.05$), while there was no difference between the −20-cm EF group and the ± 0-cm EF groups (Table 2).

The mean ratio of the jump distance with EF to the attention line distance in the ± 0-cm EF group and the +20-cm EF group was significantly lower than that in the −20-cm EF group ($p<0.01$); this ratio in the +20-cm EF group was significantly lower than that in the ± 0-cm EF group ($p<0.01$) (Table 2).

In the three groups of the participants who jumped with an attention line, there was a significant strong positive correlation between the attention line distance and the jump distance with EF (r=~0.957–0.996, $p<0.001$) (Table 3).

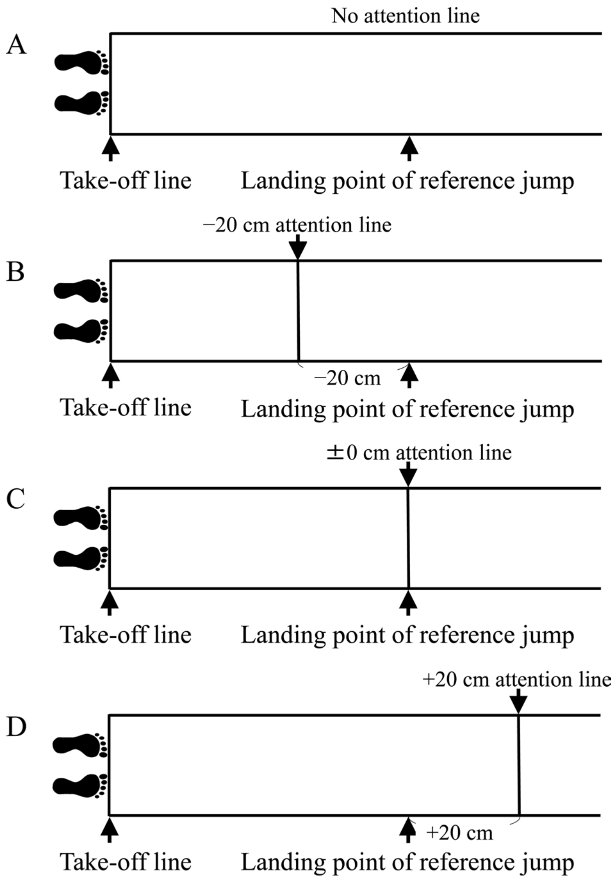

Fig. 1. Position of the attention line in each group.
A: No attention line group, B: −20 cm line group, C: ± 0 cm line group, D: +20 cm line group.

Table 1. Physical measurement parameter of the study participants (n=40)

Characteristic	No attention line (n=10)	−20-cm EF (n=10)	±0-cm EF (n=10)	+20-cm EF (n=10)
Height (cm)	164.9 ± 7.9	166.8 ± 9.9	167.8 ± 8.0	166.9 ± 9.4
Weight (kg)	59.6 ± 12.9	63.1 ± 10.5	59.3 ± 8.1	62.4 ± 11.0
BMI (kg/m^2)	21.7 ± 2.8	22.6 ± 2.9	21.0 ±2.2	22.3 ± 2.7

Data are expressed as mean ± standard deviation. BMI: body mass index.
Differences were tested using the Bonferroni correction as post-hoc analysis. There was no significant difference between the four groups in all physical measurement parameters.

Table 2. Comparison of the four groups in each variable of jump distance (n=40)

Variables	No attention line (n=10)	−20-cm EF (n=10)	±0-cm EF (n=10)	+20-cm EF (n=10)
Mean distance of reference jump (cm)	185.7 ± 35.7	190.8 ± 37.6	189.9 ± 24.3	194.1 ± 38.5
Mean increase rate of distance in reference jump (%)	104.0 ± 6.4	100.9 ± 8.3	103.7 ± 3.8	105.2 ± 6.4
Mean increase rate of distance in jump with EF (%)	101.3 ± 3.8	101.0 ± 3.5	104.4 ± 3.1	106.5 ± 7.7*
Mean reaching rate to the attention line in jump with EF (%)	−	113.2 ± 2.5	104.4 ± 2.9†	96.1 ± 5.7†$

Data are expressed as mean ± standard deviation. *Significant difference between the no attention line and +20-cm EF groups (p<0.05). †Significant difference between the −20-cm EF group and other two groups (p<0.01). $Significant difference between the −20-cm EF and +20-cm EF groups (p<0.01).

Table 3. Correlation between distance of attention line and distance of jump with EF (n=30)

Groups	Correlation coefficient
−20-cm EF (n=10)	0.996†
± 0-cm EF (n=10)	0.978†
+20-cm EF (n=10)	0.957†

Pearson's correlation coefficient †p<0.01.

DISCUSSION

The results of this study showed no significant intergroup differences in height and body weight of the participants, reference jump distance, and the rate of increase in reference jump distance. These results demonstrate that there were no statistical differences in characteristics of the groups at the reference jump stage. In other words, the jump with/without EF condition was the only difference in the group characteristics, and observed differences in the jump with/without EF distance are presumably attributable to differences in the jump with/without EF condition among the groups.

In this study, participants performed standing long jumps with an attention line placed at varying distances from the body. The rate of increase in jump distance was high when the attention line was farthest from the body, and it was low when the attention line was closest to the body. However, a previous study on attention focus has shown that the motor learning effect was improved by EF with an attention focus close to the body[8)]. In studies using these tasks, attention foci were very close to the body, and the distance from the body to the attention focus did not differ significantly between EF and IF. Nevertheless, many studies have shown the motor learning effects of EF. Those results suggest that EF of attention close to the body produces the motor learning effect in motor tasks in which the body does not move from a fixed position but not in motor tasks in which the body position moves, as in the present study.

In this study, the rate of increase in the jump distance was high when the attention line was placed farther than the jump distance without intervention. The results indicate that jump performance improves more when the distance to attention line exceeds the participant's jumping performance compared with when the distance to attention line is lower than the participant's jumping performance.

Ducharme et al.[9)] compared the motor learning effects of EF and IF using standing long jump as a motor task and found no differences in peak force and impulse values during jumping, although the jump distance was longer for EF; they attributed this result to the fact that the projection angle of EF was closer to the optimal projection angle. Wulf et al.[10)] compared the motor learning effects of EF and IF using vertical jump as a motor task and showed that EF achieved a higher jump and lower activities of anterior tibialis, biceps femoris, vastus lateralis, rectus femoris, and gastrocnemius muscles; based on these results, they suggested that EF promotes coordinated muscle activity. Together, these findings suggest that the EF effects observed in this study may involve the promotion of coordinated muscle activity and autoregulation to the optimal projection angle.

There was a strong correlation between the distance to the attention line and the jump distance in this study. A previous study reported that the motor learning effect of IF was lower than that of EF and that the performance level of the IF group was decreased compared with that of the control group receiving no IF instructions[11, 12)]. The low motor learning effects of IF have been attributed to interference to automatic motor control of the body due to attention to the local motor sensation of the body. Conversely, EF has been suggested to improve automatic motor control[13)]. These results can be explained by "the constrained action hypothesis". IF involves intentional intervention to the normal motor control process through exercise with attention to the body; as a result, it interferes with the effective and efficient motion control processes, which essentially work unconsciously. EF, on the other hand, directs attention to the outcome of exercise and maximizes the use of automatic motor control unconsciously and reflexively to facilitate the whole-body automatic motor control[14, 15)]. Based on the above hypothesis, the EF effect observed in our study is presumably attributed to the maximal use of systemically automatic motor control, which is enhanced when distance to the attention line is longer, i.e., when this distance exceeds the participant's jumping performance, resulting in the improvement of motor performance.

Conflict of interest

The authors declare no conflicts of interest associated with this study.

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