J. Phys. Ther. Sci. 35: 738–742, 2023

The Journal of Physical Therapy Science

Original Article

# Immediate effects of verbal instructions with internal focus of attention and external focus of attention on forward reach movement while standing

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**Abstract.** [Purpose] This study aimed to examine the immediate effects of verbal instructions with an internal and external focus of attention on forward reach movement while standing. [Participants and Methods] Thirty-seven healthy young males performed reach movement in three conditions: control, internal focus of attention, and external focus of attention. The measurements recorded were the movement distance of the third metacarpal bone (reach distance), the distance of the center of pressure, and the movement angles between the acromion and malleolus lateralis and between the acromion and trochanter major. [Results] Compared to the control condition, the internal focus of attention condition had a lower reach distance, angles between the acromion and malleolus lateralis and between the acromion and trochanter major, and center of pressure distance. In contrast, compared to the control condition, the external focus of attention condition showed higher reach distance and angles between the acromion and malleolus lateralis and between the acromion and trochanter major. The change rate of reach distance in the internal and external focus of attention conditions correlated significantly with the change rates of the angles between the acromion and malleolus lateralis and between the acromion and trochanter major. [Conclusion] Verbal instructions with attentional focus resulted in the simultaneous adjustment of the positional relationship between trunk and hip and immediately affected the reach distance. Our findings suggest that verbal instruction with attentional focus is an important factor affecting reach movement.

**Key words:** Verbal instruction, Reach movement, Focus of attention

*(This article was submitted Jul. 4, 2023, and was accepted Aug. 9, 2023)*

## INTRODUCTION

Verbal instructions by physical therapists can affect the patient's exercise performance. In particular, verbal instructions are frequently used by physical therapists as a cue to facilitate the effectiveness of intervention[1)]. Studies have demonstrated that verbal instructions provided prior to the start of movements can help improve the movements[2)]. A study suggested that verbal instructions provided externally by the instructor, which differ from spontaneous "shout" while exerting effort[3)], facilitate attentional focus and improve movements[4)].

Attentional focus induced by instructions is classified into two categories: instruction directing attention to performers' movements or body parts (internal focus of attention; IFA) and instruction directing attention to the effects of the individual's

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movements on the environment (external focus of attention; EFA)[2]. A previous review[5] suggested that attentional focus with IFA or EFA affects muscle activity[6–8], muscle strength[8, 9], postural balance[4, 10–12], accuracy of movements[7, 13], and movement velocity[14], and that EFA has a better effect than IFA in improving exercise performance. Wulf et al.[4] proposed the constrained action hypothesis to explain the differential effects of IFA and EFA on exercise performance. According to this hypothesis, utilization of IFA by performers may constrain or interfere with the automatic control processes that would normally regulate the movement, whereas EFA allows the motor system to more naturally self-organize[4]. This hypothesis is supported by previous studies that have examined the effects of attentional focus on performance[5, 15]. In addition, a previous study using a postural balance task suggested that EFA reduced postural sway during the task and that movement performed with EFA demanded less attention than that performed with IFA[4].

However, Gray[16] suggested that the effect of attentional focus varies depending on the motor skills and that IFA is more effective than EFA for beginners compared to experts. Other studies have found that IFA may enable immediate optimization of postural coordination in Parkinson's disease[17], and that the effects of IFA and EFA on performance vary depending on differences in the patterns of muscular activity[6, 18]. Thus, it seems plausible that verbal instruction based on IFA and EFA may have specific effects depending on the characteristics of the subject and task. In addition, the effects of verbal instructions on postural balance have been verified using static standing balance, while there is limited evidence of the effects on postural balance during movements involving center of mass shifts within the base of support. Thus, there is a need to further study the task-specific effects of verbal instructions based on IFA and EFA. In particular, the specific effects of verbal instructions with IFA and EFA on reach movement while standing have not been clarified. Of note, reach movement while standing is the basic movement required to perform activities of daily living, and it is used as one of the outcome measures for physical therapy interventions for various diseases[19–25]. Furthermore, the effects of verbal instructions are classified into the immediate effects[6–9] by giving attentional focus and the fixed-term effects[4, 10, 12, 13] by training with attentional focus over a certain period. The immediate effects refer to the immediate changes in performance after giving attentional focus, whereas the fixed-term effects refer to the changes in performance by training with attentional focus over a specific period and include the immediate effects. In order to verify the fixed-term effects of verbal instructions with attentional focus, it is necessary to examine the immediate effect of instructions with attentional focus.

Therefore, the purpose of this study was to examine the immediate effects of verbal instructions with IFA and EFA on forward reach movement while standing in healthy young males in order to establish foundational knowledge about the intervention of reach movement using IFA and EFA in clinical settings.

## PARTICIPANTS AND METHODS

Thirty-seven healthy young males (mean age 20.8 ± 1.0 years; mean height 171.6 ± 5.4 cm; mean weight 65.9 ± 10.2 kg) with no neurological or orthopedic diseases participated in this study. Written informed consent was obtained from each participant and ethics approval was obtained from the Institutional Review Board of Kyorin University (approval number: 2019-1).

All participants performed the functional reach test (FRT)[26] twice in each of the following three conditions: the control condition without attentional focus (CC), the condition with IFA (IC), and the condition with EFA (EC). According to a previous study about the FRT[27], a movable rod with small plate was used to determine the starting position and the maximum reaching position. Participants were required to touch a small plate at the end of the rod with their right fingertip in standing upright position, and to push the plate forward in all conditions. The verbal instruction in each condition was composed of brief sentences, referring to definitions from a previous study[1, 2]. The instruction in CC was: "Reach as far as possible". The instruction in IC was: "Reach as far as possible while bending forward as much as possible without pulling your hips back as much as possible". The instruction in EC was "Reach as far as possible while pushing your target as far away as possible". The order of three conditions randomized for each participant to exclude order effects of attentional focus.

The methods for measurement of reach distance and movement angles in the FRT were based on a previous study[28]. All participants wore tight-fitting elasticated clothes, and surface reflective markers were attached over the head of the third metacarpal bone, acromion, anterior superior iliac spine, trochanter major, and malleolus lateralis on the right side. The starting position for the FRT was standing adjusted by foot width combined with shoulder width, 90° flexion position of the shoulder joint, full extension of the elbow joint, and intermediate position of the forearm between pronation and supination. Participants stood on stabilometer (Zebris, PDM-S system, Isny im Allgäu, Germany), and reach movements were captured using a digital video camera (Sony, Tokyo, Japan, HDR-PJ630V, total number of pixels: 5.43 million, effective pixels for video: 5.02 million) from start to completion of the FRT. Based on the video record, digital photography at the start position and at maximum reach were tracked; then, a combination of the images and measurement of each movement were performed using Image J software (the National Institutes of Health). The measurements recorded were the movement distance of the third metacarpal bone (reach distance), the distance of center of pressure (COP distance), and the movement angles recorded were between the acromion and malleolus lateralis (A-M angle), between the acromion and trochanter major (A-T angle), and between the trochanter major and malleolus lateralis (T-M angle). The movement angles were measured as the angle formed by the line connecting the two points at the starting position and at the maximum reaching position. COP distance was measured as the maximum movement distance of COP at the maximum reaching position. Distances and movement angles in the FRT were expressed as plus (+) for the forward movement and minus (−) for the backward movement.

The data were analyzed using statistical analysis software R2.8.1. The level of significance was predetermined to be $p<0.05$ for all statistical analyses. Firstly, the mean values for each condition were calculated, and the normality of distribution was assessed using the Shapiro–Wilk test. Secondly, those values were compared between the three conditions using one-way repeated measures analysis of variance (ANOVA) followed by post-hoc Bonferroni's method for multiple comparisons. Finally, the change rates of measurements in IC or EC (difference between each condition and CC divided by CC) were computed, and the correlation between each change rate was assessed by calculating Pearson's correlation coefficient.

## RESULTS

The mean values for each condition were calculated, and the normality of distribution was confirmed by the Shapiro–Wilk test. All measurements were compared between three conditions using one-way repeated measures ANOVA, and there were statistically significant differences between all conditions ($p<0.01$). The results of multiple comparisons showed that reach distance, A-M angle, A-T angle, and COP distance in IC were significantly lower compared with those in CC. Reach distance, A-M angle, and A-T angle in EC were significantly higher, and T-M angle in EC was significantly lower compared with those in CC. In addition, reach distance, A-M angle, A-T angle, and COP distance in EC were significantly higher and T-M angle in EC was significantly lower compared with those in IC (Table 1). Compared to CC, the reach distance showed an average 15% (average 53.4 mm) decrease in IC, and an average 9% (average 31.1 mm) increase in EC.

Pearson's correlation coefficients between the change rates of measurements in IC or EC were calculated. The change rate of reach distance in IC showed significant positive correlation with the change rates of A-M angle ($r=0.95$), A-T angle ($r=0.86$), and COP distance ($r=0.46$). On the other hand, the change rate of reach distance in EC showed significant positive correlation with the change rates of A-M angle ($r=0.92$) and A-T angle ($r=0.77$) (Table 2).

## DISCUSSION

This is first study that examined the task-specific effects of verbal instructions with IFA and EFA on forward reach movement while standing. The influence of IFA and EFA may depend on the characteristics of tasks and participants, and it was unknown whether either instruction affects reach movement. In this study, reach distance, which is the typical outcome of reaching movement, was significantly higher in EC than in CC, but significantly lower in IC. This result suggested that verbal instruction based on EFA may help increase the reach distance by adjusting the relative position of each body segment during reach movement. Our results are consistent with the findings of a previous review[5)] and meta-analysis[15)] which suggested that EFA facilitates higher performance during exercise than IFA.

**Table 1.** Comparison of measurements between three conditions

| | 1<br>CC<br>Mean ± SD | 2<br>IC<br>Mean ± SD | 3<br>EC<br>Mean ± SD | Multiple comparisons<br>1–2 | <br>1–3 | <br>2–3 |
|---|---|---|---|---|---|---|
| Reach distance (mm) | 348.6 ± 49.0 | 295.2 ± 55.3 | 379.7 ± 43.0 | 2 < 1** | 1 < 3** | 2 < 3** |
| A-T angle (°) | 39.7 ± 7.3 | 33.6 ± 7.5 | 44.0 ± 6.4 | 2 < 1** | 1 < 3** | 2 < 3** |
| T-M angle (°) | −3.2 ± 2.6 | −2.4 ± 2.2 | −4.1 ± 2.3 | 1 < 2 | 3 < 1* | 3 < 2** |
| A-M angle (°) | 16.3 ± 2.3 | 13.9 ± 2.8 | 18.0 ± 2.4 | 2 < 1** | 1 < 3** | 2 < 3** |
| COP distance (mm) | 133.5 ± 25.3 | 121.6 ± 28.1 | 132.3 ± 24.8 | 2 < 1** | 3 < 1 | 2 < 3** |

*p<0.05; **p<0.001.
CC: the control condition; IC: the internal focus condition; EC: the external focus condition; SD: standard deviation; A-T angle: acromion-trochanter major angle; T-M angle: trochanter major-malleolus lateralis angle; A-M angle: acromion-malleolus lateralis angle; COP: center of pressure.

**Table 2.** Pearson's correlation coefficients between the change rates of measurements in IC or EC

| | | A-T angle | T-M angle | A-M angle | COP distance |
|---|---|---|---|---|---|
| Reach distance | IC | 0.86* | −0.05 | 0.95* | 0.46* |
| | EC | 0.77* | 0.06 | 0.92* | 0.11 |

*p<0.01. Date indicates the correlation coefficients (r).
IC: the internal focus condition; EC: the external focus condition; A-T angle: acromion-trochanter major angle; T-M angle: trochanter major-malleolus lateralis angle; A-M angle: acromion-malleolus lateralis angle; COP: center of pressure.

In terms of the movement angles, EC had significantly higher A-M angle and A-T angle, and significantly lower T-M angle than CC. The reach distance showed strong correlation with A-M angle and A-T angle, but it showed no significant correlation with T-M angle or COP distance. Especially, A-M angle showed a stronger correlation with the change rate of reach distance than A-T angle, suggesting that the forward tilt angle of the trunk against feet was more effective in increasing the reach distance than hip. Previous study reported that the movement strategy affects the association between reach distance and COP distance during the FRT, and that reach distance is not always significantly correlated with COP distance in the hip strategy[29]. Furthermore, it was suggested that the hip strategy increases reach distance by moving pelvis backward and increasing the forward trunk tilt angle[29]. Our results suggest that reach distance increased without changing COP distance in EC, because EFA facilitated the hip strategy that secured an increase in the forward trunk movement against the hip and feet by moving the pelvis backward.

Regarding the effect of EFA on exercise performance, Wulf et al. suggested that EFA facilitates the improvement of motor skills by facilitating higher degree of automaticity and less conscious interference[4], which is supported by previous studies[5, 15]. There is a paucity of studies on the neurophysiological effects of EFA, but Kuhn et al. reported that EFA prompts increased cortical inhibition in the primary motor cortex, and that EFA improves performance by affecting motor-related areas[30]. The increased reach distance observed in EC in the present study may potentially be attributable to the effect of EFA on motor-related areas and improved automaticity of postural control.

On the other hand, IC had significantly lower reach distance, A-M angle, A-T angle, and COP distance than CC. The reach distance showed significant correlation with A-M angle, A-T angle, and COP distance. Moreover, in IC, the A-M angle showed stronger correlation with the change rate of reach distance than A-T angle; this suggested that the forward tilt angle of the trunk against feet was more effective in increasing the reach distance than hip, similar to that observed in EC. Previous study indicated that reach distance is positively correlated with COP distance when using the ankle strategy or a combination of hip and ankle strategies[29]. Our results suggest that in IC, the reach distance decreased without changing the T-M angle, which indicates the movement of pelvis, because IFA facilitated the movement strategy that increased the forward trunk tilt angle while minimizing backward movement of pelvis similar to the ankle strategy; however, IFA decreased the forward trunk movement against feet and the forward movement of COP. The reach distance in IC was reduced compared to CC despite the promotion of the forward trunk tilt, which is important for reach movement[29]. This reduction of reach distance in IC might be due to the effect of IFA in constraining or interfering with automatic control processes during reach movement based on the constrained action hypothesis[4]. In addition, verbal instruction in IC was focused on movements of trunk and hip in order to simultaneously minimize backward movement of pelvis and maximize the forward trunk tilt. Therefore, the task of the simultaneous adjustment of trunk and hip position to enable an increase in the forward trunk tilt was challenging even for healthy young males, and instruction in IC might confuse their postural control during reach movement.

The results of this study suggested that verbal instructions with IFA and EFA have an immediate effect on reach movement and that the movement strategies and reach distance differ according to instructions given before the start of the movement. Therefore, the types and contents of verbal instructions are an important factor in the accurate evaluation of reach movement. Verbal instruction with EFA may facilitate an increase in reach distance by increasing the forward tilt angle of the trunk against hip and feet, and enhance effectiveness of intervention aimed at improving reach movement.

Some limitations of this study should be acknowledged. The limitation of this study is that it was conducted in healthy young males. The reach distance and the forward trunk tilt decreased in IC, while previous studies reported that IFA may be effective depending on the characteristics of participants[16, 17]. Therefore, similar studies are required in the elderly population and patients with various diseases to demonstrate the generalizability of our findings. Moreover, we did not measure brain activity during the movement, so it is not possible to make clear reference to the effects of IFA and EFA on brain activity or neurological mechanisms.

This study examined the immediate effects of verbal instructions with IFA and EFA for forward reach movement while standing in healthy young males. Reach distance was significantly higher in EC than in CC, but significantly lower in IC. In addition, the reach distance showed a strong correlation with the forward tilt angle of the trunk against hip and feet in both IC and EC. Our findings suggest that verbal instruction with attentional focus is one of the important factors that may affect the outcomes of physical therapy interventions to improve reach movement.

### *Conflict of interest*

There is no conflict of interest.

## REFERENCES


1) Johnson L, Burridge JH, Demain SH: Internal and external focus of attention during gait re-education: an observational study of physical therapist practice in stroke rehabilitation. Phys Ther, 2013, 93: 957–966. [Medline] [CrossRef]

2) Wulf G, Shea C, Lewthwaite R: Motor skill learning and performance: a review of influential factors. Med Educ, 2010, 44: 75–84. [Medline] [CrossRef]

3) Ikai M, Steinhaus AH: Some factors modifying the expression of human strength. J Appl Physiol, 1961, 16: 157–163. [Medline] [CrossRef]

4) Wulf G, McNevin N, Shea CH: The automaticity of complex motor skill learning as a function of attentional focus. Q J Exp Psychol A, 2001, 54: 1143–1154. [Medline] [CrossRef]

5) Wulf G: Attentional focus and motor learning: a review of 15 years. Int Rev Sport Exerc Psychol, 2013, 6: 77–104. [CrossRef]
6) Vance J, Wulf G, Töllner T, et al.: EMG activity as a function of the performer's focus of attention. J Mot Behav, 2004, 36: 450–459. [Medline] [CrossRef]
7) Zachry T, Wulf G, Mercer J, et al.: Increased movement accuracy and reduced EMG activity as the result of adopting an external focus of attention. Brain Res Bull, 2005, 67: 304–309. [Medline] [CrossRef]
8) Marchant DC, Greig M, Scott C: Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions. J Strength Cond Res, 2009, 23: 2358–2366. [Medline] [CrossRef]
9) Marchant DC, Greig M, Bullough J, et al.: Instructions to adopt an external focus enhance muscular endurance. Res Q Exerc Sport, 2011, 82: 466–473. [Medline] [CrossRef]
10) Chiviacowsky S, Wulf G, Wally R: An external focus of attention enhances balance learning in older adults. Gait Posture, 2010, 32: 572–575. [Medline] [CrossRef]
11) Wulf G, Landers M, Lewthwaite R, et al.: External focus instructions reduce postural instability in individuals with Parkinson disease. Phys Ther, 2009, 89: 162–168. [Medline] [CrossRef]
12) McNevin NH, Shea CH, Wulf G: Increasing the distance of an external focus of attention enhances learning. Psychol Res, 2003, 67: 22–29. [Medline] [CrossRef]
13) Wulf G, Lauterbach B, Toole T: The learning advantages of an external focus of attention in golf. Res Q Exerc Sport, 1999, 70: 120–126. [Medline] [CrossRef]
14) Porter JM, Nolan RP, Ostrowski EJ, et al.: Directing attention externally enhances agility performance: a qualitative and quantitative analysis of the efficacy of using verbal instructions to focus attention. Front Psychol, 2010, 1: 216. [Medline] [CrossRef]
15) Kim T, Jimenez-Diaz J, Chen J: The effect of attentional focus in balancing tasks: a systematic review with meta-analysis. J Hum Sport Exerc, 2017, 12: 463–479. [CrossRef]
16) Gray R: Attending to the execution of a complex sensorimotor skill: expertise differences, choking, and slumps. J Exp Psychol Appl, 2004, 10: 42–54. [Medline] [CrossRef]
17) Beck EN, Almeida QJ: Dopa-responsive balance changes depend on use of internal versus external attentional focus in Parkinson disease. Phys Ther, 2017, 97: 208–216. [Medline] [CrossRef]
18) Marchant DC, Greig M: Attentional focusing instructions influence quadriceps activity characteristics but not force production during isokinetic knee extensions. Hum Mov Sci, 2017, 52: 67–73. [Medline] [CrossRef]
19) Rockwood K, Awalt E, Carver D, et al.: Feasibility and measurement properties of the functional reach and the timed up and go tests in the Canadian study of health and aging. J Gerontol A Biol Sci Med Sci, 2000, 55: M70–M73. [Medline] [CrossRef]
20) Rosa MV, Perracini MR, Ricci NA: Usefulness, assessment and normative data of the Functional Reach Test in older adults: a systematic review and meta-analysis. Arch Gerontol Geriatr, 2019, 81: 149–170. [Medline] [CrossRef]
21) Muir-Hunter SW, Graham L, Montero Odasso M: Reliability of the berg balance scale as a clinical measure of balance in community-dwelling older adults with mild to moderate Alzheimer disease: a pilot study. Physiother Can, 2015, 67: 255–262. [Medline] [CrossRef]
22) Trautwein S, Maurus P, Barisch-Fritz B, et al.: Recommended motor assessments based on psychometric properties in individuals with dementia: a systematic review. Eur Rev Aging Phys Act, 2019, 16: 20. [Medline] [CrossRef]
23) Merchán-Baeza JA, González-Sánchez M, Cuesta-Vargas AI: Reliability in the parameterization of the functional reach test in elderly stroke patients: a pilot study. BioMed Res Int, 2014, 2014: 637671. [Medline] [CrossRef]
24) Moore JL, Potter K, Blankshain K, et al.: A core set of outcome measures for adults with neurologic conditions undergoing rehabilitation: a clinical guideline. J Neurol Phys Ther, 2018, 42: 174–220. [Medline] [CrossRef]
25) Steffen T, Seney M: Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. Phys Ther, 2008, 88: 733–746. [Medline] [CrossRef]
26) Duncan PW, Weiner DK, Chandler J, et al.: Functional reach: a new clinical measure of balance. J Gerontol, 1990, 45: M192–M197. [Medline] [CrossRef]
27) Hasmann SE, Berg D, Hobert MA, et al.: Instrumented functional reach test differentiates individuals at high risk for Parkinson's disease from controls. Front Aging Neurosci, 2014, 6: 286. [Medline] [CrossRef]
28) Suzuki T, Hashisdate H, Fujisawa Y, et al.: Reliability of measurement using Image J for reach distance and movement angles in the functional reach test. J Phys Ther Sci, 2021, 33: 112–117. [Medline] [CrossRef]
29) Liao CF, Lin SI: Effects of different movement strategies on forward reach distance. Gait Posture, 2008, 28: 16–23. [Medline] [CrossRef]
30) Kuhn YA, Keller M, Ruffieux J, et al.: Intracortical inhibition within the primary motor cortex can be modulated by changing the focus of attention. J Vis Exp, 2017, 11: 127. [Medline]