Turk J Kin 2017; 3(2): 26-30
www.turkishkinesiology.com **Original Research**

The effect of attentional focus strategies on children performance and their EMG activities in maximum a force production task

Ramin Ashraf [1], Mohammad Taghi Aghdasi [2], Mansor Sayyah[3]

[1] *Department of Human Motor Behavior, Faculty of Physical Education, University of Shahid Beheshti, Tehran, Iran.*
[2] *Faculty of Education and Psychology, University of Tabriz, Iran*
[3] *College of Medicine, Kashan University of Medical Sciences, Kashan, Iran.*

Abstract. Research has demonstrated the effectiveness of adopting external focus of attention compared to internal focus of attention in children's motor performance and learning. The purpose of present study was to determine whether the external focus of attention had any effect on efficiency (reduction of EMG activity) of children's motor performance. The participants (twenty 8-10-year-old children) first performed vertical jump task in the control condition, then performed under two conditions in a counterbalanced order: external attentional focus and internal attentional focus. In the control condition, the participants performed vertical jump without giving attentional focus instruction. In the external focus condition, the participant's attention was directed to the rungs of a measurement device, namely, Vertec and in the internal focus condition, their attention was directed to their fingers with which they were to touch the rungs. The participants performed 8 vertical jumps in every three conditions and the heights of their jumps were measured. In addition, EMG activity of various muscles (anterior tibialis, biceps femoris, vastus lateralis, rectus femoris, and gastrocnemius) was measured when participants jumped, using electromyography. Results showed that the external focus of attention led to significantly better performance (higher vertical jump) compared to internal focus and control conditions. Also, in the external focus condition, EMG activity was significantly reduced compared to internal the focus and control condition. This present study suggests that adopting external attentional focus will improve effectiveness and efficiency of children's movement in tasks which require maximum force production.

Keywords. Children, EMG, external focus, internal focus, vertical jump.

Introduction

It has been specified that external focus of attention compared to the internal one has benefited movement efficiency and effectiveness (for reviews, see Wulf, 2007a, 2007b, Marchant, 2012). Numerous studies have indicated such advantages for variety of sport skills including Gulf (e.g., Wulf & Su, 2007), basketball (e.g., Zachry et al., 2005), Dart (e.g., Marchant et al., 2007), as well as various motor skills such as vertical jump (e.g., Wulf et al., 2010) and standing long jump (Porter et al., 2010).

In addition, benefits of adopting external focus relative to control condition (without attentional focus) were seen in some studies (e.g., Landers et al., 2005; Marchant et al., 2006; Wulf et al., 2009; Wulf & McNevin, 2003; Wulf et al., 2003; Ashraf et al., 2012).

One of the factors that may explain the efficiency of movement result on external focus of attention more clearly was the reduction of muscular activity. While most of attentional focus studies have remained at the behavioral level, some studies examined this issue in the muscular activity level. For instance, Vance et al. (2004) used a biceps-curl task, with performers being instructed to focus either on the movements of the curl bar (external focus) or of their arms (internal focus). The results showed that muscular activity (i.e., as measured by electromyography, EMG) was significantly reduced in the external relative to the internal focus condition. As the weight lifted was identical under both conditions, this finding indicated that movements were performed more efficiently with an external attentional focus. Zachry et al. (2005) examined EMG activity during basketball free throw when participant adopted an external focus (basket) compared to an internal focus (wrist motion). Their findings showed that free-throw accuracy was enhanced under the external focus condition. In addition, EMG activities were reduced not only in the muscle group that participant focused on but also reduced in the muscle group that participant were not specifically instructed to focus on. Marchant et al. (2006) extended Vance et al. (2004) findings by showing that instructing participants to external focus (on the curl bar) resulted in less EMG activity not only in those who were instructed to focus on their arms but also those with no focus instruction (control condition). All of other studies examined the effect

Corresponding Author: R. Ashraf, e-mail; raminashraf88@gmail.com

To cite this article: Ashraf R, Aghdasi MT, Sayyah M. The effect of attentional focus strategies on children performance and their EMG activities in maximum a force production task. Turk J Kin 2017; 3(2): 26-30.

of attentional focus on the muscular activity by using different tasks showing that muscular activity were reduced as a function of attentional focus (e.g., Marchant et al., 2009a, 2009b; Wulf & Dufek, 2009; Wulf et al, 2010; Lohse et al, 2011).

Results of these studies suggest that external focus enable individuals to produce greater and more accurate force with less muscular activity (therefore improved movement efficiency) and finally resulting in improved outcome. The predominant explanation for the effect of attentional focus centers on the idea that an internal focus induces conscious control and constrains the motor system whereas an external focus promotes automaticity in movement control (''constrained action hypothesis''; Wulf et al., 2001). Support for this notion has been provided by these researchers through other studies (e.g., McNevin et al., 2003; Wulf et al., 2001). This assumption implies that an external focus leads to a more advanced stage of learning faster– where performance is not only more effective but the movement efficiency is enhanced as well (Wulf, 2007b).

These studies have employed adult participants and for the purpose of generalizing the results to the children we need to take into account the psychological differences between the adult and children. Michelene (1976) suggests that what appears to be a STM capacity limitation in children is actually a deficit in the processing strategies as well as a deficit in processing speeds. It is well recognized that children have different information processing capabilities compared to adults (Pollock & Lee, 1997). Children differ in their cognitive processes such as selective attention (Tipper et al., 1989) and speed of information processing (Chuah & Maybery, 1999; Ferguson & Bowey 2005). In addition, children use different strategies to process information compared to adults in tasks that require higher-level attention focusing (Karatekin et al., 2007; Mantyla et al., 2007). These differences in cognitive and psychological ability can contribute to motor performance and learning differences between children and adults and can raise an issue for further consideration or discussion over the generalizability of motor learning principles derived primarily from adults (e.g. attentional focusing instructions) to children (Sullivan et al., 2008). Moreover, children may not have the attention span or attentional capacity to follow instructions while executing a motor performance. Alternatively, they might have a natural propensity to the outcome of their actions, making external focus instructions essentially redundant (Wulf, 2007).

There are studies that were designed to examine the effect of attentional focusing instruction on children motor learning and performance (Thorn, 2006; Emanuel et al., 2007; Ashraf et al., 2012; Chiviacowsky et al., 2012). Thorn (2006) examined the balance performance and learning of 9-12 year old children using internal and external focus of attention strategies with a balance task. Result of this study showed that there are some benefits for children when adopting an external focus of attention. Emanuel et al. (2007) examined effect of focus of attention on motor performance and learning (dart throwing) in children and adults. The findings suggest that external focus is more effective than internal focus in adults, but perhaps directing the children's attention internally would be more effective; however, further study is needed to make firm conclusion. Recently, Chiviacowsky et al. (2012) demonstrated that instructions that induce an external focus of attention can enhance motor learning in children with IDs. Also Ashraf et al. (2012) examined effect of external and internal focus of attention on children's vertical jump task. Result revealed that children's jump height increased in the external focus of attention condition compared to control and internal focus of attention condition.

Although the effectiveness of external attentional focus on children motor learning and performance seems reasonable, the efficiency of external attentional focus on children's motor learning and performance is not well established. Thus, in this study the researcher used vertical jump task for measuring performance and used electromyography for measurement of EMG activity in the lower extremity muscles in children. The hypothesis was that jump height would increase and EMG activity in the lower extremity muscles would be reduced in the external compared to the control and internal focus condition.

Methods

Participants

Twenty healthy and physically active volunteer male students (mean age 9 ± SD: 0.94years) participated in the study. They were not aware of the specific purpose of the study. Informed consent was obtained from all the participants and their parents before the start of the experiment.

Apparatus and task

Digital vertical jumping tester (JC - D100) was used to record vertical jump-and-reach height. It consisted of a digital displaying system and touch board (consist of a series of horizontal plastic rungs incrementally spaced (1cm) at different heights) in which the participants reached for during maximum counter-movement jumps. The participants were asked to stand with their dominant hand closest to the Vertec. From a standing position, the subjects reached up with their dominant hand along the spine of the measurement device. The height of the device was then adjusted so that the lowest rung was 12 in. from the extended fingertips of the participant. EMG activity during the jump was obtained from Biometrics Ltd EMG System (Type: P3X8) with surface electrodes (Inc., 2.5 cm center-to-center distance). EMG data were analyzed with Data Log PC Software (Version 5.06).

Procedure

The participants were instructed to jump straight up and touch the highest rung they could reach with the tips of the fingers of their dominant hand. They were free to warm up and practice sub-maximally until they felt comfortable with the equipment, protocol, and technique. Following the practice and instruction, participants were instrumented with EMG electrodes. Standard EMG skin preparation methods were utilized including shaving and lightly abrading the skin with alcohol to reduce electrical impedance. The electrodes were positioned to record the activity of five right lower extremity muscles including: rectus femoris (RF), biceps femoris (BF), vastus lateralis (VL), lateral gastrocnemius (LG), and the anterior tibialis (AT). The electrodes were positioned using anatomic surface landmarks and palpation in accordance with methods recommended in the literature (Konrad, 2005). Anatomical function of each of the five muscles selected for evaluation is given in Table 1.

Table 1
Anatomical function of muscles evaluated.

Muscle	Action(s)
Anterior tibialis (AT)	Ankle dorsi flexion, inversion
Biceps femoris (BF)	Hip joint extension, knee joint flexion
Vastus lateralis (VL)	Knee joint extension
Rectus femoris (RF)	Hip joint flexion, knee joint extension
Lateral gastrocnemius (LG)	Knee joint flexion, ankle plantar flexion

Each participant performed 8 jumping trials under each of the internal, external focus and control conditions with the general instruction to reach as high as possible during each jump. The participants first performed vertical jump task in the control condition, then performed under other two conditions in a counterbalanced order: external attentional focus and internal attentional focus. In the control condition, the participants performed vertical jump without giving attentional focus instruction and in internal focus conditions, participants were instructed to concentrate on the tips of their fingers, whereas under external focus conditions, they were instructed to concentrate on the rungs. Attentional focus reminders were given before each trial. After the attentional focus reminder, the participant jumped when he was ready. In the selection of muscles and design of experiment we used study of Wulf and colleagues (2010).

Dependent variables and data analysis

The experimenter recorded the highest rung touched for each jump displayed digitally. EMG amplitude was first corrected by removing DC-bias from the signal. The RMSE of the EMG signal during the jump phase was calculated for each muscle and trial.

Jump-and-reach height and EMG RMSE were averaged across the 8 trials. Jump height was analyzed by using one-way analysis of variance (ANOVA). EMG RMSE was analyzed in 3 (Attentional Focus: control, internal, external) ∗5 (Muscles: AT, BF, VL, RF, LG) MANOVA-repeated measures on the first factor.

Results

Vertical jump height

The result of analysis indicated that the type of attention focusing strategy significantly changed the Jump-and-reach height (F (2, 38) =30.09, p=0.001, η= 0.613). Post hoc analysis using LSD revealed that Jump-and-reach height was significantly higher in the external focus condition (26.05cm, SE = 2.45) compared to the internal (24.75 cm, SE = 2.38) and control conditions (24.92 cm, SE = 2.22) (see Figure 1).

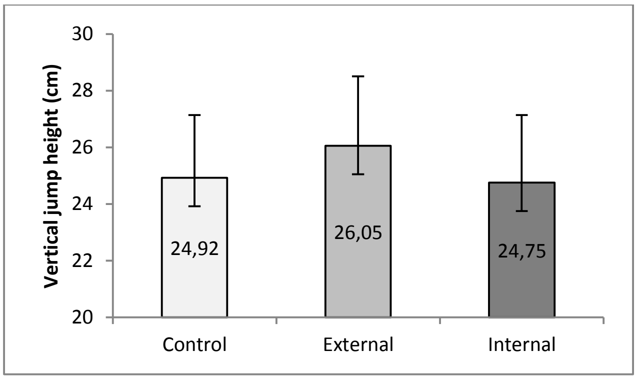

Figure 1. Jump-and-reach height as a function of internal versus external focus.

EMG RMSE

The results showed that the main effect of attentional focus was significant (F (2,38) = 93.02, p= 0.001, η= 0.495). Post hoc analysis by LSD revealed that EMG RMSE was significantly lower in the external condition compared to the internal (MD= -12.34, p= 0.001) and control conditions (MD= -18.58, p= 0.001).In addition, muscle main effect was also significant (F (4, 95) =9.83, p= 0.001, η= 0.293). LSD Post-hoc tests indicated that AT had significantly larger RMSE than BF and VL, but no significant difference from RF and LG was observed. Moreover, BF had significantly lower RMSE than RF, VL from RF and LG. None of the other differences were significant. The interaction of focus and muscle was not significant (F (8, 190) = 1.96, p= 0.053, η= 0.076).

Discussion

Numerous studies have showed movement efficiency and effectiveness of adopting the external focus of attention compared to the external focus of attention in adult participants. Effectiveness of adopting the external focus in children's movement was seen in some studies (Thorn, 2006; Ashraf et al., 2012; Chiviacowsky et al., 2012). The goal of the present study was to examine the generalizability of the advantage of external focus on movement efficiency in children performance. Thus, this is the first study to address the movement efficiency and effectiveness of attentional focus in children's jump performance. The researcher used the vertical jump-and-reach task which previous studies with adult participants have demonstrated increase in jump height, vertical COM displacement, impulse and joint moments and also decrease in EMG activity with an external focus (Wulf & Dufek, 2009; Wulf et al., 2007; Wulf et al., 2010). In addition, a control condition was employed in this study. Consistent with those previous results, it was found greater jump heights in the external compared to the internal focus condition in children's vertical jump. This advantage of external focus was also present when compared to the control condition. This result showed that children in the force production tasks would better perform jumping when adopting external focus rather than adopting the internal one. Increase in the children's vertical jump as a result of external focus was consistent with studies of Thorn (2006), Ashraf et al. (2012) and Chiviacowsky et al. (2012) which showed that external focus for children is better than internal focus. Based on these results, it was concluded that an external focus of attention compared to the internal focus conveys an advantage in movement effectiveness in children performance.

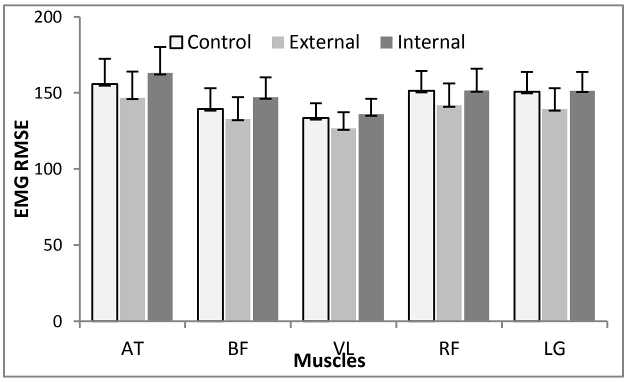

Figure 2. EMG root-mean-square error (RMSE), from muscle onset to takeoff, for the various muscles as a function of internalversus external focus (AT = tibialis anterior; BF = biceps femoris; VL = vastus lateralis; RF = rectus femoris; LG = lateralgastrocnemius).

Several studies with adult participants have showed this advantage in various motor tasks (e.g., Marchant et al., 2009a, Wulf & Dufek, 2009; Wulf et al, 2010; Lohse et al, 2011). We also found this effect in selected muscles when participants were instructed to focus on the rungs (external focus) instead of their fingers (internal focus), which resulted in generally lower EMG activity. As predicted by constrained action hypothesis, if attention is directed to the effect or outcome of on action, there should be a greater coherence between the outcome and the sensory consequences of the action. This greater sensory-motor coherence allows the motor system to adjust more adaptively to task demands. As a result, only the minimally necessary number of motor units required to produce a desired outcome would be recruited (Wulf, 2007b). These effects were seen in the present study and confirmed the constrained motor action in the children performance in the maximum force production task.

Acknowledgements

The authors would like to thank Professor Gabriele Wulf and Professor Abbas Bahram for their fruitful comments.

References

Ashraf R, Aghdasi MT, Sayyah M, Taghibiglo N. The effects of internal and external focus of attention on children`s performance in vertical jump task. International Journal of Basic Sciences & Applied Research 2012; 1(1): 1- 7.

Chiviacowsky S, Wulf G, Avila LTG. An external focus of attention enhances motor learning in children with intellectual disabilities. Journal of Intellectual Disability Research 2012; doi: 10.1111/j.1365-2788.2012.01569.x.

Chuah YM, Maybery MT. Verbal and spatial short term memory: common sources of developmental change? Experimental Child Psychology, 1999; 73: 7-44.

Emanuel M, Jarus T, Bart O. Effect of focus of attention and age on motor acquisition, retention, and transfer: A randomized trial. Physical Therapy 2007; 88: 1-10.

Ferguson AN, Bowey JA. Global processing speed as a mediator of developmental changes in children's auditory memory span. Experimental Child Psychology 2005; 91: 89-112.

Karatekin C, Marcus DJ, Couperus JW. Regulation of cognitive resources during sustained attention and working memory in 10-year-olds and adults. Psychophysiology 2007; 44: 128-144.

Konrad P. The ABC of EMG. Noraxon: Scottsdale, AZ. Retrieved July 29, 2009, from http://www.demotu.org/aulas/ ABC of EMG.pdf, 2005.

Landers M, Wulf G, Wallmann H, Guadagnoli MA. An external focus of attention attenuates balance impairment in Parkinson's disease. Physiotherapy 2005; 91: 152–185.

Lohse KR, Sherwood DE, Healy AF. Neuromuscular effects of shifting the focus of attention in a simple force production task. Journal of Motor Behavior 2011; 43: 173–184.

Mantyla T, Carelli MG, Forman H. Time monitoring and executive functioning in children and adults. Journal of Experimental Child Psychology 2007; 96: 1-19.

Marchant DC, Greig M, Scott C. Attentional focusing strategies influence bicep EMG during isokinetic biceps curls. Athletic Insight. Retrieved July 11, 2009, from http://www.athleticinsight.com/Vol10Iss2/MuscularActivity.htm, 2009b.

Marchant D, Clough P, Crawshaw M. The effects of attentional focusing strategies on novice dart throwing performance and their task experiences. International Journal of Sport and Exercise Psychology 2007; 5: 291–303.

Marchant D, Greig M, Scott C. Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions. Journal of Strength and Conditioning Research 2009a; 23: 2358–2366.

Marchant D, Greig M, Scott C, Clough P. Attentional focusing strategies influence muscle activity during isokinetic bicep curls. In Poster presented at the annual conference of the

British Psychological Society. Cardiff, UK, 2006.

McNevin NH, Shea CH, Wulf G. Increasing the distance of an external focus of attention enhances learning. Psychological Research, 2003; 67: 22-29.

Michelene TH. Short-term memory limitations in children: Capacity or processing deficits? Memory & Cognition 1976; 4(5): 559-572.

Pollock BJ, Lee TD. Dissociated contextual interference effects in children and adults. Perceptual Motor Skills 1997; 84: 851-858.

Porter J, Ostrowski EJ, Nolan RP, Wu WF. Standing long-jump performance is enhanced when using an external focus of attention. Journal of Strength and Conditioning Research 2010; 24(7): 1746-1750.

Sullivan KJ, Kantak SS, Burtner PA. Motor learning in children: feedback effects on skill acquisition. Physical Therapy 2008; 88: 720-732.

Thorn J. Using attentional strategies for balance performance and learning in nine through 12 year olds. Doctoral Dissertation, Florida State University, Rellahassee, 2006.

Tipper SP, Bourque TA, Anderson SH, Brehaut JC. Mechanisms of attention: a developmental study. Experimental Child Psychology 1989; 48: 353-378.

Vance J, Wulf G, Tollner T, McNevin NH, Mercer J. EMG activity as a function of the performer's focus of attention. Journal of Motor Behavior 2004; 36: 450-459.

Wulf G. Attentional focus and motor learning: A review of 10 years of research (target article). E-Journal Bewegung and Training 2007a; 1: 1–74.

Wulf G. Attention and motor skill learning. Champaign, IL: Human Kinetics, 2007b.

Wulf G, Dufek JS. Increased jump height with an external focus due to enhanced lower extremity joint kinetics. Journal of Motor Behavior 2009; 41: 401–409.

Wulf G, McNevin NH. Simply distracting learners is not enough: More evidence for the learning benefits of an external focus of attention. European Journal of Sport Science 2003; 3: 1–13.

Wulf G, Su J. An external focus of attention enhances golf shot accuracy in beginners and experts. Research Quarterly for Exercise and Sport, 2007; 78: 384–389.

Wulf G, Dufek JS, Lozano L, Pettigrew Ch. Increased jump height and reduced EMG activity with an external focus. Human Movement Science 2010; 29: 440–448.

Wulf G, Landers M, Lewthwaite R, Töllner T. External focus instructions reduce postural instability in individuals with Parkinson disease. Physical Therapy 2009; 89: 162–168.

Wulf G, McNevin NH, Shea CH. The automaticity of complex motor skill learning as a function of attentional focus. The Quarterly Journal of Experimental Psychology 2001; 54A: 1143-1154.

Wulf G, Shea CH, Park JH. Attention in motor learning: Preferences for and advantages of an external focus. Research Quarterly for Exercise and Sport 2001; 72: 335–344.

Wulf G, Weigelt M, Poulter DR, McNevin NH. Attentional focus on supra-postural tasks affects balance learning. Quarterly Journal of Experimental Psychology 2003; 56: 1191–1211.

Wulf G, Zachry T, Granados C, Dufek JS. Increases in jump-and-reach height through an external focus of attention. International Journal of Sports Science and Coaching 2007; 2: 275–284.

Zachry I, Wulf G, Mercer J, Bezodis N. Increased movement accuracy and reduced EMG activity as the result of adopting an external focus of attention. Brain Research Bulletin 2005; 67: 304-309.