Int. J. Sport Psychol., 2015 46: 311-320
doi: 10.7352/IJSP 2015.46.311

Benefits of external focus instructions on the learning of a balance task in children of different ages

FÁBIO SARAIVA FLÔRES, JOSÉ FRANCISCO GOMES SCHILD, SUZETE CHIVIACOWSKY

Federal University of Pelotas, Brazil

Studies have shown that adult's motor learning can be enhanced by directing the learner's attention to the effects of their movements on the environment (external focus), rather than on their body (internal focus). The objective of the present study was to investigate if this effect can be generalized to 6- and 10-year-old children while learning a balance task. In each age group, four groups were given different instructions inducing: a distal external, proximal external, internal or no specific instructions regarding attentional focus (control group) before they began practicing. The task involved participants to ride a Pedalo. One day after practice transfer tests were conducted, in order to evaluate learning. The findings showed that both external focus conditions resulted in faster movement times than internal focus and control conditions, regardless age. The findings demonstrate that instructions inducing external focus of attention can enhance the learning of balance tasks in children.

KEY WORDS: Balance, Attention, Infancy Motor Learning.

The form by which individuals use information from the environment, to guide their actions, may contribute or limit their process of learning (Wulf, 2007). Studies with young (e.g.,

Totsika & Wulf, 2003) as well as older (Chiviacowsky, Wulf, & Wally, 2010) adults have shown, in different kinds of tasks, that motor performance and learning are influenced by the use of certain focus of attention strategies. Specifically, these findings demonstrate that instructions inducing an external focus of attention, where the learners focus on the effects of their movements on the environment, can benefit learning when compared to instruc-

Correspondence to: Suzete Chiviacowsky, Ph.D., Escola Superior de Educação Física Universidade Federal de Pelotas,Rua Luís de Camões, 625 - CEP 96055-630, Pelotas - RS, Brazil (mail: suzete@ufpel.edu.br)

tions inducing an internal focus of attention, that is, focus on the learner's body.

Studies with adults have also shown that distant external focus can benefit learning and performance, compared to internal or proximal external focus conditions. For example, McKay and Wulf (2012) using a dart throwing task, found that increasing the distance of the attentional focus is beneficial in learning situations. In that experiment, the task was performed under two conditions: focusing on the target (distal) and focusing on the dart flight (proximal). Similar results were found in other studies with adults, using different tasks (e.g., McNevin, Shea, & Wulf, 2003), showing that this is a phenomenon that can be generalized to different contexts.

While the benefits of an external focus of attention in adults are already consolidated in the literature (Wulf, 2013), only a few studies have investigated how this variable affects motor learning in children. Wulf, Chiviacowsky, Schiller and Ávila (2010) found higher learning of movement form for 10- to 12-year-old children who received external focus feedback while practicing a soccer throwing task, when compared with children performing the task receiving feedback related to internal focus. Benefits of external focus instructions were also observed in 12-year-old children with intellectual disabilities, while learning a beanbag throwing task (Chiviacowsky, Wulf, & Ávila, 2012). In the study by Emanuel, Jarus and Bart (2008), however, the benefits of external focus instructions were not observed in 8- to 9-year-old children, while learning a dart-throwing task.

As observed, research investigating the effects of different foci of attention in children is still limited. Further, the potential benefits of this important learning variable on children's balance have yet to be examined. In addition, it is still unknown if different kinds of external focus instructions would result in different learning outcomes in this population. Children differ from adults in several ways, including the ability to control their focus of attention (Wendelken, Baym, Gazzaley, & Bunge, 2011), making difficult the generalization of findings from adult to children population. They are considered to present lower capacity for top-down control of attention, showing less capacity to pay attention to more stimulus, allocating their attention less efficiently according to task demands, and using less sophisticated strategies in dual-task involving complex activities (Karatekin, 2004; Wendelken, et al. 2011). They also demonstrate less efficiency and flexibility on strategies of visual selectivity in order to adjust behavior to task demands, and are more vulnerable to interference from distracters relative to adults (Bjorklund & Harnishfeger, 1990; Ordaz, Davis, & Luna, 2010). Considering these aspects, we deemed it important to further investigate the effects of focus of attention on the learning of motor skills in this population.

The purpose of the current study was to examine the effects of different foci of attention on the learning of a balance task in children. Considering previous results in the literature, we hypothesized that children adopting external focus of attention would show better learning, exhibiting higher performance on the transfer tests, than those adopting an internal focus or not induced to any specific attentional focus (control). We also expected that children who perform the task adopting a distal external focus, increasing the distance of the body to the effects of the action movements on the environment, would show learning benefits than children who adopt a proximal external focus of attention. Further, we were interested in potential age-related differences in adopting different foci of attention.

Method

Participants

One hundred and eight children (52 boys and 56 girls), at ages 6 and 10 years old, were recruited from schools in southern Brazil. Oral assent was obtained from the participants and written consent from their parents/guardians, and the schools, before beginning the experiment. The research was approved by the university's ethics committee. None of the participants had prior experience with the task, and all of them were naive as to the purpose of the experiment.

Apparatus and task

The balance task required participants to ride a Pedalo (Figure 1) along a distance of 7m, marked by starting and finishing lines. All trials started with the instrument behind the starting line, ending when the front wheels crossed the finish line. When participants stood on the Pedalo, they could pedal up and down and rotate the wheels to move forward or backward. The dispositive had two platforms with dimensions of 30 x 14, 5 cm, and the wheels had a diameter of 21, 5 cm. The trials started with the children's right foot on the upper platform. A timer was used to measure the time between the start and finish lines (movement time - MT). Data collection began as soon as the wheels of the Pedalo touched the starting line.

Procedure

The experiment was performed and conducted individually, in a separated room of the children's school. Before the beginning of the practice phase, participants were informed that they had to complete 20 trials riding the Pedalo forward, from the start to the finish line. A 30-s break was provided between each trial. Participants were quasi-randomly assigned to the different groups, in alphabetical order, with an equal number of participants regarding gender (7

Fig. 1 - The Pedalo™ (Holz-Hoerz, Münsingen, Germany).

boys and 7 girls in age 6, and 6 boys and 7 girls in age 10). Thus, in each age group, four different groups were given instructions inducing a distal external focus (DEF), a proximal external focus (PEF), an internal focus (IF) or no focus or control group (C) instructions, before they began practicing.

Before practice and specific focus instructions, all participants performed a pre-test trial. After the pre-test, similar to Totsika and Wulf (2007), participants in the IF groups were instructed to focus on pushing their feet forward. Children in the PEF groups were told to focus on pushing the platforms (under each foot) forward, while those in the DEF groups were instructed to focus on an orange marker positioned after the finish line. Participants of the C groups were not given specific instructions in relation to focus of attention. Also, all participants were instructed to perform the task at their own pace. Transfer tests, used to measure generalization to novel situations of the practiced task, were conducted one day after practice, consisting each of five trials. In the first test, participants were instructed to perform riding the Pedalo forward as fast as they could. The second transfer test consisted of riding the Pedalo forward, as fast as possible, with both hands touching their heads. No attentional focus instructions or feedback were given during the tests.

Data analysis

Movement time (MT), that is, the time needed to ride the Pedalo from the start to the finish line, on the pre-test, practice, and transfer trials, was used as the dependent variable. MT on the pre-test was analyzed in a 2 (age: 6 and 10 years) x 4 (group: DEF, PEF, IF, and C) analysis of variance (ANOVA). The practice data were analyzed in a 2 (age) x 4 (group) x 20 (trials) ANOVA with repeated measures on the last factor. Transfer tests were analyzed in 2 (age) x 4 (group) x 5 (trials) separated ANOVAs. For follow-up analyses we used Tukey's *post-hoc* test. In addition, the Greenhouse-Geisser adjustment was used, in order to report *F* values in repeated measures factors, if necessary. Effect sizes were reported by partial eta-squared values for significant results. In all analyses, the Alpha level for significance was set at .05.

Results

Pre-test

On the pre-test, there were no differences between groups (see Figures 2 and 3). The main effects of age, *F* (1, 100) < 1, and focus of attention, *F* (3, 100) < 1 were not significant. Also, there was no interaction between age and focus of attention, *F* (3, 100) < 1.

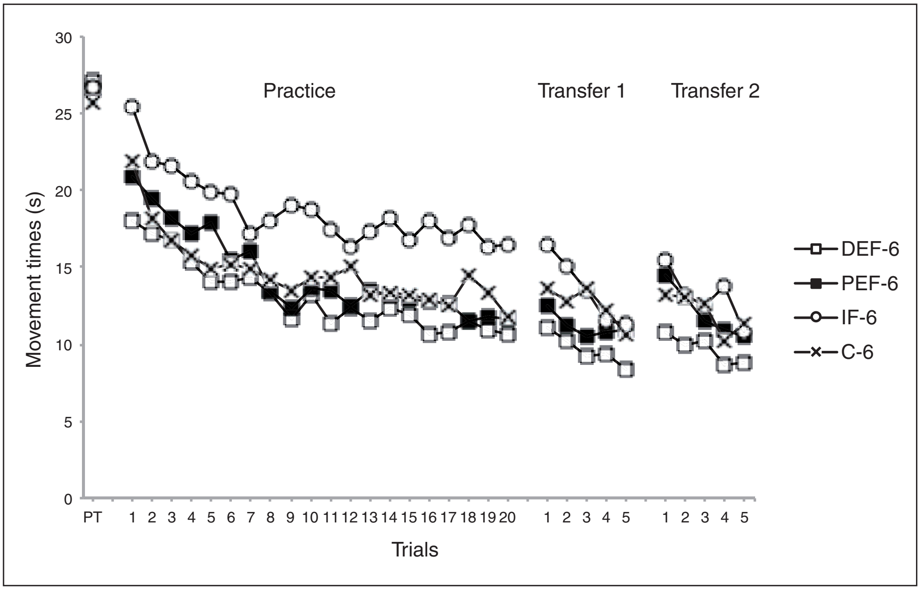

Fig. 2 - Movement times for 6-year-old children on the pre-test, during practice, and transfer tests.

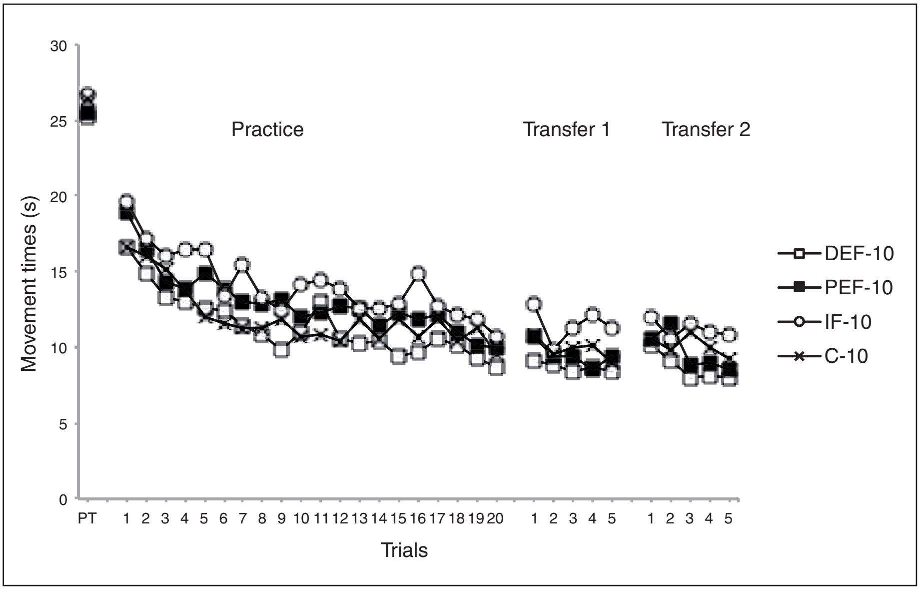

Fig. 3 - Movement times for 10-year-old children on the pre-test, during practice, and transfer tests.

Practice

The time needed to perform the task decreased across the practice trials, with the IF groups demonstrating longer MTs than the other groups, in both ages (see Figures 2 and 3). In addition, older children demonstrated faster MTs than younger children. The main effects of trial, F (19, 1900) = 30,48, $p < .01$, $Eta^2 = .23$; age, F (1, 100) = 11,04, $p < .01$, $Eta^2 = .01$; and focus of attention, F (3, 100) = 5,17, $p < .01$, $Eta^2 = .13$ were significant. *Post hoc* tests confirmed significant differences among the IF groups and all the other groups, *p*s < .05. They also confirmed differences between trial 1 and all the other trials; trial 2 and all the other trials excepting trials 3 and 4; trial 3 and all the other trials excepting trials 3-5, and 7; trial 4 and all the other trials excepting trials 3-7; trial 5 and trials 9, and 12-20; trial 6 and trials 15-20; trial 7 and trials 16, 19, and 20; and trials 8-17 and trial 20; all *p*s < .05. There were no other differences between trials, or interactions between trials, ages, and the different focus conditions, F (57, 1900) < 1.

Transfer tests

Speed Pressure. On the first transfer test, children were asked to perform the task as fast as they could. The MTs decreased across trials (central panels of Figures 2 and 3), with older children showing better results than the younger. The main effect of trial, F (4, 400) = 10,42, $p < .001$, $Eta^2 = .094$; age, F (1, 100) = 10,61, $p < .01$, $Eta^2 = .096$; and focus conditions, F (3, 100) = 6,23, $p < .001$, $Eta^2 = .16$, were significant. *Post hoc* tests showed differences between both external focus groups and the IF group, $p < .05$, with the IF group demonstrating worse results than the former ones. In addition, the DEF group outperformed the control group, $p < .05$. No interactions between trials, age, and focus conditions were found, F (12, 400) = 1,26, $p > .05$.

Hands on Head and Speed Pressure: On this second transfer test, children were requested to perform the task with the hands touching the top of the head, and as in the previous test, as fast as they could. A decrease in the MTs (right panels of Figures 2 and 3) can be also observed across trials, for both ages, in all focus conditions. The main effect of trial, F (4, 400) = 13,68, $p < .001$, $Eta^2 = .12$; age, F (1, 100) = 11,76, $p < .01$, $Eta^2 = .11$; and focus conditions, F (3, 100) = 4,84, $p < .01$, $Eta^2 = .13$, were significant. *Post hoc* tests demonstrate the DEF groups were significantly better than the IF groups, $p < 0,01$, and marginally significantly superior than the C groups, $p = .06$. No interactions between trials, age, and focus conditions were found, F (3, 100) = 1,04, $p > .05$.

Discussion

The objective of the present study was to investigate the effects of different foci of attention instructions on the learning of a balance task in children of different ages. Our results are in accordance with previous research findings in adults (for a review see Wulf, 2013), as well as in children learning throwing tasks (Chiviacowsky et al., 2012; Wulf et al., 2010). Participants practicing with instructions inducing an external focus of attention outperformed those induced to an internal focus, or that received no instructions regarding attentional focus. The benefits of an external focus in adults have previously been found regarding movement effectiveness, as in balance tasks (Jackson & Holmes, 2011; McNevin et al., 2003; Shea & Wulf, 1999; Wulf, Höß, & Prinz, 1998), or tasks involving accuracy as throwing at a target (Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002; Lohse, Sherwood, & Healy, 2010; Marchant, Clough, & Crawshaw, 2007). Movement efficiency was also observed to be enhanced by external focus of attention, as results have shown low muscular activity (Marchant, Greig, & Scott, 2009), and maximum force production (Marchant et al., 2009; Porter et al., 2010; Wu, Porter, & Brown, 2012) for adult participants practicing with external focus. Thus, the present findings generalize the benefits of instructions inducing learners to give attention to the effects of their movements on the environment, instead of to the movements of the body, for children learning balance tasks.

In addition, similar to previous studies with adults (McKay & Wulf, 2012; McNevin et al., 2003) our results demonstrate learning advantages for a more distal external focus of attention in this population. While both kinds of external focus improved learning when compared to an internal focus condition during the first transfer test, only the distant external focus condition outperformed the control groups. During the second transfer test, the benefits of a distal external focus, compared to a proximal external focus, are more apparent. No differences between the PEF groups and the other groups were found, but the DEF groups showed superior results than the internal focus groups. The differential impact of both external focus conditions on the second transfer test may reflect the fact that participants were confronted with a more challenging situation having to perform under speed pressure and hands on the head conditions. As no instructions or reminders regarding focus of attention were given during the transfer tests, there is a possibility that participants induced to a proximal external focus were more vulnerable in maintaining their external focus during the second test, degrading performance.

The benefits of external focus in relation to internal focus of attention are explained by the constrained action hypothesis (McNevin et al., 2003; Wulf, 2013; Wulf et al., 1998). According to this hypothesis, when we focus our attention on the body, during performance and learning, we constrain the motor system, interfering with automatic motor control processes. On the other hand, when we focus our attention on the effects of our movements on the environment, we allow the motor system to operate normally, without interferences caused by conscious control, resulting in more effective learning and performance. This view was recently expanded by Wulf and Lewthwaite (2010). The authors suggest that internal focus of attention may act as a "self-invoking trigger", where references to body parts or movements can result in higher access to the neural representation of the *self*. This, in turn, can bring about self-evaluative regulatory processes that influence thoughts and behaviors, resulting in micro-chocking episodes, degrading performance and learning.

The differences found in performance and learning regarding age, with older children outperforming younger, were expected. Ten-year-old children are considered to be in a more advanced stage of the development process, showing improved capacity of information processing, and better coordinative levels than younger children (Connolly, 1977; Ripoll, Kerlirzin, Stein, & Reine, 1995; Thomas, 1980). Considering these aspects, there was a possibility that different focus of attention would not impact children at different developmental levels in the same way. However, the fact that no interaction was found between 6- and 10-year-old children, and the different focus conditions, implies that the mechanisms involved in the constrained action hypothesis may act similarly in the different motor development levels.

The present findings add new information about the influences of different foci of attention in children. We demonstrated that children focusing on the effects of their movements on the environment, especially at greater distances from the body, can have improved learning of a balance task. The results have implications in practical settings. Teachers can increase children's levels of performance and learning, from a simple change in the instructions, simply directing the learners to external, preferentially distant, focus of attention. Future studies could examine the effects of different foci of attention on children's movement efficiency. The benefits of external focus of attention on learning could also be investigated using a higher number of practice sessions, as well as retention tests, in this population.

REFERENCES

Al-Abood, S. A., Bennett, S. J., Hernandez, F. M., Ashford, D., & Davids, K. (2002). Effect of verbal instructions and image size on visual search strategies in basketball free throw shooting. *Journal of Sport Sciences, 20*, 3, 271-278.

Bjorklund, D. F., & Harnishfeger, K. K. (1990). The resources construct in cognitive development: Diverse sources of evidence and a theory of inefficient inhibition. *Developmental Review, 10*, 1, 48-71.

Chiviacowsky, S., Wulf, G., & Ávila, L. T. G. (2012). An external focus of attention enhances motor learning in children with intellectual disabilities. *Journal of Intellectual Disability Research*, *57*, 7, 627-634.

Chiviacowsky, S., Wulf, G., Wally, R. (2010). An external focus of attention enhances balance learning in older adults. *Gait & Posture, 32*, 4, 572-575.

Connolly, K. (1977). The nature of motor skill development. *Journal of Human Movement Studies*, *3*, 3, 128-143.

Emanuel, M., Jarus, T., & Bart, O. (2008). Effect of focus of attention and age on motor acquisition, retention, and transfer: A randomized trial. *Physical Therapy*, 88, *2*, 251-260.

Jackson, B. H., & Holmes, A. M. (2011). The effects of focus of attention and task objective consistency on learning a balancing task. *Research Quarterly for Exercise and Sport*, *82*, 3, 574-579.

Karatekin, C. (2004). Development of attentional allocation in the dual task paradigm. *International Journal of Psychophysiology*, *52*, 1, 7-21.

Lohse, K. R., Sherwood, D. E., & Healy, A. F. (2010). How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Human Movement Science*, *29*, 4, 542-555.

Marchant, D. C., Clough, P.J., & Crawshaw, M. (2007). The effects of attentional focusing strategies on novice dart throwing performance and their task experiences. *International Journal of Sport and Exercise Psychology*, *5*, 3, 291-303.

Marchant, D. C., Greig, M., & Scott, C. (2009). Attentional focusing instructions influence force production and muscular activity during isokinetic elbow flexions. *The Journal of Strength & Conditioning Research*, *23*, 8, 2358-2366.

McKay, B., & Wulf, G. (2012). A distal external focus enhances novice dart throwing performance. *International Journal of Sport and Exercise Psychology*, *10*, 2, 149-156.

McNevin, N. H., Shea, C.H., & Wulf, G. (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research*, 67, 22-29.

Ordaz, S., Davis, S., & Luna, B. (2010). Effects of response preparation on developmental improvements in inhibitory control. *Acta Psychologica*, *134*, 3, 253-263.

Porter, J. M., Nolan, R. P., Ostrowski, E. J., & Wulf, G. (2010). Directing attention externally enhances agility performance: a qualitative and quantitative analysis of the efficacy of using verbal instructions to focus attention. *Frontiers in Psychology*, 1, 216, doi: 10.3389/fpsyg.2010.00216.

Ripoll, H., Kerlirzin, Y., Stein, J. F., Reine, B. (1995). Analysis of information processing, decision making, and visual strategies in complex problem solving sport situations. *Human Movement Science*, *14*, 3, 325-349.

Shea, C. H., & Wulf, G. (1999). Enhancing motor learning through external-focus instructions and feedback. *Human Movement Science*, *18*, 4, 553-571.

Thomas, J. R. (1980). Acquisition of motor skills: Information processing differences between children and adults. *Research Quarterly for Exercise and Sport*, *51*, 1, 158-173.

Totsika, V., & Wulf, G. (2003). The influence of external and internal foci of attention on transfer to novel situations and skills. *Research Quarterly of Exercise and Sport*, *74*, 2, 220-225.

Wendelken, C., Baym, C., Gazzaley, A., & Bunge, S. (2011). Neural indices of improved attentional modulation over middle childhood. *Developmental Cognitive Neuroscience*, *1*, 2, 175-186.

Wu, W. F., Porter, J. M., & Brown, L. E. (2012). Effect of attentional focus strategies on peak force and performance in the standing long jump. *The Journal of Strength & Conditioning Research*, *26*, 5, 1226-1231.

Wulf, G. (2007). *Attention and motor skill learning.* Champaign, IL: Human Kinetics.

Wulf, G. (2013). Attentional focus and motor learning: a review of 15 years. *International Review of Sport and Exercise Psychology*, *6*, 1, 77-104.

Wulf, G., Chiviacowsky, S., Schiller, E., & Ávila, L. T. G. (2010). Frequent external-focus feedback enhances learning. *Frontiers in Psychology*, *1*, 190, doi: 10.3389/fpsyg.2010.00190.

Wulf, G., Höß, M., & Prinz, W. (1998). Instructions for motor learning: Differential effects of internal versus external focus of attention. *Journal of Motor Behavior*, *30*, 2, 169-179.

Wulf, G., & Lewthwaite, R. (2010). Effortless motor learning? An external focus of attention enhances movement effectiveness and efficiency. In B. Bruya (Ed.), Effortless attention: A new perspective in attention and action (pp. 75–101). Cambridge, MA: MIT Press.

Manuscript submitted April 2014. Accepted for publication March 2015.