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Individual Differences Influencing Immediate Effects of Internal and External Focus Instructions on Children's Motor Performance

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ABSTRACT

Purpose: A large pool of evidence supports the beneficial effect of an external focus of attention on motor skill performance in adults. In children, this effect has been studied less and results are inconclusive. Importantly, individual differences are often not taken into account. We investigated the role of working memory, conscious motor control, and task-specific focus preferences on performance with an internal and external focus of attention in children. **Methods**: Twenty-five children practiced a golf putting task in both an internal focus condition and external focus condition. Performance was defined as the average distance toward the hole in 3 blocks of 10 trials. Task-specific focus preference was determined by asking how much effort it took to apply the instruction in each condition. In addition, working memory capacity and conscious motor control were assessed. **Results**: Children improved performance in both the internal focus condition and external focus condition (η_p^2 = .47), with no difference between conditions (η_p^2 = .01). Task-specific focus preference was the only factor moderately related to the difference between performance with an internal focus and performance with an external focus (*r* = .56), indicating better performance for the preferred instruction in Block 3. **Conclusion**: Children can benefit from instruction with both an internal and external focus of attention to improve short-term motor performance. Individual, task-specific focus preference influenced the effect of the instructions, with children performing better with their preferred focus. The results highlight that individual differences are a key factor in the effectiveness in children's motor performance. The precise mechanisms underpinning this effect warrant further research.

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When people perform or learn motor skills, they are often provided with instructions on how to best perform the movement task. Apart from giving a specific description (in different degrees of detail), these instructions guide the focus of attention to different aspects of movement execution. More specifically, instructions can direct attention to internal aspects of the movement (i.e., related to movements of the body) or to its external aspects (i.e., related to the effects of the movement on the environment; Wulf, Höß, & Prinz, 1998). During the past two decades, research in healthy adults has consistently shown enhanced motor performance and learning when adopting an external focus of attention compared with an internal focus (see Wulf, 2013, for a recent review). This effect has been explained with the constrained action hypothesis (Wulf, McNevin, & Shea, 2001), which states that when adopting an internal focus, the learner constrains the motor system by a greater reliance on conscious control strategies and thus a larger involvement of cognitive resources. According to Wulf, McNevin, et al. (2001), the conscious control strategies interfere with the normal automatic control processes of the motor system. By contrast, with an external focus of attention, the automatic control processes are promoted and lead to more efficient motor performance (Kal, van der Kamp, & Houdijk, 2013).

Despite consistent evidence in favor of this hypothesis in adults, research on the relative benefits of an internal and external focus of attention in children is limited. The results of the few studies that have been performed are equivocal. While some studies confirmed the beneficial effects of instructions that induce an external focus of attention in children (Abdollahipour, Wulf, Psotta, & Nieto, 2015; Brocken, Kal, & van der Kamp, 2016; Flôres, Schild, & Chiviacowsky, 2015; Hadler, Chiviacowsky, Wulf, & Schild, 2014; Thorn, 2006), others have not shown a difference in children's motor learning and performance as a function of focus of attention (Chow, Koh, Davids, Button, & Rein, 2013; Emanuel, Jarus, & Bert, 2008; Perrault & French, 2016). Also, for studies that did reveal an advantage of an external focus of attention, questions remain regarding its actual benefits

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and the robustness thereof. As an example, Flôres et al. (2015) had 6- and 10-year-old children practice a pedalo task under different foci instructions. While the internal focus group (i.e., focus on pushing their feet forward) showed worse performance during practice compared with all other groups, the external focus groups were not different compared with a control group. Also, during the transfer tests, beneficial effects were only apparent for children practicing with a distal external focus (i.e., focus on a marker at the finish line), which was not directed at a movement effect, but rather at the goal of the movement. Beneficial effects were less clear with a proximal external focus (i.e., focus on pushing on the platforms), which in fact was directed at a movement effect. This finding contradicts the theory that the external focus of attention is beneficial when it is skills-focused and only differs slightly in wording from the internal focus (see Wulf, 2013, for elaborate discussion).

Several authors have suggested that the effects of attentional focus instructions might be modulated by individual differences, like the child's or adult's preference to focus attention internally or externally (Brocken et al., 2016; Emanuel et al., 2008; Kal et al., 2015). Whether this presumed focus preference affects motor performance and learning has not been investigated in detail. Therefore, in the present study, we examined the role of individual differences in attentional focus effects on children's motor performance. Specifically, we determined the impact of three (possibly interrelated) factors that have been suggested to modulate the influence of attentional focus instructions on children's motor performance: working memory capacity, the disposition to consciously control movements, and the task-specific focus preference.

A first factor that is thought to underlie individual differences in the effect of an internal and external focus of attention is working memory. Instructions that induce an internal focus of attention are supposed to trigger conscious control of motor execution that involves more cognitive resources than instructions that induce an external focus (Poolton, Maxwell, Masters, & Raab, 2006; Wulf, McNevin, et al., 2001). Consequently, practicing with an internal focus of attention has been shown to lead to a larger pool of declarative knowledge about movement execution compared with an external focus (Poolton et al., 2006). In this respect, especially working memory capacity is considered a crucial cognitive resource for the accumulation of this declarative knowledge. Adequate working memory is also needed for memorizing, manipulating, and applying the instructions (Buszard et al., 2017; Buszard, Farrow, Zhu, & Masters, 2013; Maxwell, Masters, & Eves, 2003). It is well known that working memory capacity develops until adolescence (Alloway & Alloway, 2013). Consequently, working memory capacity may be a limiting factor in the effectiveness of instructions with an internal focus for children's motor performance and learning. Brocken et al. (2016) tested this hypothesis in 8- to 12-year-old children who practiced golf putting. However, the study failed to discern a significant relationship between verbal working memory capacity and motor learning with an internal focus. In this study, there was a narrow range in working memory scores that may have reduced the sensitivity for discerning any existing relationship between working memory and learning. Additionally, Brocken et al. 2016 only assessed verbal working memory. Visuospatial working memory was not included, but was previously shown to contribute to motor learning (see Bo, Jennett, & Seidler, 2012). Hence, in the present study, we examined to what degree the influence of attentional focus on children's motor performance is modulated by both verbal and visuospatial working memory.

The disposition for conscious movement control is a second factor that has been proposed to influence the effect of attentional focus instructions on motor performance and learning. This disposition for conscious control is gauged with the Movement-Specific Reinvestment Scale (MSRS). Reinvestment refers to the shift toward conscious control after the skill has been automatized—for instance, when a performer is under pressure (Masters & Maxwell, 2008). It has been shown that a high MSRS score is associated with an enhanced synchronicity in the activity of verbal and motor cortical areas when performing movements, indicating higher cognitive control of this movement (Zhu, Poolton, Wilson, Maxwell, & Masters, 2011). Additionally, several patient groups, including those who have suffered a stroke (Kal et al., 2015, 2016; Orrell, Masters, & Eves, 2009), have higher MSRS scores compared with healthy adults. These patient groups need the cognitive control of their movement to be successful, which likely induces an internal focus of attention. For example, Kal et al. (2015) reported a positive correlation between the MSRS score and motor performance with an internal focus of attention among individuals recovering from stroke. In other words, it has been suggested that a strong disposition for conscious movement control may encompass a preference for an internal focus of attention (Van Ginneken et al., 2017).

Movement-specific reinvestment consists of two related constructs: movement self-consciousness (MS-C) and conscious motor processing (CMP). Movement self-consciousness is related to the monitoring of one's own movement style. In contrast, CMP refers to the active process of consciously controlling or intervening with movement execution (Malhotra, Poolton, Wilson, Leung, et al., 2015; Malhotra, Poolton, Wilson, Omuro, & Masters, 2015; Masters & Maxwell, 2008). Accordingly, it was shown that a higher CMP score was linked to faster rates of learning and more rapid improvements on novel motor tasks (Malhotra, Poolton, Wilson, Leung, et al., 2015; Malhotra, Poolton, Wilson, Omuro, et al., 2015). In addition, CMP (and not MS-C) has been suggested to be related to an enhanced tendency to use an internal focus of attention (Van Ginneken et al., 2017). Therefore, we only included CMP in the present study.

Except for a general disposition to consciously control movements, children may also have task-specific preferences to focus their attention either internally or externally. The few studies that have assessed task-specific focus preference have all indicated better performance with the preferred or familiar focus (Ehrlenspiel, Lieske, & Rübner, 2004; Marchant, Clough, Crawshaw, & Levy, 2009; Maurer & Munzert, 2013; Weiss, Reber, & Owen, 2008; Wulf, Shea, & Park, 2001). These studies were all performed with adults and used different methods for assessing focus preferences across studies. In most studies, participants briefly performed with both types of instruction and then rated their preference for both attentional foci (Marchant et al., 2009; Weiss et al., 2008, first study; Wulf, Shea, et al., 2001). However, this preference rating may be largely dependent on performance outcomes rather than the perceived mental effort or cognitive load to adhere to the instructed focus. In this respect, Marchant et al. (2009) found that participants who practiced with their preferred focus also experienced needing less effort to perform the task. They highlighted the importance of when the preference was formed (i.e., initial vs. resulting preference) or evolved during practice (i.e., as a function of performance changes). In the present study, we examined to what degree the effects of attentional focus were modulated by task-specific focus preference in a group of children. Focus preference was determined using participants' ratings of perceived effort immediately after having performed the first trial (i.e., initial preference).

To sum up, the main goal of the study was to examine the individual differences in the benefits of internal and external focus instructions on golf putting performance in children aged 8 years to 12 years old. Performance was determined in three blocks of 10 trials in each condition, as performance change can occur very rapidly (see Magill & Anderson, 2014). Furthermore, we were specifically interested in determining how the individual differences were modulated by working memory capacity, disposition for conscious movement control, and the task-specific focus preference. To this end, we used a cross-over design within which children put golf balls both in an internal focus of attention condition and in an external focus of attention condition. Working memory capacity, the disposition for conscious movement processing, and task-specific focus preference were measured. It was expected that children would perform better with an external focus of attention. Additionally, we hypothesized that the anticipated benefits of external focus instruction would be reduced when children had (a) a larger working memory capacity, (b) a stronger disposition for the conscious control of movements, and (c) a stronger initial preference for focusing internally on the golf putting task.

Methods

Participants

In this study, children aged 8 to 12 years old were recruited at a mainstream primary school. All children in eligible classes received an information letter for their parents. In total, 25 children (12 girls, M_{age} = 10.4 years, SD = 1.1 years) returned the written informed consent before the experiment, and all gave verbal assent during the experiment. No children dropped out. Parents completed a health questionnaire to ensure that the children had no known neurological or psychological disorders. The procedures of the study were approved by the local ethics committee. Children received a small gift for their participation.

Materials

Golf task

Children performed the golf putting task on an artificial grass putting mat, measuring 500 cm long and 100 cm wide (adapted from Brocken et al., 2016; see Figure 1). The hole, with a diameter of 10 cm, was located at a distance of 250 cm from the "tee," where the participant was standing to putt the golf ball. Special putters for children were used: Spalding Junior Putter Green of 70.0 cm for children with a height up to 132 cm and Spalding Junior Putter Blue of 77.5 cm for children taller than 133 cm. The goal of the task was to putt standard golf balls into the hole. Golf performance was determined by measuring the distance between the end

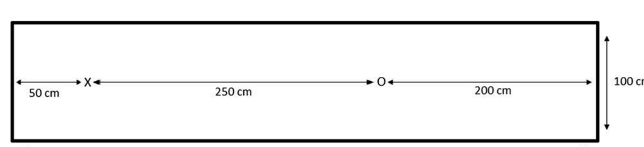

Figure 1. Schematic representation of the grass putting mat; O represents the hole, X represents the starting point from where the golf ball was putted (i.e., the "tee").

position of the putted ball and the hole. If the ball was putted into the hole, a score of 0 cm was given and if the ball fell off the green, the maximum score of 200 cm was given (14.8% of the putts). In all other cases, the distance from the middle of the ball to the middle of the hole was measured (in cm).

Working memory

To assess working memory capacity, children performed the screener of the Dutch version of the Automated Working Memory Assessment (AWMA; Alloway 2007). Two subtests were used: Listening Recall to measure verbal working memory and Spatial Recall to measure visuospatial working memory. Both subtests have been reported to have good test–retest reliability with reliability coefficients of .88 and .79, respectively.

The disposition for conscious control

A Dutch version of the MSRS (Masters & Maxwell, 2008) was developed (MSRS-C-NL) based on the validated Dutch version for adults (Kal et al., 2016) and the validated English (Buszard et al., 2013) and Chinese versions for children (Ling, Maxwell, Masters, McManus, & Polman, 2015). Questions were pilot-tested with five 8-year-old children to evaluate the use of language and layout. Afterward, a few modifications were considered appropriate. The final questionnaire has been used in a number of studies conducted by our research group. Confirmatory factor analysis from the combined data of 244 children aged 7 to 13 years old showed good psychometric properties, $X^2(31) = 54.4$, $p = .015$, $X^2/df = 1.6$, Goodness-of-Fit Index = .96, Comparative Fit Index = .89, standardized root mean square residual = .05, root mean square error of approximation = .05). The questionnaire consisted of 10 questions, 5 of which were related to the concept of CMP (e.g., "Do you try to find out why a certain movement didn't go well?") and 5 of which were related to the concept of MS-C (e.g., "Do you know what you look like when you move?"). Questions were answered on a 4-point Likert scale. The options "never," "sometimes," "often," and "always" were scored as 1, 2, 3, and 4 points, respectively. A higher score represented a higher propensity for reinvestment. To measure the disposition for conscious control, we only used the scores for the CMP factor.

Task-specific focus preference

To measure children's preference for employing an internal or external focus of attention in the golf putting task, they were asked to rate the amount of effort they experienced to perform the task according to the instructions immediately after the first trial as well as after the last trial of each condition ("How much effort does it take to perform according to this instruction?"). The rating scale was derived from the Rating Scale of Mental Effort (RSME; Zijlstra, 1993) and involved a visual analogue scale with the left endpoint of the line stating "no effort at all" and the other endpoint stating "a lot of effort." Children marked a cross on the line between the endpoints where they felt it best represented their perceived effort. Less effort was taken as a stronger preference.

Manipulation check

After each condition, a verbal recall protocol was used in which the children were asked to answer the following question: "On what aspects were you focusing during putting?" The experimenter immediately wrote down the answer(s).

Procedure

A within-subjects design was used in which children performed the golf putting task with instructions for both the internal and external focus of attention. The order of instruction was counterbalanced across children with 1 week in between sessions. Half the children were randomly assigned to receive internal focus instruction in the first session and external focus instruction in the second session (the IF-EF group); the other half of the children received the instructions in reversed order (EF-IF group). At the beginning of the first session, the goal of the task was explained. The children then performed 10 practice trials with a few basic instructions about grip, stance, and posture. Next, they received the appropriate attentional instructions by the experimenter who was not—and could not be—blind for the intervention. For the internal focus condition, children were told to move their *arms* like a pendulum; for the external focus condition, children were told to move the *golf club* like a pendulum. Instructions were given both verbally and visually by showing the children what a pendulum is and how it works (see Brocken et al., 2016). Following the instruction, children performed the 1st trial, after which they rated the mental effort to perform according to the instructions (i.e., focus preference). Subsequently, the remaining 29 trials were performed. After every 5 trials, the experimenter repeated the instructions verbally. After the final trial, the children again rated perceived mental effort and answered the verbal-recall question. Children also completed the MSRS-C-NL and the AWMA. During the second session, children underwent exactly the same protocol, but with the instructions for the other focus of attention and without the first 10 familiarization trials, the MSRS-C-NL, and the AWMA.

Analyses

The average distance from the hole (in cm) for each block of 10 trials was calculated and served as the performance measure. This measure allowed for comparison of golf putting performance over three blocks of trials across the two attentional focus conditions. The verbal and visual working memory capacity scores were the raw scores from Listening and Spatial Recall tests, respectively, while the sum score on the five questions for the CMP factor of the MSRS-C-NL served as the measure for the disposition for conscious control. Finally, the focus preference of the children was based on the ratings of the initial focus preference measured after the first trial in both conditions. It was defined as the percentage of total line length starting from the left (i.e., indicating "no effort at all") until the point where the child had marked the scale. A low percentage thus indicated a strong preference. To determine focus preference, the rating for the external focus instruction was subtracted from the rating of the internal focus instruction. Accordingly, a negative outcome indicated a stronger preference for the internal focus, while a positive outcome indicated a stronger preference for the external focus.

First, to examine the difference in golf putting performance on a group level as a function of attentional focus and block, a 2 (condition: internal focus instructions vs. external focus instructions) × 3 (block: first 10 trials, second 10 trials, final 10 trials) analysis of variance (ANOVA) with repeated measures on both factors was performed. Significant effects were followed up by pairwise post-hoc comparisons with Bonferroni correction.

Next, and more importantly, we assessed the role of the individual factors on the difference between performance with an internal focus of attention and performance with an external focus of attention on an individual level. To this end, performance in the external focus condition was subtracted from performance in the internal focus condition, and this difference served as the dependent variable: Positive values indicated superior performance in the external focus condition and negative values indicated enhanced performance in the internal focus condition. We performed a correlation analysis between the performance difference, verbal and spatial working memory capacity, CMP, and task-specific focus preference. We planned to do this for each block separately, depending on the outcomes of the ANOVA described earlier. In addition, in the case of multiple significant correlations, a hierarchical regression analysis was performed, in which the factor with the highest correlation would be entered in the first step, followed by the factor with the second largest correlation and so on.

Finally, the outcomes of the manipulation check were analyzed. The answers were divided into segments that represented an individual aspect to which children paid attention (Chi, 1997). The first and second authors then coded these segments according to a scheme adapted from Perrault and French (2016; see Table 1). Interrater agreement was 90%. Items on which the raters disagreed were discussed until consensus was reached. A Wilcoxon signed-rank test was used to compare the number of aspects to which the children attended in the internal focus condition and external focus condition.

Normality of the data was checked with a Shapiro-Wilks test. When the assumption of normality was violated, the appropriate nonparametric test was used. Statistical significance was set at $p < .05$. All analyses were performed using the Statistical Package for the Social Sciences (Version 23).

Results

Performance in internal and external focus conditions

The results of the repeated-measures ANOVA did not show a significant effect of condition, $F(1, 24) = 0.32$, $p = .579$, $\eta_p^2 = .01$. However, there was a significant main effect of block, $F(2, 48) = 21.52$, $p < .001$, $\eta_p^2 = .47$.

Table 1. Coding scheme for the segments reported in the manipulation check.

Code	Definition	Example
Initial instruction internal (II)	Directed at the initial instruction about the movement of the arms	"the arm movements"
Initial instruction external (IE)	Directed at the initial instruction about the movement of the club	"the pendulum movement of the club"
Goal (G)	Directed at the end-goal of the task (the put), also considered an external focus	"make a hit"
Cue internal (CI)	Directed at an internal element of the task other than the initial instruction	"if the arms were good"
Cue external (CE)	Directed at an external element of the task other than the initial instruction	"focus on the balls"
Aiming (A)[a]	Directed at specific aiming aspects without a clear internal or external focus	"not too hard or too soft"
Movement without focus (UF)[a]	Directed at elements of the movement without a clear internal or external focus	"move calmly"
Evaluative (E)	Directed at the level of performance	"I didn't get a single put."
Other (O)	Other	"the rules"

[a]Directing attention at the movement is often considered an internal focus of attention. However, in this case, children only reported to "focus on the movement" without an indication as to whether it was the movement of the club or the movement of the body, which is why this category was scored as unfocused. The same holds for segments related to aiming.

Post-hoc comparisons with Bonferroni correction showed that putting performance significantly improved over time from Block 1 (M = 99.43, SE = 5.75) to Block 2 (M = 87.39, SE = 5.28; p = .01, 95% CI [2.5, 21.6]) and from Block 2 to block 3 (M = 72.9, SE = 4.01; p = .001, 95% CI [5.3, 23.8]). There was no significant interaction between condition and block, $F(2, 48) = 0.17$, $p = .841$, $\eta_p^2 < .01$. Together, these results indicated that children improved performance within a session, but the focus of attention instruction did not enhance or reduce this improvement.

The relation of working memory, disposition for conscious control, and task-specific focus preference with the relative benefits of external and internal focus instructions

As a significant effect of block was found, we calculated correlations for each block separately. The correlations between performance difference (i.e., between conditions) and verbal working memory capacity (M = 17.20, SE = 0.61), spatial working memory capacity (M = 23.88, SE = 1.15), CMP (M = 11.44, SE = 0.55), and focus preference (M = –9.07, SE = 5.93) for each of the three blocks are reported in Table 2. The only moderate correlation was between performance difference and task-specific focus preference in Block 3 (r = .56, p = .004), indicating that the stronger the preference for an external focus, the larger the performance advantage for putting with an external focus of attention, and vice versa (see Figure 2). The other factors were not related to this relative benefit (see Table 2).

Table 2. Correlation coefficients between individual factors and the difference in performance between practice with an internal and external focus of attention in the three practice blocks.

	Performance difference Block 1	Performance difference Block 2	Performance difference Block 3
Verbal WM	–.04	.18	–.29
Spatial WM	.10	.06	–.18
CMP	–.36	–.28	< .01
Preference	.23	.11	.56**

Note. *Statistically significant at $p < .05$. **Statistically significant at $p < .01$. WM = working memory; CMP = conscious motor processing.

Exploratory analysis of focus preference

Because our analyses indicated that task-specific focus preference was the most important factor for the difference between performance with an internal focus and an

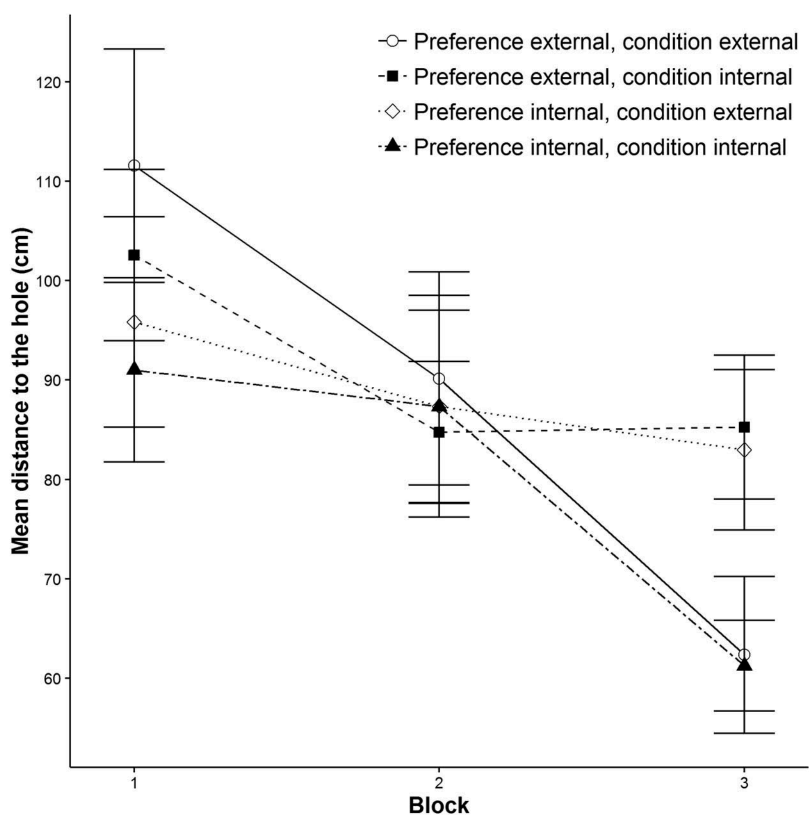

Figure 2. Visual representation of the effect of focus preference on putting performance in the internal and external focus conditions. For clear representation of the effect of preference, the continuous preference score was categorized. Children with a positive value were classified as having a preference for an external focus of attention, and children with a negative value were classified as having a preference for an internal focus of attention. Error bars represent standard error.

external focus of attention, we decided to further examine this construct. For 11 children, the difference in the rate of mental effort after the first trial favored an external focus of attention, while 14 children reported lower rates of mental effort for an internal focus of attention. We argued in the introduction that self-rated preference might be related to actual performance (i.e., you prefer what works best). To evaluate this hypothesis, we correlated the resulting focus preference (i.e., the second rating of mental effort after 30 trials) with performance on the last block of the corresponding condition. No significant relationship between performance and the resulting focus preference was found. We also examined the change in the strength of the focus preference, which was expected to increase with increasing experience with a specific focus of attention. Inspection of individual data revealed that only 4 children had a stronger preference on the second rating compared with the first rating. In addition, 10 children "switched" preference; of these children, 4 switched from preferring an external focus of attention to preferring an internal focus, 4 children switched from preferring an internal focus to preferring an external focus, and 2 children preferred an internal focus in the first rating but did not show a difference in mental effort for the internal and external focus instructions on the second rating. The strength of preference of the remaining 11 children decreased over time, but they did not switch their preference.

Manipulation check

The responses on the manipulation check for both conditions are displayed in Table 3. Responses for each category were compared between the internal and external focus conditions. The analysis only showed a significant difference between reports after completion of both the internal focus and external focus conditions for the aspects II (initial internal instruction; $Z = 2.24$, $p = .025$) and CI (cue internal; $Z = 2.24$, $p = .025$). These internal aspects were reported more often after practice in the internal focus condition compared with the external focus condition. We also compared the total number of internal aspects (II + CI) to the total number of external aspects (IE [initial internal instruction] + CE [cue external] + G [goal]) within both conditions. Results showed that after the external focus condition, children reported more external than internal aspects ($Z = 2.89$, $p = .004$). After the internal focus condition, children reported an equal number of internal and external aspects. These results indicate that external task aspects were reported after both the internal and external focus conditions, while internal aspects were primarily reported after the internal focus condition.

Table 3. Results of the manipulation check.

	II	CI	IE	CE	G	A	UF	E	O
Internal instruction	5	5	0	3	2	10	5	2	3
External instruction	0	0	5	3	2	9	12	2	2

Note. Number of segments in each category split for the received instruction. Abbreviations are as follows: II = initial internal instruction; CI = cue internal; IE = initial external instruction; CE = cue external; G = goal; A = aiming; UF = unfocused movement; E = evaluative; O = other.

Discussion

This study aimed to evaluate the immediate effects of instructions for the internal focus of attention and external focus of attention on golf putting performance in children. We were particularly interested in examining the degree to which these effects were modulated by working memory capacity, CMP, and individual focus preference. In contrast to current views about the benefits of an external focus relative to an internal focus of attention, we did not find a difference in golf putting performance following the two attentional focus instructions. Children performed to the same level in both conditions, although performance did improve during the session. Importantly, however, individual differences were observed in that some children performed better with internal instructions, while others demonstrated superior performance with external instructions. Further analysis indicated that working memory capacity or CMP did not account for these interindividual differences in attentional focus effects. We did find, however, that task-specific focus preferences (i.e., the perceived mental effort to adhere to the instruction after the first trial) did relate to relative effects of attentional focus. Specifically, in the final performance block, children performed better with attentional focus instructions that matched their focus preference.

The observation that children (as a group) performed (and improved performance across blocks) irrespective of the focus of attention adds to the mixed picture concerning the presumed benefits of an external attentional focus in children (Abdollahipour et al., 2015; Brocken et al., 2016; Chow et al., 2013; Emanuel et al., 2008; Flôres et al., 2015; Hadler et al., 2014; Perrault & French, 2016; Thorn, 2006). Consequently, the evidence to support the constrained action hypothesis in children is equivocal. One explanation for the discrepant findings in adults and children might be that children are less experienced in these types of complex motor skills. Automaticity has not been (sufficiently) developed, and hence, internal focus is less likely to disrupt automatized control. Accordingly, children might benefit from any type of instruction to improve performance—provided they have sufficient informational content. Only after some automaticity has been developed would the attentional focus elicit differences. In other words, in childhood, the different benefits of attentional focus may not have immediate effects on performance but only emerge with more prolonged practice or learning (e.g., Brocken et al., 2016). Yet, some other studies with similar small amounts of trials have shown an immediate beneficial effect of an external focus of attention (Flôres et al., 2015). This finding highlights that the distinction between immediate performance effects and long-term learning effects is not the only factor modulating the attentional focus effects. Perhaps scaling the amount of practice to children's initial automaticity provides more accurate predictions of attentional focus effects.

In addition to examining the difference between an internal and external focus of attention on a group level, we also examined the difference on an individual level. Although the external focus instruction was not more effective on a group level, we did find that task-specific focus preference was significantly related to individual differences in the benefits of an external focus relative to an internal focus: Children with a preference for an external focus performed better with external focus instructions in the final block of the test session and vice versa. Contrary to what we predicted, working memory and the disposition for conscious control did not influence the relative effects of attentional focus. A recent study by Buszard et al. (2017) did show that working memory capacity constrains motor learning in children, but only when multiple instructions were used that overloaded working memory capacity. Therefore, the absence of a role for working memory capacity in the current study may be caused by the use of only one instruction in the form of an analogy, which did not place a high demand on working memory capacity. We did not perform a-priori power calculations. If we had done so, we would have found that our sample size (i.e., $\alpha = .05$, $\beta = 0.80$, and $r = .5$ returns 26 children) would have been small for determining relations between the individual variables and differences in performance and therefore was sensitive to only large effect sizes. Future research must ensure sufficient participants to verify the current findings.

Focusing more on the observed effect of task-specific focus preference, previous studies in adults also showed that task-specific focus preference affects attentional focus on motor learning (Ehrlenspiel et al., 2004; Marchant et al., 2009; Maurer & Munzert, 2013; Weiss et al., 2008; Wulf, Shea, et al., 2001). Our results confirm this observation for children. It is therefore important for researchers —and practitioners alike—to take task-specific focus preference into account when comparing and/or adopting attentional focus instructions to promote motor performance and learning. Matching instructions to the individual preferences may make it easier for children to apply the instructions and promote performance and learning. In fact, focus preference may have differed between the studies that examined attentional focus in children, which might explain the mixed findings in studies that examined the relative benefits of attentional focus only on a group level (Chow et al., 2013; Emanuel et al., 2008).

Our results are among the first to show the important role of focus preference in explaining individual differences in motor performance in children. We used a rating of mental effort to determine this preference. Previously, Marchant et al. (2009), in studying adults, found that the perceived effort of performing a dart throw was lower when performed with the preferred focus of attention. Even though their operationalization of effort was not identical to the current mental effort scale, the results of both studies are in line. In the study of Marchant et al., participants rated general effort on a scale from 1 (none at all) to 7 (a great deal). Despite this difference in measurement, the correspondence in results suggests that the concepts of preference, general effort, and mental effort are likely measuring the same underlying construct. Yet neither has been validated, and it is therefore important to validate rating scales for focus preference. In doing so, it is also important to verify the stability of these preferences—the present study, for instance, suggested that a considerable number of children had changed their preference after 30 trials. Further to this point, although Marchant et al. suggested that such changes were driven by performance, our exploratory analyses did not confirm a relation between the resulting focus preference and performance. Clearly, further scrutiny of focus preference is warranted to unravel the possible mechanisms underpinning the effect of focus preference on performance.

A final confounding factor in the effects of internal and external focus instructions was the actual use of these instructions. Emanuel et al. (2008) commented that children adhere less to the given instructions compared with adults, which may diminish any performance and learning differences as a consequence of attentional focus. In line with this finding, in a recent study, Perrault and French (2016) found no group differences, but additional analysis showed that participants with high performance reported more external task aspects irrespective of the instructions they received. We also included a verbal recall protocol, which should be closely related to the aspects that were used for performance. This protocol indicated that children focused attention externally in the external focus condition as well as in the internal focus condition, while they only attended to internal aspects in the internal condition. It must be noted that many aspects that children recalled did not indicate a clear focus of attention. Also, verbal recall can be subject to verbal abilities as well as socially desirable answers. So, on one hand, children can use more aspects than the ones they reported but may not have been able to verbalize these aspects. On the other hand, children may report rules they think the experimenter wants to hear without actually having used them. Nevertheless, the results suggest that the actual focus did not always correspond to the focus instructions. This discrepancy may cloud performance differences as a function of attentional focus.

Conclusion

This study investigated individual differences in the immediate effects of internal and external attentional focus instructions on motor performance in children. It showed that both types of instruction can directly enhance motor performance, but the benefits depend on the individual child's task-specific focus preference; children performed better when the instructed focus and preferred focus matched. Working memory capacity and conscious motor control did not explain individual differences in the effects of internal and external focus. We suggest that focus preference should be an important constraint in designing instruction protocols to enhance motor performance.

What does this article add?

The literature has been inconclusive about the benefits of using an external focus of attention in children when practicing motor skills. The current study focused on individual differences that may underlie the relative benefits of an internal focus and external focus of attention. Specifically, the results showed that performance benefits were related to individual ratings of task-specific focus preferences. This finding can help explain the lack of differences found between an internal focus and external focus of attention in children. To further understand the differences between performance and learning with an internal focus and external focus of attention, it is critical that individual differences, including focus preference, are taken into account in future studies. However, focus preference has not been studied often, especially in children, and no golden standards exist to determine focus preference. Therefore, more research is needed on this topic to create validated measures. These measures can also aid professionals working in the field of sport and exercise, like teachers, trainers, and therapists, to develop more personalized training, coaching, and rehabilitation for both children and adults.

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