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Children's conscious control propensity moderates the role of attentional focus in motor skill acquisition

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ABSTRACT

We investigated whether conscious control propensity moderates the role of attentional focus in motor skill acquisition of children. The propensity for conscious control of elementary school children was determined using an adapted version of the Movement Specific Reinvestment Scale (MSRS) (Masters, Eves, & Maxwell, 2005). They then practiced a darts task using an internal (focus on limb movements), external (focus on the target) or non-specific focus of attention and performed a transfer test (i.e. 20% increase in distance). After one week, they engaged in a delayed retention test. Results were analyzed using ANOVA with repeated measures. During the initial practice phase, no significant effects were found. However, during the transfer test and delayed retention interactions between conscious control propensity and group emerged, such that children with a high conscious control propensity performed better in the internal focus group and ones with a low propensity did better in the external focus group. These findings suggest children's motor skill acquisition is most effective when instructions align with their personality predispositions.

1. Introduction

Coaches, teachers and physical health practitioners often rely on verbal instructions to guide motor skill acquisition (Perreault, 2013; Schmidt, 1988; Williams & Hodges, 2005; Wulf, Höß, & Prinz, 1998). With regard to verbal instructions, the influential constrained action hypothesis proposes that it is more beneficial to focus on the outcome of a movement than on the movement itself[1] (Wulf, 2013), because an external (i.e. outcome directed) focus of attention enhances movement automaticity (Wulf, Shea, & Park, 2001). Therefore, verbal instructions geared towards external foci may be more beneficial than instructions that prompt internal foci.

Although for adults the benefits of external foci are well documented (for a review, see Wulf, 2013), studies have found mixed results regarding children. Even though external focus instructions were found to promote children's balance (Thorn, 2006), soccer throw-in (Wulf, Chiviacowsky, Schiller, & Ávila, 2010), beanbag throwing (Chiviacowsky, Wulf, & Ávila, 2013) and tennis forehand strokes (Hadler, Chiviacowsky, Wulf, & Schild, 2014), it did not do so for basketball free-throws (Perreault, 2013) and internal (not external) foci benefitted learning of a darts task (Emanuel, Jarus, & Bart, 2008). These findings indicate that the role of attentional focus in motor performance may be more complex for children than for adults.

The literature contains two disparate explanations for the benefits of internal and those of external foci in children. Compared to adults, children possess limited cognitive resources (Gallagher & Thomas, 1980, 1986; Pollock & Lee, 1997; Tipper, Bourque, Anderson, & Brehaut, 1989), but also lower levels of movement automaticity (Ruitenberg, Abrahamse, & Verwey, 2013). Together, these two facts can explain any difference between the foci. When studies show benefits of external foci, authors tend to argue that

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[1] The proposed underlying mechanism for this effect is that "conscious attempts to control movements interfere with automatic motor control processes, whereas focusing on the movement effects allows the motor system to self-organize more naturally, unconstrained by conscious control" (Wulf et al., 2001, p. 342).

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external foci promote automaticity (Chiviacowsky et al., 2013; Hadler et al., 2014; Thorn, 2006; Wulf et al., 2010) or circumvent reliance on scarce cognitive resources (Capio, Poolton, Sit, Eguia, & Masters, 2012; Capio, Poolton, Sit, Holmstrom, & Masters, 2011).[2] Conversely, benefits of internal foci are interpreted as indicating that internal foci are reasonable alternatives in the absence of sufficient movement automaticity (Bernstein, 1996; Emanuel et al., 2008; Ruitenberg et al., 2013). The next challenge is to predict when which focus trumps the other. This is the novel contribution of the current study.

Personality predispositions may provide a window into the question which children may benefit from internal foci and which from external ones. For example, conscious control propensity – which can be measured using the Movement Specific Reinvestment Scale (Masters, Maxwell, & Eves, 2005) – captures people's tendency to use explicit, verbalizable knowledge to control their movements and hence adopt internal foci of attention (Masters & Maxwell, 2008). As this propensity has been found to moderate the effects of attentional focus in adults (Maxwell, Masters, & Eves, 2000; Van Ginneken, Poolton, Masters, Capio, Kal, & van der Kamp, 2017), it is worthwhile to investigate whether it also does in children.

We investigated whether children with high conscious control propensities would learn a darts throwing task better under internal focus conditions and whether children with low propensities would benefit from external foci. Children may develop high conscious control propensities for two reasons. One, as suggested by Emanuel et al. (2008) they may possess low levels of movement automaticity, which prompts them to rely on the alternative strategy – i.e. internal foci. Two, they may possess larger cognitive resources allowing internal foci to be more effective. Conversely, high levels of automaticity and low cognitive resources may prompt the development of low conscious control propensities in children. For these reasons, children with a high propensity for conscious control were expected to learn the task better when adopting an internal compared to an external focus. Those with a low propensity were expected to fare better under conditions of external focus.

2. Methods

2.1. Ethics

Ethical approval was granted by the ethics committee of the first author of this paper.

2.2. Participants

One-hundred-and-two elementary school children (66 boys and 36 girls, aged $M = 10.0$, $SD = 4.1$ years) were recruited, 60 of which (36 boys and 24 girls, aged $M = 10.4$, $SD = 1.8$ years) received darts practice based the following inclusion criteria: (1) had not been diagnosed with any developmental disorders (e.g. developmental coordination disorder); (2) had normal or corrected to normal vision; (3) had no experience in throwing dart and (4) had no motor deficits reported by parents.

[2] Although technically Capio et al. (2011) and Capio et al. (2012) studied the effects of explicit and implicit learning, these have been found to be high similar, if not equivalent, to internal and external foci (Poolton, Maxwell, Masters, & Raab, 2006).

2.3. Materials

Ten standard darts (12 g Dart Dual) and a standard size and height dart board (Unicorn Eclipse Pro) were used. In line with Emanuel et al. (2008), the height and distance of the board was adjusted for children's height as prescribed by (Eoff, 1985)). Statistical analyses were carried out using IBM SPSS Statistics Version 18.

The MSRS for Chinese children (MSRS-CC (Ling, Maxwell, Masters, McManus, & Polman, 2015),) was used to record conscious control propensity. The MSRS-CC measures children's propensity to be self-conscious about one's style of movement (e.g. 'I am concerned about my style of movement') and their subsequent propensity for conscious control (e.g. 'I reflect about my movement a lot'). Each item is rated on a six-point Likert scale from 1 (strongly disagree) to 6 (strong agree). At the scale comprises 10 questions, scores can range between 10 and 60 points.

2.4. Procedure

After 102 children and their parents provided written informed consent, the children completed the MSRS-CC. In line with (Uiga, Capio, Wong, Wilson, & Masters, 2015)), only the 30 children with the lowest MSRS-CC scores ($M = 14.2$, $SD = 1.0$) and 30 with highest MSRS-CC scores ($M = 48.8$, $SD = 0.4$) were requested to engage in darts skill acquisition.

The experiment consisted of three sessions: 1) acquisition, 2) transfer and 3) retention.

Prior to acquisition, each child received instructions regarding handgrip and standing position (e.g. "stand behind the position line", "hold the dart with your thumb and index fingers"). They then received either internal, external or non-specific focus instructions. The instructions were similar to Emanuel et al., (2008), but translated to Chinese (see Appendix for detailed instructions). Children in the external focus group were instructed to focus on the dart's flight path, while those in internal focus group were instructed to focus on the movement of their throwing arm. Children in the control group did not receive any attentional focus instruction. The number of children with high and low conscious control propensity was counterbalanced between these groups. The children were allowed six warm-up throws, after which they performed 5 blocks of 10 trials separated by 3-min of rest. The focus instructions were repeated prior to each block and adherence was verbally checked at the end of each block by asking what the participants focused on while performing the task.

2.4.1. Transfer

Right after the acquisition phase, children engaged in a transfer test in which the distance was increased by 20%.

2.4.2. Retention

The delayed retention session was conducted one week after the acquisition and the transfer test. The children performed 10 dart throws from the same distance as during acquisition. However, they received no instructions shortly before or during this retention test.

2.5. Measures and statistics

Similar to Emanuel et al., (2008) study, throwing performance was measured as mean radial error (MRE) (see Table 1). MRE indicates the average deviation (in centimeters) of the darts from the center of the dartboard. The measurement was taken after each trial block.

A 2 (Reinvestment Group) x 3 (Instruction Group) x 5 (Block: 1