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Original Article

Cognitive style and teaching style influences on the motor skill performance of 11 and 12 year old physical education students

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Abstract:
The current study examined the influence of cognitive style and teaching style on the motor skill performance of children. A sample of 163 students aged 11 to 12 years old (M = 11.31, SD = 0.46) were categorized as either field dependent or field independent on the basis of their scores on the Group Embedded Figures Test. Children completed a ball handling skills task that assessed throwing and catching abilities at the commencement and completion of the treatment. Sessions were delivered for 15 minutes at the commencement of their standard lessons that were undertaken over a period of one academic year. Analysis of variance was used to contrast pre and post test throwing and catching skill change scores (i.e., motor skill) of students categorized as field dependent or field independent for each of the holistic, analytic and control teaching groups. The Tukey's Honest Significant Difference post hoc test was used to analyse the motor skill change score differences according to teaching protocol group. A preset alpha level of $\alpha = .05$ was used for all statistical procedures. A significant between subject difference was found for the teaching protocol category ($F(2, 157) = (3.298$, $p = .040$, $\eta 2p = .040$). No significant differences were found for the interaction of teaching protocol and cognitive style. A significant post hoc difference was found for the contrast according to teaching protocol between the holistic and analytic groups, $p = .048$. These findings highlight that student performance in a throwing and catching task was influenced by both the matching and mis-matching of cognitive style and teaching style within the field independent sample. The children categorized as field dependent did not demonstrate any significant changes in the performance task as an outcome of participation in any of the three teaching groups.
Key words: cognitive style, teaching style, motor skills, physical education

Introduction

Successful learning outcomes in school based teaching situations are dependent on a variety of factors that could include the intentional or unintentional matching of cognitive style to teaching style. Previous evaluation of the relationship of the cognitive and teaching style constructs indicate that if students' learning preferences match their instructors' teaching styles, student motivation and achievement usually improve (Stitt-Gohdes, 2003). Identifying and promoting a particular teaching style can serve to facilitate an understanding of its relationship with individual students' learning styles, however, few teachers are aware of the exact nature of their own teaching style and the cognitive style preferences of their students (Prashnig, 2004). Pedagogical domains such as physical education and more specifically motor skill learning serve as relevant platforms on which to examine and evaluate the efficacy of aligning teaching style with the cognitive style of students.

Cognitive style is considered an important human characteristic that can affect the set of information processing heuristics necessary for problem-solving. It is a psychological dimension that highlights the consistencies and patterns of how an individual acquires and processes information (e.g., Ausburn & Ausburn, 1978; Blazhenkova & Kozhevnikov, 2010; Thomson, Watt, & Liukkonen, 2014). The construct of cognitive style represents a specific approach to encoding, storing, and utilising content, usually conceptualized as the characteristic ways in which individuals perceive environmental stimuli, organize and analyse new sensorial input and memory (Guisande, Páramo, Tinajero, & Almeida, 2007; Kozhevnikov, 2007; Messick, 1984), and the use of these interpretations to guide their actions (Hayes & Allinson, 1998).

The term teaching style appears to have no universally accepted definition, but has been broadly referred to in the domain of physical education as 'a set of teaching tactics' (Galton, Simon, & Croll, 1980), 'instructional format' (Siedentop, 1991) and a 'general pattern created by using a particular set of strategies' (Mosston & Ashworth, 1986). In the student learning field, teaching style has been defined by Butler (1984, p. 47) as a collection of "attitudes and actions that open a formal and informal world of learning to the student. It is a subtle force that influences access to learning and teaching by establishing perimeters around acceptable

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learning procedures, processes and products." It is important to also acknowledge the relationship between teaching practices and the principal goals of student learning. More (1993, p. 12) provided a succinct description of this association relevant to the learning of skills and stated the "relationship between teaching style and learning style is analogous to the relationship between learning and teaching. Learning is the acquisition of knowledge, understanding, skills, and attitudes by individuals. Teaching is the provision of a situation in which learning may occur." Furthermore, Wilson (2012) supports the notion that teachers will benefit from an awareness of the learning and cognitive style attributes of their students and noted that the integration of instructional approaches which consider a variety of learning styles may be even more beneficial than tailoring teaching to specifically match student preferences. In contrast, previous literature has also highlighted that learning may still take place in situations where there is a mis-match between teaching and cognitive style (Evans & Waring, 2012).

A commonly considered cognitive style theory in the discipline of educational psychology (e.g., Sternberg & Zhang, 2001; Zhang, Sternberg, & Fan, 2013) is that of field dependence-independence (FDI) (Witkin & Goodenough, 1981). The primary focus of Witkin and colleagues was the examination of individual differences related to distinct cognitive styles labelled field dependent (FD) and field independent (FI). Styles represent an outcome of the developmentally conditioned process of psychological differentiation, which involves the separation of perceptive and intellectual skills and self-differentiation (i.e., conceptualization of the body into a coherent entity) (Witkin, Goodenough, & Oltman, 1979). The specific preference of an individual for a comprehensive view of the visual field (i.e., priority of the whole over components) denotes field dependence, whereas, differentiation, and concentrating on distinct components is a sign of field independence (Witkin, Oltman, Raskin, & Karp, 1971). Supplementary explanations of the FDI concept have focussed more directly on individual differences associated with cognitive processing. The dependent style may "involve slow differentiation (selection) of a figure from the background and lingering of an entire context in short-term memory" (Bednarek & Orzechowski, 2008, p. 54). Individuals who are labelled FD attempt to preserve a figure – pattern during figure differentiation from the background which can result in slower processing of perceptual data and transition between basic mental processes. Handal and Herrington (2004) construed that the FD style may require greater effort and time in the construction of meaningful information when the field lacks structure and limited clues are accessible. The FI style is proposed to employ an active analytic approach for perceiving data that incorporates enhanced differentiation of field fragments against the entire background, fast scanning of both the figure-ground background and criteria for field differentiation (Bednarek & Orzechowski, 2008).

Weiss (2011) proposed that fundamental motor skills need be taught and practiced in order to be mastered, because the skills are not automatic consequences of maturation and physical development across childhood. Understanding how motor skills are learned influences how one teaches effective motor skill attainment. Schmidt and Wrisberg (2004, p. 11) have defined motor learning as "an internal process that reflects the level of an individual's performance capability for producing a particular movement." Specifically, in relation to motor skill learning a sequential progression exists from the foundational to the sophisticated that involves mastering one level and moving on to the next (Haywood, 1993). An example of the process of throwing a ball as described by Schmidt and Wrisberg outlines that a child begins by throwing and chasing on their own, then progress as their skill develops to throwing to a partner. They further add that catching a ball is a stage later in the sequence as it requires additional skills such as "visual tracking, anticipation, accurate hand placement, and time grasping" (2004, p. 13). Overall, the learning process necessitates substantial practice of the basic skills of the motor movement and the capacity that once these are mastered to transition to more advanced stages in the execution of movements with greater "accuracy, consistency, and diversity" (2004, p. 13).

Approaches to teaching areas such as motor skills in physical education vary from the strict and disciplined 'traditional' method towards exploratory and more individualised teaching. Earlier research has demonstrated that student outcomes in learning motor skills will vary dependent on the teaching approach implemented (Emmanouel, Zervas, & Vagenas, 1992). Emmanouel et al. (1992) investigated the effect of the 'direct,' 'indirect,' 'combined,' and 'game-oriented' methods on the development of motor skills of 10 year old Greek children. The 'direct' method is characterised by a central role played by the teacher (teacher-centred method), whereas, the 'indirect' method is marked by the leading role of the pupils (learner-centred method). The 'combined' method was then produced by a combination in approximately equal proportions of the 'direct' and 'indirect' methods. The 'game oriented' method was also created by a combination in approximately equal proportions of the 'direct' and 'indirect' methods, the difference being that the program included only games of low organization, relays, and simple team games. Results showed that there were significant differences in throwing skills between the 'direct' and 'indirect' methods, and between the 'direct' and the 'game-oriented' methods.

Limited previous investigations have considered the connections of a learner's preferred cognitive style and teaching approach in the acquisition of motor skills within the motor skill learning domain. Murray (1979) examined the whole-part methodology issue for teaching physical skills in view of individual differences in the learner's cognitive style. One hundred college students were classified as either holistic or sequential information processors and completed a program of learning to juggle with either whole or part teaching methods. Results clearly indicated that sequential learners using the part method and holistic learners using the whole method took less time learning the motor skill than sequential learners using the whole method and holistic learners using the

part method. Learning efficiency was increased by implementing appropriate instructional strategies to meet the unique needs of the individual learner.

Specific consideration of the cognitive style domain of FDI has previously occurred in relation to physical activity engagement, sporting ability, motor skill acquisition, and student learning outcomes in physical education (e.g., Ennis & Chepyator-Thomson, 1989; Liu, 2006; Liu & Chepyator-Thomson, 2008; McMorris, 1992; Swinnen, 1984; Swinnen, Vandenberghe, & Van Assche, 1986). Liu and Chepyator-Thomson (2008) surmised that because FI individuals have an internalised frame of reference (e.g., internal kinaesthetic information, proprioception detail) in processing information they may have an advantage in sport and motor skill performance and typically favour closed skill over open skill activities. Engaging in physical activity was also found to be more likely in college students that were FI (Liu, 2006). Scores associated with the acquisition of a gross motor skill for a sample of 13 year olds was shown to be significantly greater for the boys who were FI. A correlation value of r = .25 found between these variables for the females reflected the expected pattern for the FDI construct and motor learning but was not significant. Furthermore, Ennis and Chepyator-Thomson (1989) suggested that FD children could have difficulties in achieving learning outcomes in physical education activities where the emphasis is on the understanding of movement concepts that are integrated with the traditional goals of movement performance. Their research involved the delivery of a movement skills program utilising an analytic and individualised teaching structure to a group of 52 FD second grade children. The main finding was that the type of teaching style did allow the productive engagement of the FD students within the activities. The teachers reported that the FD children needed additional support from themselves, or be able to work in larger learning group arrangements that promote the opportunity for socialisation with their peers. In general, physical education and motor acquisition tasks tend to be a teacher centred instructional models, involving the limited use of text content, and regularly incorporating activities that utilise individual practice (Jaakkola & Watt, 2011). It is possible that the common pedagogical framework underpinning physical education is inherently predisposed to the FI style rather than the FD style.

Following consideration of existing theory and research regarding cognitive style and teaching style relevant to the physical education domain, the current study aimed to examine the FDI construct in relation to the motor skill learning of children. To achieve this aim a sample of elementary school students were categorized as either FD or FI, and subsequently participated in one of three physical education classes that followed only the standard physical education program (i.e., control), commenced with an analytic teaching style motor skills protocol, or commenced with a holistic teaching style motor skills protocol. All children completed a ball handling skills task that assessed throwing and catching abilities at the commencement and completion of the treatment. It was proposed that the throwing and catching skills of the children would demonstrate significantly greater improvement when the teaching style group in which they were involved matched their cognitive style. Specifically, FD children in the holistic group and FI children in the analytic group would show significantly greater improvements than the FI children in the holistic group and the FD children in the analytic group. Change in the throwing and catching skills of children in the control group was expected to follow the typical pattern of improvement resulting from participation in the general physical education curriculum.

Material & methods

Participants

Participants in this study were drawn from two elementary school cohorts in Finland and one elementary school in Estonia. The final sample of 163 students aged 11 to 12 years old (M = 11.31, SD = 0.46) comprised 80 boys and 83 girls. Following consent from the schools' Principals, students were asked if they would be willing to participate in a school based project that examines their cognitive style preference and differences in their motor skill learning, as an outcome of their teachers adopting different teaching styles. Students participated in the study voluntarily, and their parents completed an informed consent form. The Ethics Committee of the University of Jyväskylä reviewed the research plan and provided approval to undertake the study.

Measures

Group Embedded Figure Test: The present study utilized the Group Embedded Figure Test (GEFT) designed by Oltman, Raskin, and Witkin (2003). The GEFT is a paper-and-pencil instrument which requires students to attempt to discern simple geometric figures from more complicated patterns. Each complex figure included an embedded simple figure, which the subject is to identify as quickly as possible. The number of correct figures located is taken as the score on the GEFT. This score indicates the position of the individual in the field-independence/field-dependence cognitive style continuum. A high score indicates a relatively higher inclination towards analytical thinking (field independence) or less inclination towards global thinking (field dependence). Categorizations of participants on the basis of their GEFT scores for field-dependence/field-independence were achieved according to the following scoring framework: field-independent - 10-18 points and field-dependent – 0-9 points.

Motor skill performance: A simple throwing and catching measure was developed for the current research and labelled as the *Throwing-Catching Criterion* (TCC). The test required the participants to throw and catch the ball quickly and accurately, thus, incorporating two elements fundamental in many ball-games. Set up

of the test requires a smooth wall surface where two square outlines, 40×40 cm perimeter, are marked by tape on the wall. Distance between squares is also 40 cm. The height of the lower line of the left square from the floor was 1m 30 cm, and right square, 1 m 70 cm. The throwing distance to the target-squares is 2 m 50 cm for the boys and 1 m 70 cm for girls. Each participant was given one attempt on the test to familiarize themselves with the protocol of throwing the ball toward the square and catching the ball after it bounces off the wall and then throwing the ball towards the opposite square. Participants were then given 5-10 minutes warm-up prior to their performance. The student stood behind the throwing line, holding a ball and facing the target. Then the experimenter signalled the start of the test. The first throw should be directed towards the left target-square and then rotate between the left and right target-squares during a 1 minute interval. The International Handball Federation official handball for children was used as the compulsory ball. The scoring of the test was as follows: (a) One point is awarded for each overhand throw that hit the target or on the target lines and the ball was caught successfully; (b) No points are awarded if a student's foot was on or over the restraining line, or if a throw other than an overhand throw was used; or the ball was not caught; or bounced before the caught; and (c) the resultant test score is obtained after a 1 minute interval. The test retest evaluation sample recruited for the reliability evaluation of TCC involved 28 Estonian participants aged from 11-12 years. The test retest correlation for this group was r = .94. The test retest correlation for the sample of 13 girls was r = .97, and for the sample of 15 boys the correlation was r =.96. Tests were performed within a time difference of 5 hours after the first test.

Teaching style protocols

During the course of the study two pedagogical protocols involving the holistic and analytic teaching approaches, respectively, were offered to students as components within standard physical education classes to support the learning associated with motor skill acquisition. The conventional Finnish school PE curriculum includes approximately 15 lessons at both Grade 5 and 6 levels focussing on the development of throwing-catching skills applicable to ball-games across the academic year. The conventional Estonian school PE curriculum includes approximately 15-30 lessons at Grade 5 and 16-20 lessons at Grade 6 focussing on the development of throwing-catching skills applicable to ball-games across the academic year. At each school, the teaching style motor skill treatments lasted for 30 weeks and were implemented for 15 minutes twice per week at the commencement of the physical education classes. The control groups only followed activities from the standard school PE programs.

The pedagogical approach underpinning of holistic or whole game protocol involved the ball-game 'Dodgeball'. The approach promoted student participation to incorporate all the components of the motor skills of which the game consists, noting that the game involves the general use of skills associated with catching and throwing towards a specified target. It was considered by the researchers that this appropriately represented the holistic approach of activity (i.e., a variety skills practiced in task performance) and also represented the assessable elements of the TCC.

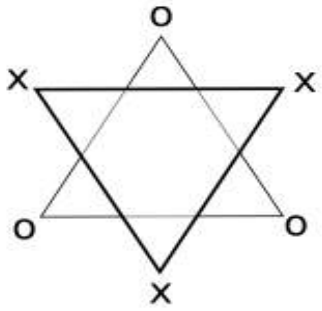

Fig. 1 First phase analytic activity.

In contrast to the holistic approach, the analytic protocol in the current study required students to use only catching and throwing skills at any time to fully engage in the requirements of the tasks that comprised the analytic protocol. The pedagogical interactions of the analytic approach used exercises for developing only throwing-catching skills (two skills from the whole game approach) and were divided into three 10-week phases. Phases progressed by increasing the complexity of the activity, allowing for regulation of the number of throwing-catching attempts and supporting correct performance of skills. In the first phase, one exercise was performed using a single ball in every group to practice throwing and catching only. For example, groups of three children (x – one group; o – another group) pass the ball at the same time. Chidlren in each group only pass their own group members. (see Figure 1). Two exercises were used for the second phase that simultaneously involved throwing, catching and running activities, and the introduction of multiple balls within the tasks. For example, nine persons are running and the distance between each other is 1.5 meters. The arrow of the dashed line show the ball flight and non-dashed line shows the running direction. Every trial lasts 3 minutes. The ball needs to be passed before leaving the runner exits the loop. (see Figure 2). The third phase used exercises from the first and the second phases.

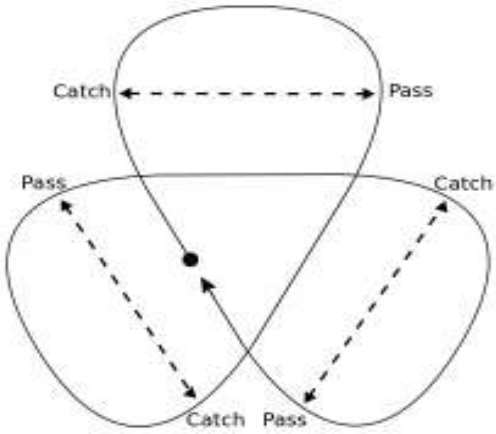

Fig. 2 Second Phase analytic activity.

Procedure

The participants completed the GEFT and provided basic demographic information regarding their gender, and age at the time of testing, during the final term of their Grade 5 year at school. The testing protocol requires the administration of the GEFT in three sections: an initial practice section of 7 items, completed over a 2 minute interval. Participants are then provided with an opportunity to discuss concerns or ask questions regarding the administration, completion or content of the measure. Following this, two sections, each comprising 9 items and requiring 5 minutes to finalise, are completed by the participants. All testing sessions were conducted by the first author in a classroom setting organised by the participating schools. Students were classified as field-independent (FI), and field-dependent (FD), based on their performance on the GEFT.

Teaching style groups were established using a convenience approach, and protocols administered from the commencement of the Grade 6 school year. The first participating Finnish school comprised a control group and the holistic group, which were formed from three classes who were taking physical education at the same time. The second Finnish school comprised a control group and the analytic group, and was formulated from two classes that were completing their physical education at the same time. The Estonian school participants were drawn from four classes that completed their physical education program at the same time as a large cohort that utilised four teaching staff.

To minimise any disruption to normal school practices, the distribution of students into groups could not be based upon equitable numbers of students according to their FDI preference, or to ensure that the sample size of the control and teaching protocol groups were matched. Distribution of participants in relation cognitive style were according to the natural distribution of the students relative to their FDI preference that occurred in any of the control or teaching protocol groups. Additionally, the unequal group distribution was also an outcome of the students being able to volunteer to participate in a particular protocol. This was adopted as the approach so that no child was participating in a protocol they were not comfortable to engage in as a participant. The possible attractiveness of the "dodge ball" game may have been a contributing factor to a higher number of children selecting this protocol. Final distribution of students engaged in the teaching protocol groupings was 53 in the control, 33 in the analytic, and 77 in the holistic.

Pretesting of students using the TCC skills test was completed during the early phase of the European school year. The exact testing date varied depending on the school setting. Post testing of throwing and catching skills occurred during May of the following year at the completion of the 30 week treatment protocols.

Statistical analysis

Due to differences in the TCC throwing distance procedure for boys and girls, change scores were used as the dependent variable rather than raw scores at pre test and post test, as the two variants represent similar procedures but do not result in standardized scores. All statistical analyses were completed using SPSS Version 20. Means and standard deviations were calculated for the dependent variable in relation to cognitive style preference, teaching group, and gender at pre and post test. Univariate analysis of variance (ANOVA) was used to contrast pre and post test throwing and catching skill change scores (i.e., motor skill) of students categorized as field dependent or field independent for each of the control, analytic and holistic teaching groups. The Tukey's HSD (Honest Significant Difference) post hoc test was used to analyse the motor skill change score differences according to teaching protocol group. This test takes account of unequal group sizes in the analysis. A preset alpha level of $\alpha = .05$ was used for all statistical procedures.

Results

Descriptives for motor skill Scores

Table 1 details the summary of means, standard deviations, and change scores for the TCC, according to gender, FDI preference and teaching protocol group before and after the administration of the teaching protocols.

Table 1 Pre, post, and change motor skills scores for Gender, FDI categories and teaching style groups.

Gender	Cognitive Style	Teaching Group	Pre treatment Score		Post Treatment			Change Score
			Mean	SD	Mean	SD	n	
Male	Field Dependent	Control	13.3	4.24	13.2	4.34	10	-0.10
		Analytic	9.64	5.66	9.82	5.78	11	0.45
		Holistic	11.33	4.53	12.04	4.536	27	0.63
		Total	11.35	4.81	11.77	4.84	48	0.44
	Field Independent	Control	15.17	4.36	16.50	5.01	6	1.33
		Analytic	11	3.54	11.67	4.38	12	0.50
		Holistic	11.36	4.34	9.86	5.86	14	-1.43
		Total	11.94	4.24	11.78	5.59	32	-0.19
Female	Field Dependent	Control	10.5	5.85	11.31	7.59	16	0.81
		Analytic	9.5	3.54	16.00	4.24	2	6.50
		Holistic	16.48	7.65	17.00	7.15	29	0.52
		Total	14.15	7.49	15.02	7.59	47	0.87
	Field Independent	Control	12.19	4.24	13.19	4.02	21	1.00
		Analytic	15.88	4.61	21.88	6.36	8	5.00
		Holistic	16.86	3.24	17.29	3.55	7	0.43
		Total	13.92	4.55	15.92	5.69	36	1.78

Table 2 details the means and standard deviations for the motor skill changes scores for the combined male and female samples according to cognitive style and teaching protocol group.

Table 2 means and standard deviations for the motor skill changes scores for the combined male and female samples according to cognitive style and teaching protocol group.

		Motor Skill Change		
Cognitive Style	Protocol	M	SD	n
FD	Control	.46	3.797	26
	Analytic	1.38	3.948	13
	Holistic	.57	2.564	56
FI	Control	1.07	3.222	27
	Analytic	2.30	4.543	20
	Holistic	-.81	4.308	21

Contrast of motor skill change scores based on teaching protocol group and FDI preference

A series of univariate ANOVA's were performed to examine differences between participants' motor skill change scores for the independent variables of cognitive style group and teaching protocol group. A significant between subject difference was found for the teaching protocol category (F (2, 157) = (3.298, p = .040, η^2_p = .040). No significant differences were found for cognitive style or for the interaction of teaching protocol and cognitive style. A significant post hoc difference was found for the contrast according to teaching protocol between the holistic and analytic groups, p = .048.

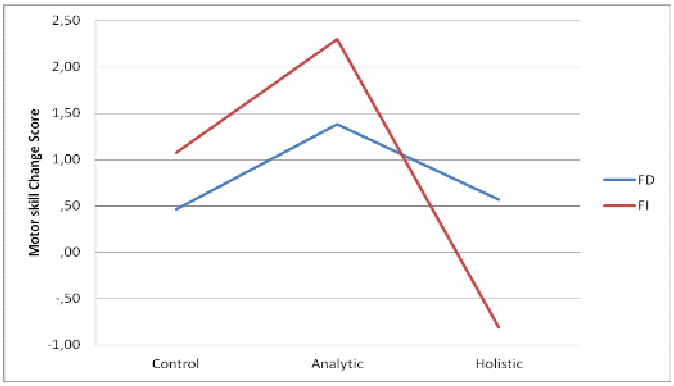

Fig. 3 Motor Skills changes scores for protocol groups and cognitive style

Discussion

The main aim of this study was to extend understanding of the relationship of the cognitive style construct and children's motor skill learning within the school physical education setting. Specifically, this research sought to investigate the influences of both teaching styles and students` field dependence-

independence (FDI) cognitive style preferences on the performance of a motor skills task. Teaching style protocols that focussed on activities aligned with either a field dependent or field independent cognitive style preference were implemented as additional components to the standard delivery of physical education classes.

Earlier evaluation of the relationship of the two style constructs indicated that if students' learning preferences match their instructors' teaching styles, student motivation and achievement usually improve (Stitt-Gohdes, 2003). Treatment groups teachers in the current research implemented different styles as an adjunct to the standard teaching of a motor skill within the physical education curriculum (i.e., control group) and the results demonstrated a partial relationship between matching teaching style and cognitive style. Previous research has also shown that students learn best when they are taught with the method that aligns with their learning style (e.g., Liu & Chepyator-Thomson, 2008).

Analysis of the current data generated basic evidence in support of style matching (i.e., teaching and cognitive) in one domain of FDI. The students who are FI improved in the motor skill task more when taught within the analytic teaching protocol group. Characteristics of the analytic protocol allowed the FI students to focus on separate skill elements of the task, facilitating their improved capacity to undertake the motor movements connected with the performance assessment activity, thus in alignment with the cognitive processing preferences of an FI cohort (McMorris, 1992). Liu and Chepyator-Thomson's (2008) conclusion that FI learners are advantaged within tasks that are reliant on internal kinaesthetic information, proprioception detail, and spatial awareness is also supported by these results as a reflection of the compatibility of the FI cognitive style and the analytic teaching protocol motor skill activities. FI individuals also express a stronger capacity for cognitive restructuring in field dependence-independence theory (Witkin & Goodenough, 1977; Witkin et al., 1977). Cognitive restructuring would contribute to the faster early stage learning of motor skills that lack a clear inherent structure (Swinnen, 1984). Since field-independent people can do better in separating an item (e.g. hidden simple figure in GEFT) from an organized field they should better separate the ball or target from the background (McMorris, 1992).

A strong indication of the impact of teaching and cognitive style mismatching was observed in the decline of the throwing and catching assessment scores for students in the holistic teaching protocol group who were FI. The results also highlighted equivocal trends in the acquisition of motor skills not obviously guided by the matching or mismatching of styles. Students who are FD improved their motor skills marginally more when in the analytic teaching group, however, they showed similar minimal improvements in motor skills across both the holistic and control groups. Previously researchers proposed (Evans & Waring, 2012; Zhang et al., 2013) that although some students are not affected by style mismatch, for others it can impede or stimulate their capacity to engage in their learning in a productive manner.

Overall, the literature has consistently reported that FD individuals, who are less autonomous in decision-making processes and less effective in detecting and using body information (kinesthetic feedback and proprioceptive awareness), tend to demonstrate less desirable performance in sport, motor learning, and physical education settings compared with their FI counterparts (Liu & Chepyator-Thomson, 2009; Swinnen et al., 1986). The current results reinforce the perspective that FD students typically score lower in relation to motor skills as evidenced by the overall smaller change scores for the FD children in the control and analytic groups. Similar skill acquisition results presented by Swinnen et al. (1986) support the proposition that FI children are more successful than FD children in situations with only a general demonstration of a skill and where the individual is reliant on their own organization and structuring of the task requirements. This is because their information processing systems seem to make better use of mediators connected with cognitive analysis and structuring. The pattern of findings also congruent with the explanation that the FD children may benefit from additional support that promotes motor skill development opportunities incorporating an individualised teaching approach (Emmanouel et al., 1992).

Limitations of the current study were associated with the sample size and homogeneity of the cohort recruited. A larger sample involving a broader age range of children would allow for greater generalizability of results. An additional limitation was due to the need to engage pre-existing class composition as the sample rather than being able to balance the student numbers in relation to FDI and motor skill level within each of the teaching protocol and control groups. On-going research should endeavour to work with schools and teachers prior to commencing any interventions to achieve greater consistency in pre-treatment sample sizes related to the dependent and independent variables.

Questions about the necessity to match teaching and cognitive styles and the potential for flexibility in their use continue to surface. Thomson et al. (2014) reported that students´ cognitive style and engagement within the typical school teaching and learning setting are culturally dependent and can consequentially influence the refinement and development of analytical thinking. Although there are benefits to the matching of teaching style and cognitive style, it appears that this alone does not guarantee greater learner achievement. An alternative argument is that the concept of style match requires reconsideration and may warrant attempts to foster students' knowledge attainment via their least preferred styles. Zhang et al. (2013) proposed that mismatching or challenging a student's way of learning with the teacher's approach to teaching could be beneficial from the perspective of encouraging students to engage in the use of learning activities they would not necessarily utilise. One possible way to continue to investigate both consistency and variability in the teaching

style and cognitive style relationship may be based around implementation of Mosston and Ashworth's Spectrum of teaching styles. Students of both FDI preferences would participate in teaching protocols developed based on contrasting approaches selected from within the reproductive and productive style continuum. Assessments indicative of motor skill acquisition would serve to identify if a particular teaching style demonstrates a greater influence on performance change scores within the cognitive style groups. Teachers involved in the delivery of physical education curriculum generally have a pre-existing understanding of the spectrum, which should serve to assist in effective implementation of protocols.

Conclusions

Results of the current research demonstrated a partial relationship between matching teaching style and cognitive style. The students who are FI improved in the motor skill task more when taught within the analytic teaching protocol group. Students who are FD improved their motor skills marginally more when in the analytic teaching group, however, they showed similar minimal improvements in motor skills across both the holistic and control groups. Findings also provided a strong indication of the impact of teaching and cognitive style mismatching that was observed in the decline of the throwing and catching assessment scores for students in the holistic teaching protocol group who were FI.

Overall, these findings highlight children's performance in a motor skill assessment task support an association with the FI cognitive style preference and participation in ball handling skill activities embedded within specific teaching approaches. Future studies could also specifically investigate the role of the dominant teaching style of physical education (i.e., reproductive) in affecting motor skill development in younger children. Monitoring of the learning outcomes of children may generate valuable evidence from which to clarify that the influence of matching cognitive style and teaching style warrant continued attention within the physical education domain.

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