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Chapter 6

Four weeks of goal-directed learning in primary physical education classes.

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ABSTRACT

Relatively little is known about how practice relates to children's improvement in gross motor skill performance. The aim of this study is to determine to what extent6- and 7-year-old children improve their gross motor skill performance in a four-week period, in which goal-directed learning is stimulated and to determine whether differences between boys and girls occur. Groups of 6-year-olds (n=167) and 7-year-olds (n=140) practiced their gross motor skill for four weeks. Physical education teachers stimulated goal-directed learning by their instruction, skill-specific exercises, and individual practice. The week before and after, gross motor skill performance was assessed, using the Körperkoordinationstest für Kinder, and compared with a control group (n=131). Both 6- and 7-year-olds in the intervention group improved their gross motor skill performance significantly more than the control group. The results show the relevance of goal-directed learning for the improvement of gross motor skill performance.

Keywords: Motor development, learning, skill-specific, goal-directed.

INTRODUCTION

The understanding of how practice relates to improvement in children's performance of gross motor skills (GMSs) at a young age is limited. This is remarkable, since GMSs are the foundation for motor development and are considered a prerequisite for learning specific sports skills later in childhood (Malina, Bouchard, & Bar-Or, 2004; Stodden et al., 2008). Although more insight is needed into the underlying mechanisms, practice is the driving force in the improvement of GMS performance' (Clark, 2007; Goodway, Gallahue, &Ozmun, 2013). Especially in early childhood (i.e., from age 6 to around 8), children are expected to improve rapidly in GMS performance due to an acceleration of cortex maturation and to the cortex becoming more organized (Gallahue & Donnely, 2003). In a recent review, Morgan et al. (2013) described multiple studies that supported significant improvement occurring in children ages 4 to 14, even in a short timeframe of four weeks, if developmentally appropriate learning experiences are delivered by experts like physical education (PE)specialists. However, more research is needed to understand how developmentally appropriate learning experiences can be arranged (Morgan et al., 2013). It is hypothesized that appropriate learning experiences can be enhanced when children's goal-directed learning is stimulated. The importance of goal-directed learning strategies for sport performance has been previously shown in studies of talent development (e.g., Toering, Elferink-Gemser, Jordet, Pepping, & Visscher, 2012). Whether goal-directed learning also is of importance in improving GMS performance of children under the age of 8has received little attention in the literature so far. Goal-directed learning can positively be influenced by appropriate instruction (Derri, Tsapakidou, Zachopoulou, & Kioumourtzoglou, 2001). Instruction that directs children toward a goal, i.e., to improve their GMS performance, is assumed to help children learn and improve these skills, especially if time span between instruction, learning, and improving, and measurement is relatively short (Gagen & Getchell,2006; Robinson, Webster, Logan, Lucas, & Barber, 2011). Goal-directed learning can also be stimulated if qualified sport professionals organize skill-specific practice in a challenging environment (Iivonen, Sääkslahti, & Nissinen, 2011). In such an environment, children experience opportunities for individual practice, which has been proven to be an efficient way to improve GMS performance (Karabourniotis, Evaggelinou, Tzetzis, & Kourtessis, 2002; Martin, Rudisill, &Hastie, 2009; Robinson et al., 2011).Professionals expected to be able to organize such an environment are PE teachers. PE is assumed to be an environment in which highly educated professionals support children in their learning by making use of developmentally appropriate and skill-specific exercises (Abbott, Collins, Sowerby, & Martindale,2007; Morgan et al., 2013). However, not much is known about the improvement of GMS performance in typically developing children during PE classes. This gap in the literature is remarkable, especially since PE is most often the first and highly suitable environment where children in early childhood practice and learn to improve their GMS performance in a more structured manner (Clark, 2007). Two variables that are known to be related to the improvement of GMS performance are sex and age (Kiphard & Schilling, 1974, 2007; Vandorpe et al., 2011). Although the basic developmental pattern is similar for boys and girls in early childhood, a few sex differences in improvements of GMS

performance in elementary school have been reported (Ahnert, Schneider, &Bos, 2009). Most studies reported that both sexes improved their GMSs (e.g., Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012; Kakebeeke, Locatelli, Rousson, Caflisch, & Jenni, 2012), while only one study reported greater gains for boys (i.e., McKenzie, Alcaraz, Sallis, & Faucette, 1998) and only one study greater gains for girls (i.e., Sollerhed & Ejlertsson, 2008).When it comes to age, most of the literature regards differences in GMS performance (Ahnert et al., 2009; Chow & Lobo, 2013; Vandorpe et al.,2011) and not about how this factor relates to improvement in GMS performance in various age groups. The aim of this study is to determine to what extent 6- and 7-year-old children improve their GMS performance over a four-week period in which goal-directed learning is stimulated and to determine whether differences between boys and girls occur. It is hypothesized that children will improve their GMS performance over the four-week period, as they are instructed toward a clear goal, are offered skill-specific exercises, and have many opportunities for individual practice in a group setting. There are no expectations about the influence of sex on the improvement of GMS performance in both age groups.

METHOD

Participants

Four hundred and twenty-five children aged 6 (n = 244, 57%) and 7 (n = 181, 43%) (M = 6.4, SD = 0.52), from eight regular elementary schools in the east of the Netherlands, participated in this study. Six schools were used as intervention group (n=294), two schools as control group (n=131); 233 (55%) of the participants were girls, while 192 were boys (45%). At each of the eight schools, a qualified PE specialist administered the PE classes. Permission from the schools and the parents of the children was obtained. The study fits the established ethical standards for sports medicine (Harris & Atkinson, 2011).

Goal-directed learning in PE

All children attended two PE classes of 45 minutes each for four weeks. To improve GMSs, a goal-directed learning intervention was implemented in one of the two weekly PE classes for two periods of four weeks. During these PE classes, the gymnasium was divided in three sections. In one section, one third of the children (six to nine children) practiced for the exercises for 8 minutes. Goal-directed learning was arranged as follows:

1. Goal-directed instruction. The PE teachers told the children that their GMS performance would be tested twice and that between both measurements' children would have the opportunity to practice their GMS performance in PE classes. Furthermore, before each class in which children could practice their GMS performance, the PE teachers reminded the children briefly (15 to 20 seconds) about the purpose of the exercises, i.e., improving GMS performance. At the first class, children received short instruction about the

exercises, and the PE teacher showed how to do the exercises once.

2. Goal-directed individual practice. By providing children with the opportunity to make own choices which exercises to practice to learn and improve their GMS performance, and only using general motivational comments like "come on," "well done," "great performance," all children had the opportunity to learn and improve at their own level and pace of skill development.
3. Goal-directed exercises. Two experienced PE teachers designed seven exercises for typically developing children of 7 years of age. The exercises stimulate the improvement of GMS performance. The exercises were based on information in the Dutch national handbook for PE in primary education (Mooij & Van Berkel, 2011). The exercises were: walking forward over an inclined bench 10 cm in wide on the ground, walking forward over an instable inclined bench10 cm in wide that is placed on another inclined bench on the ground, jumping from a box (100 cm40 cm80 cm) on a gymnastic mat, zigzagging between poles, throwing a ball through a basket, making agile leaps over a low box (100 cm40 cm30 cm) with hands placed on the box, and running over three gymnastic mats (120 cm80 cm10 cm) 1 m apart from each other. The week before the intervention and the week after, children were tested on their GMS performance. GMS performance of children in the control group was also tested the week before and after a four-week period. These children were after the pre-test not told that they would be tested again and followed regular PE classes twice a week. The PE teacher of the control group was not informed about the purpose of the tests.

GMS performance

The Körperkoordinationstest für Kinder (KTK, Body Coordination Test for Children, Kiphard & Schilling, 1974, 2007) was used to measure the GMS performance. This test is a widely used, valid, and reliable instrument to assess GMS performance (Ahnert et al., 2009; Vandorpe et al., 2011). The KTK battery consists of four items:

1. Balance: the child walks backwards on a balance beam 3 m in length and 5 cm in height. There are three beams with decreasing widths (6 cm, 4.5 cm, 3 cm) and on each beam a child has three tries. The maximum score is 24 steps (8 per trial) for each balance beam.
2. Hopping over an Obstacle: a child is instructed to hop on one foot at a time over a stack of foam squares (60 cm x 20 cm x 5 cm) after a short run-up. Three or two points or one point are/is awarded for hopping successfully after the first, second, or third try, respectively. For each leg, a maximum of 39 points could be scored, yielding a maximum score of 78.
3. Shifting Platforms: a child begins with both feet on one platform (25 cm x 25 cm x 5.7 cm) and moves across the floor in 20 s by stepping from one plate to another, transferring to the first, stepping on it, etc. The number of relocations is counted and summed over the two tries.

4. Jumping Laterally: a child jumps laterally as many times as possible over a small beam (60 cmx 4 cm x 2 cm) in 15s. The number of jumps over two tries is summed. All children were assessed under similar conditions during a PE class at school. The testers were students of PE, who were trained to guarantee that the test protocols were used in a standardized way; they were familiarized with the test protocol, and instructions and feedback were given during a training session by a researcher from the University of Applied Sciences. Before each subtest, the children were instructed about the test procedure. Following the manual, participants performed each item barefoot. Administration, scoring, and computation of the KTK test were done according to the manual (Kiphard & Schilling, 2007). For the analysis, the raw scores of the KTK overall score, and each subtest were used.

Statistical analysis

For the four categories of KTK subscales (Balance, Hopping over an Obstacle, Shifting Platforms, Jumping Laterally, KTK Overall Score) for 6 - and 7-year-old children, mean scores and standard deviations were calculated for pre- and post-test scores by group (control, experimental) and sex. Repeated measures analyses of variance (ANOVA) were used to examine group differences for both age groups based on group together with differences in KTK scores over time. The statistical techniques provide comparisons of the subgroups overtime. In the between-subjects analysis, the group effect showed differences in average scores on pre- and post-tests between the control group and the experimental group. In the within-subjects analysis, a measurement effect shows differences between scores on both measurements. An interaction effect between group and measurement revealed differences between the control group and experimental group that change as a function of time. An alpha of .05 was adopted for all tests of significance.

RESULTS

Means and standard deviations for the raw scores of the KTK overall score and for four subtests at pre- and post-test are presented in Table 1.

6-year olds

A significant main effect was found for group, $F(4, 237) = 16.24, p < .05$, Wilks' Lambda = .79. An overview of improvement from pre- to post-test for raw scores on KTK overall and of the four subtests is presented in Figure 1. On average, no differences were found between pre-test children's KTK overall score in the intervention group (M = 113.70, SD = 26.77) and children's score in the control group (M = 117.43, SD = 28.26). At post-test children in the intervention group (M = 135.20, SD =31.43) had a higher mean score on the KTK overall than children in the control group (M = 127.00, SD = 27.93). Concerning the development of GMS performance in four weeks, an inter-action effect was found between measurement and group, indicating that children in the intervention group improved their score

more than children in the control group, F(4, 237) = 21.16, p<.05, Wilks' Lambda = .74. 6 year olds in the intervention group improved more on the subtests Hopping over an Obstacle, F(1, 237) =17.79,p<.05, and Jumping Laterally, F(1, 237) = 56.33,p<.05. No other interaction effects were found indicating that from pre- to post-test, the improvement on Balance and Shifting Platforms is similar for both 6-year-old boys and girls. As can be seen in Table 1, on average, the children in the intervention group improved their mean KTK overall score 21.73 ± 16.77 and children in the control group 10.38 ± 11.69.

7-year olds

A significant main effect was found for group, F(4, 174) = 12.37,p<.05, Wilks' Lambda =.78. An overview of improvement from pre- to post-test for raw scores on KTK overall and of the four subtests is presented in Figure 2. On average, children's mean score at pre-test in the intervention (M= 133.00, SD =31.54) and control group (M = 132.87, SD = 28.48) were similar. At post-test, children in the intervention group (M=160.53, SD = 35.29) had a higher mean score on the KTK overall than did children in the control group (M=141.87, SD=32.70). Concerning the development of GMS performance in four weeks, an interaction effect was found between measurement and group, indicating that children in the intervention group improved their mean score more than children in the control group, F(4, 174) = 14.72, p<.05, Wilks' Lambda = .75. Seven-

year-olds in the intervention group improved more on the subtests Balance, F(1, 174) = 4.93, p<.05, and Jumping Laterally, F(1, 174) = 57.52, p<.05. No other interaction effects were found indicating that from pre- to post-test, the mean improvement on hopping over obstacles and shifting platforms was similar for both 7-year-oldboys and girls. As can be seen in Table 2, on average the children in the intervention group improved their mean KTK overall score 27.79 ± 21.53 and children in the control group 9.00 ± 11.40.

Table 1. Raw scores (mean, standard deviation) for the four subtests of the KTK and KTK overall for 6-year-old boys (n = 109) and girls aged 6 (n = 135), and overall score of children aged 6 (n = 244).

	Age 6							
	Intervention (n = 168)				**Control (n = 76)**			
Overall	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	113.70	26.77	135.20	31.43	117.17	28.26	126.45	27.93
Boys	112.72	25.43	133.49	29.60	114.31	31.97	123.24	28.84
Girls	114.48	27.91	136.57	32.93	120.02	24.83	130.05	27.14
BA	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	25.22	10.34	27.35	11.27	26.35	11.30	30.41	12.64
Boys	23.73	10.42	25.48	11.56	24.91	11.20	28.38	11.67
Girls	26.42	10.28	28.86	10.85	27.79	11.34	32.43	13.22
HS	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total*	24.30	12.58	32.51	11.59	28.66	10.12	31.74	10.61
Boys	24.89	12.48	32.43	11.96	28.37	12.26	30.65	11.98
Girls	23.83	12.69	32.58	11.34	28.95	8.07	32.05	9.47
SP	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	30.24	6.48	33.42	7.63	31.30	8.34	33.33	7.76
Boys	30.52	6.02	32.81	7.10	30.77	9.33	33.47	8.33
Girls	30.01	6.85	33.90	8.04	31.83	7.50	33.21	7.47
JL	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total*	33.93	9.15	41.92	11.64	30.85	7.47	30.73	8.70
Boys	33.57	8.71	42.77	10.95	30.26	6.88	29.86	9.00
Girls	34.23	9.52	41.23	12.18	31.45	7.96	31.60	8.47

*p <0.05

Note 1. – KTK = Körperkoordinationstest für Kinder; BA = Balance; HS = Hopping over an Obstacles; SP = Shifting Platforms; JS = Jumping Laterally

Note 2. – A significant main effect was found for measurement x group. Children in the intervention group improved their score more at the subtests Hopping over an Obstacles and Jumping Laterally

Table 2. Raw scores (mean [SD]) for the four subtests of the KTK and KTK overall for 7-year-old boys (n = 83) and girls aged 7 (n = 98), and overall score of children aged 7 (n = 181)

	Age 7							
	Intervention (n = 126)				Control (n = 55)			
Overall	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	133.00	31.54	160.53	35.92	132.90	28.48	141.96	32.70
Boys	130.31	30.64	159.55	35.76	131.29	25.03	139.96	26.57
Girls	134.95	32.25	161.25	36.25	134.52	32.07	143.85	38.46
BA	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	27.92	11.34	33.85	11.39	30.37	12.35	32.95	13.42
Boys	25.22	11.19	32.93	11.00	27.21	9.95	30.04	9.25
Girls	29.87	11.12	34.53	11.69	33.52	13.87	35.85	16.35
HS	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total*	32.16	14.15	36.84	14.14	32.25	10.45	36.20	12.50
Boys	32.31	14.10	36.44	14.48	33.18	9.65	36.11	10.86
Girls	32.05	14.27	37.13	13.97	31.93	11.36	36.30	14.20
SP	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total	34.66	6.13	39.29	6.65	34.30	7.72	36.44	7.10
Boys	34.89	5.74	38.89	6.16	34.75	7.04	37.32	5.43
Girls	34.50	6.43	39.58	7.02	33.85	8.47	35.56	8.51
JL	M_1	SD_1	M_2	SD_2	M_1	SD_1	M_2	SD_2
Total*	38.76	11.93	51.39	12.25	35.46	8.49	36.33	8.38
Boys	38.11	10.94	52.27	12.58	36.14	7.66	36.50	7.53
Girls	39.22	12.65	50.75	12.05	35.22	9.47	36.15	9.31

*p <0.05

Note 1. – KTK = Körperkoordinationstest für Kinder; BA = Balance; HS = Hopping over an Obstacles; SP = Shifting Platforms; JS = Jumping Laterally

Note 2. – A significant main effect was found for measurement x group. Children in the intervention group improved their score more at the subtests Balance and Jumping Laterally.

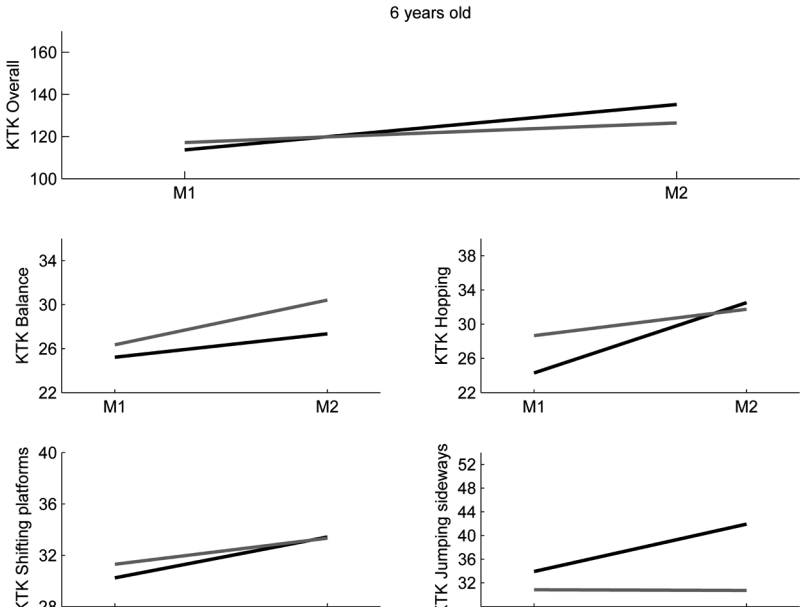

Figure 1. Raw scores at pre and post on KTK overall and each KTK item for 6-year-oldboys and girls. Solid black line represents average score of intervention group, solid grey line represents average scores of the control group.

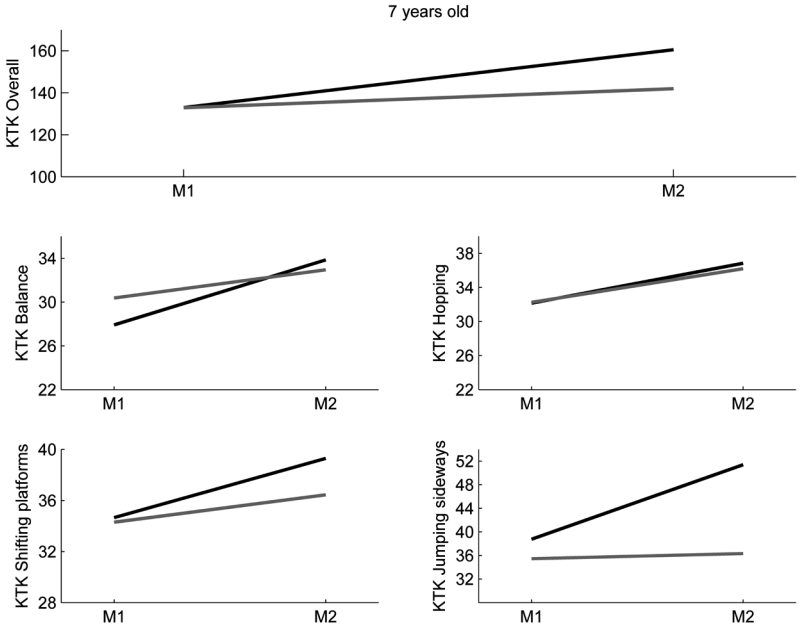

Figure 2. Raw scores at pre and post on KTK overall and each KTK item for 7-year-oldboys and girls. Solid black line represents average score of intervention group, solid grey line represents average scores of the control group.

DISCUSSION

The main aim of this study is to determine to what extent 6 - and 7-year-old children would improve their GMS performance over a four-week period in which goal-directed learning is stimulated and to determine whether differences between boys and girls occur. The results supported the hypothesis. The larger improvement in mean KTK scores from pre- to post-test of the intervention group compared with the control group who followed regular PE classes is expected to be the result of goal-directed learning. The importance of making use of a goal-directed learning strategy for quality of practice has been shown before among adolescents (Iivonen et al., 2011; Toering, Elferink-Gemser, Jordet, Jorna, Pepping, & Visscher, 2011). Children in the intervention and control groups had both two classes of PE of 45 minutes per week for four weeks. PE teachers of the intervention group were instructed to direct children toward a goal (i.e., to improve their GMS performance) by using goal-directed instruction, skill-specific exercises, and many opportunities for individual practice. Other studies have shown the importance of goal-directed learning for performance (Iivonen et al., 2011; Toering et al., 2011), appropriate instruction(Deli, Bakle, & Zachopoulou, 2006; Logan, Robinson, Wilson, & Lucas, 2011;Robinson et al., 2011), goal-directed individual practice (Karabourniotis et al.,2002; Martin et al., 2009; Robinson et al, 2011), and skill-specific exercises (Iivonen et al., 2011; Robinson et al., 2011) for the improvement of GMS performance. It is supposed that this unique combination of methods stimulated goal-directed learning, and explained the improvement of GMS performance, even though the absolute time that children in the intervention group spent practicing their GMSs was relatively short (four times for 8 minutes).For both 6 and 7 year olds, no differences were found in improvement of GMS performance between boys and girls. Apparently, not just the performance itself but also the improvement in GMS performance after a short period of practice is more or less similar in boys and girls. This result is not surprising as differences between boys and girls are more apparent around puberty due to the differences in physical development (Ahnert et al., 2009; Vandorpe et al.,2011). The results of this study suggest that at age 7, children are in a more favourable phase for improving their GMS performance than they are at age 6. The greater improvement in GMS performance of 7-year olds may be explained by a better understanding of the requirements of the given tasks and goals of the lessons. In the current study, the 6-year-old children were probably still in the beginning of a more structured learning process, while at least some of 7-year olds were already at the end of this early childhood phase. It is possible that 7-year-oldchildren profited more from a goal-directed learning environment, because, for example, they are better able to understand the teacher's instructions, to reflect on their own performances, and to make tasks harder for themselves if they want. In this way, 7-year-olds are expected to engage in more deliberate practice, which can then explain differences in performance (MacNamara, Hambrick, &Oswald, 2013). One important question that still remained after the current study was whether there were any sustained or long-term effects due to the improvement in GMS performance after the four-week period. Several studies showed that differences between children's motor skill performance measured short term, remain similar or

increase after four months to two years (Haga, 2009; Matvienko & Ahrabi-Fard, 2010). Apparently, well-improved GMS performance, even after a short period of practice, has long-term effects. As time children spent in PE is often not more than two times per week for 45 minutes, it is highly relevant to develop interventions that improve children's GMS performance effectively and with long-term effects. This is especially true given the importance of well-improved GMS performance to learning and improvement of sport-specific skills and providing children a greater chance of finding activities that they enjoy and can do well(Clark & Metcalfe, 2002; Malina et al., 2004; Stodden et al., 2008).Except swimming, which many children in The Netherlands start with at age6 as did the children in this study, most children were not involved in organized sport activities yet. There is no information available on how much the children practiced their GMSs when not in PE classes and what the possible influence of the environment on this was, such as physical (e.g., opportunities to play out-side, transport to school) and social factors (e.g., parents, peers, siblings). This may have influenced individual differences in the improvement of GMS performance, for example, in the use of goal-directed learning strategies. Perhaps, the children who improved more also practiced their GMS performance more when not in PE classes. Although studies have shown the influence of the environment on the improvement of GMS performance (e.g., Liong, Ridgers, &Barnett, 2015), further research is warranted. To conclude, this study has shown that an environment in which goal-directed learning is stimulated, as in PE classes, can enhance the learning of GMS performance over four weeks. Children who did not experience a goal-directed earning environment improved their GMSs less. Given the importance of well-learned GMS performance, PE teachers should be taught how to implement goal-directed learning into their classes.

Declaration of Conflicting Interests

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