Original Article

Effect of modified equipment on the acquisition of motor task performance among children of low and high working memory capacity: A basketball-based experimental study

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Abstract

The capability of children to learn and retain motor-related tasks could ease the pathway of mastering sport-specific skills that are non-trivial in spurring children's athletic development. Learning motor tasks in children constitute a diverse dimension of constraints that need to be overcome in order to accentuate mastery of tasks. Modification of equipment may facilitate the acquisition of complex motor tasks in synchronization with the learners' specific characteristics. The effect of modified equipment in motor task acquisition in children with different working memory capacities is examined in this study. Forty children aged 9-10 years were recruited and the Wechsler Intelligence Scale for Children was used to determine the working memory capacity of the children. High and low working memory (HWM), (LWM) were identified and allotted into 4 different groups of 10 children each Viz. (A) HWM with standard mini basketball equipment, (B) LWM with standard mini basketball equipment, (C) HWM with modified mini basketball equipment and (D) LWM with modified mini basketball equipment. Basketball throw from the free-throw line in pre and post-tests were used as the acquisition tasks measure. The result from a mixed designed repeated measure revealed a significant difference across the two time points, significant interactions were also observed within memory types and equipment. No statistically significant difference was detected between the two groups with respect to working memory and task acquisition skill. It is postulated from the findings of the present study that customizing learning experiences that do not rely on working memory capacity, could have a positive long-term effect for learning motor skills in children.

Keywords: Skill acquisition, Modified equipment, Working memory capacity, Motor learning

Introduction

Adjustment or otherwise modification of equipment has been shown to facilitate motor learning as well as improve skill acquisition amongst young children in different sporting activities such as tennis, basketball, badminton, volleyball, and baseball (José L Arias, 2012; Buszard et al., 2016; Damayanti et al., 2018; Jackson, S, 1997; Pellett et al., 1994). Such adjustments range from modifying the balls, net, size of the court and in some instances changing the rules of the game for different age categories. The use of standard equipment might present some constraints to children due to the lack of physical preparation and attributes that might be a barrier to the children in learning the techniques better which could consequently lead to a lack of enthusiasm and dropout. Evidence from the previous studies has documented that better performance of physical activities is attained when the equipment is modified to tailor the attributes of the participants (Evans, 1980; Kirk, 2004; Suppiah et al., 2019). This implies that the application of modified equipment in learning motor patterns could accelerate the acquisition of the skills necessary to execute motor tasks. Moreover, changing the equipment with conformity to the age and levels of children as well as unifying the motor activities of children could have a positive impact on the learning process.

Basketball is considered as one of the fancied and most viewed sport in the world with a wider range of amateur and professional players. Children could begin to play basketball as early as 5 years old. It is worth to note that children's participation in a basketball game could foster their development through active movement

as well as promote the acquisition of basic gross and motor skills such as coordination, balance, and agility. Many skills are required to play the game of basketball, nonetheless, for a beginner and children alike, learning to score points (i.e. shooting baskets) could be fun that many would prefer to begin with. This skill would be preferred by both beginners and children since it is a skill that is directly leading to a score. Moreover, it was reported that the skill is the most favourite amongst many participants (Palao et al., 2004); and has also been connected to the attainment of fun and satisfaction in a group of children (Piñar et al., 2007).

Equipment is required to play a game of basketball. This equipment ranges from the ball, the net as well as the rim. The utilization of standard equipment in the sport of basketball might provide a hindrance towards the acquisition of basic motor skills in children and some level of expertise. Similarly, the size of the ball could also affect the quality of the shot in children. Previous researchers revealed that the use of smaller balls could assist the children in the execution of effective shots (Jose L Arias et al., 2011).

The authors further inferred that changing the ball mass could also lead to a better shot. Hitherto, the results of a similar study showed that a decrease in the height of the ring was effective in throwing performances amongst children, but no positive effect was found when the ball dimension was decreased (Chase et al., 1994). Moreover, children were reported to be more motivated when small balls, as well as the sizes of the rings, are lowered. Consequently, the mastery of the skill in a shooting is observed through the execution of quality shots which in turn brings about high motivation in the participants (Chase et al., 1994; Grawer et al., 2003; Hanlon, 2005; Piñar López, 2005).

Working memory capacity is one of the major challenges in the children learning process. This process lasts more than adults. Therefore, the involvement of working memory capacity should be used less than it is used to (Alloway et al., 2006; Grawer et al., 2003; Hanlon, 2005; Luciana et al., 2005; Piñar López, 2005; Thomason et al., 2009). Since working memory plays an important role in explicit motor learning in adults, the development of working memory during childhood will likely increase explicit information processing for obvious information processing. Going by this hypothesis, then the children might learn more in a situation that does not employ more memorization and use of working memory capacity (Berry & Broadbent, 1988; Hammond & Smith, 2006).

It is worth highlighting that reducing environmental as well as equipment constraints could minimize errors and subsequently resulted in the successful delivery of motor tasks. Designing a customized training technique could be used as a panacea to enhance the attainment of motor skills in children with low motor skills. By simplifying skills, children may be more likely to perform their skills using unconscious processing. By contrast, using equipment that increases the skill difficulty (a heavy basketball) may increase the willingness to use conscious processes (Capio et al., 2013). It also seems that the effect of working memory capacity in children's motor learning is high, although its exact role has not been proven. Hence, the present study was intended to test the effectiveness of modified equipment on the performance of 9-10 years old students with high or low working memory capacity in the execution of basketball shots.

Material and methods

Participants

The participants were 40 children without any previous basketball experience. All selected participants were right-handed, between the ages of 9 to 10 and reported no previous injury. Participants were briefed on the physical risks and informed consent was received from parents and participants. The study was approved by the Ethics Committee of the Ferdowsi University of Mashhad (IR.FUM.ICBS.97.1435). Based on their scores in the Wechsler Intelligence Scale for Children - Memory for Digit Span (Wechsler, 1974), the participants were divided into categories High Working Memory Capacity (HWMC) and Low Working Memory Capacity (LWMC). The participants were tested for their performance in the basketball free-throw test before being randomly distributed using the matched-pair design. The description of the groups and experimental task conditions are presented in Table 1. All groups attempted the free throw 4.25 m from the backboard.

Experimental Procedure

Each practice session in the acquisition phase (8 days) consisted of 4 blocks of 15 trials per block. Participants were allowed to rest for 10 minutes before beginning with the next block. A day before the first practice session, participants underwent a pretest for the experimental task; attempting to score from the free-throw line. A day after the final practice session, participants underwent the post-test.

The experimental task for the groups HWMC- Standard and LWMC – Standard performed the basketball free throw under standard mini basketball regulations; from a line 4.25 m behind a backboard with a rim circumference of 45 cm at a height of 2.60m. The ball used weighed 485 g with a circumference between 69 and 71 cm. The HWC – Modified and LWMC – Modified groups used modified equipment; rim circumference 45cm at a height of 2.00m for the experimental task. The ball used had a smaller mass 440g and a circumference between 69 and 71 cm. The specifications of the equipment for the experiment are summarized in table 1.

Table 1: Group descriptions and experimental task conditions.

Group	Experimental Condition	Ball Weight	Diameter of ball	Diameter of rim	Height of basket
HWMC Standard	- High working memory capacity with standard mini basketball equipment.	485 g	21.97 22.61	– 45 cm	2.60 m
HWMC Modified	- High working memory capacity with modified mini basketball equipment.	440 g	21.97 22.61	– 45 cm	2.00 m
LWMC Standard	- Low working memory capacity with standard mini basketball equipment	485 g	21.97 22.61	– 45 cm	2.60 m
LWMC Modified	- Low working memory capacity with modified mini basketball equipment	440 g	21.97 22.61	– 45 cm	2.00 m

Evaluation of the skills

To assess the learning of free-throw basketball skill, the performance in each attempt was determined accordance with the American Alliance for Health, Physical Education, Recreation and Dance (AAPEHRD) basketball test based on which each throw was scored as follows: a 3 point score if the ball hit the basket without hitting the hoop or the board, a 2 point score if the ball hit the board or the hoop of the basket, and a 1 point score if neither the board nor the hoop was hit by the ball.

Data Analysis

Prior to the commencement of the full analysis in the present study, normality distribution assessment was carried out using Kolmogorov–Smirnov tests in order to ensure that the study variables are normally distributed in line with the requirement of the statistical test needed in the study. After confirming the normality distribution of the data acquired, split-plot also known as mixed-design ANOVA, with equipment (standard and modified) and working memory (high and low) as the between-subject factors and performance (pre-test and post-test scores) was conducted. A Bonferroni was used as a post-test measure in this study. A value of $P < 0.05$ was considered as significant level. Statistical software SPSS version 20.00 was used as a platform for conducting the data analysis.

Results

Table 2 shows the descriptive statistics of the variables experimented in the current study. The two-time points (Pre and Post), the types of working memory and the equipment, number of observations, mean as well as standard deviations are displayed. It could be observed from the table that the mean performances of both high and low working memory have increased between pre and post-test with respect to the variations of the equipment used.

Table 2: Descriptive Statistics of the experimental variables

Time	Memory	Equipment	N	Mean $\pm$ SD
Pre-Test	HWM	Standard	10	4.4 $\pm$ 0.699
		Modified	10	7.8 $\pm$ 1.398
	LWM	Standard	10	4.3 $\pm$ 0.948
		Modified	10	7.3 $\pm$ 1.636
Post-Test	HWM	Standard	10	9.1 $\pm$ 0.994
		Modified	10	15.3 $\pm$ 1.503
	LWM	Standard	10	7.7 $\pm$ 0.674
		Modified	10	14.0 $\pm$ 0.816

Table 3 demonstrates the inferential statistics of the within subjected variables investigated in the current study. It could be seen from the table that statistically significant differences were observed with regards to the equipment used at pre and post measurements $p < 0.001$. This result implies that the intervention proposed in the present experiment is effective in accelerating the motor skill acquisition of the children in the study.

Table 3: Inferential statistics of within-subjects' effect

Equipment	Time	Mean	Std. Error	95% CI
standard	Pre	4.35	0.274	3.794 4.906
	Post	8.4*	0.214	7.965 8.835
modified	Pre	7.55	0.274	6.994 8.106
	Post	14.65*	0.214	14.215 15.085

* $P < 0.001$

Table 4 reveals the inferences of between-subject effect measured. It could be detected from the table that there is a significant difference in both pre and post-test with respect to the type of working memory. The results further demonstrate that the children's performances of motor task acquisition have significantly improved across both HWM as well as LWM.

Table 4: Inferential statistics of Between subjects' effect

	Memory	Time	Mean	Std. Error	95% C I	
HWMC	Pre	6.1	0.274	5.544	6.656	
	Post	12.2*	0.214	11.765	12.635	
LWMC	Pre	5.8	0.274	5.244	6.356	
	Post	10.85*	0.214	10.415	11.285	

*P < 0.001

Figure 1. Comparative analysis of the experimental variables in the study.

Figure 1 displays the box plots of comparative analysis of the variables experimented in the current investigation. It could be seen from Figure(a) that the mean performances of both HWM and LWM have greatly increased when the modified equipment was used at pre and posttests whereas, the increase in the mean performance was slightly lower when standard equipment is used in (b). Interestingly, the mean performances of the LWMC group in (c) were observed to be much higher at pre and posttests when the modified equipment is used as compared to standard equipment.

A similar trend was also detected in (d) in which a higher increase in the acquisition of the motor task is observed across the HWMC group when subjected to the use of modified equipment as compared to the standard equipment. Overall, the figure indicated that the acquisition of motor tasks skill could be effectively attained when the equipment used are modified to reflect the characteristics of the children regardless of their working memory capacities.

Discussion

The present study aimed to investigate the effect of modified basketball equipment in motor skill acquisition of children with high and low working memory capacity. The findings of the experiment carried out demonstrated that the adjustment of the equipment was effective in enhancing the children's performance in between pre and post measurement. Similarly, the findings revealed that the performance of the children whilst using modified equipment was better as compared to using standard equipment (Table 2). This finding has substantiated the theoretical believe that modification of equipment might help children to perform better. The finding is therefore incongruent with the proponents of the constraints-led approach who infer that modifying the task allows children to search for new solutions by exploring the practice environment, which ultimately facilitates unconscious processes of learning (Renshaw et al., 2010). In a nutshell, modification of equipment could lead to a positive change in the performance of the children by minimizing working memory capacity in motor learning. Reducing the working memory capacity is an important factor that pushes the children to focus more on the execution of the motor tasks rather than memorizing the techniques needed to execute the tasks which could take longer to master and consequently inhibit faster learning.

It was also found from the findings of the study that both HWMC and LWMC have significantly improved in their motor task performances when subjected to the use of modified equipment as opposed to the standard equipment (Table 3). The more a situation coincides with a test environment, the better the performance will become. These two factors are interrelated (Charles et al., 2017; Magill, 1998). For the acquisition of new skills, the environment and skill interact with each other (Abdullah et al., 2017; Razali et al., 2017). In fact, it was observed from the experiment that the LWMC children were able to improve better at post-tests when they utilized the modified equipment (Figure 1c). Smaller working memory capacity leads to reduce phonological items in mind (Alloway et al., 2006; Baddeley et al., 1998). Hence, children with LWMC face a problem when they want to process the activity with standard equipment such as adult ball. Therefore, the children with LWMC are likely to have experienced the greater difficulty of processing cues when performing with equipment that placed larger loads on working memory (i.e., the standard equipment and adult ball).

Although, no statistically significant difference was detected between the two groups with respect to working memory and task acquisition skill, the performances of the HWMC group was found to be slightly better than the LWMC group (Figure 1a and b). Evidence suggests that children with HWMC are more likely to develop skills faster or better than children with low memory capacity (Buszard et al., 2014). It is believed that children with higher working memory capacity can acquire and use new skills better than those with low working memory capacity whereas children with LWMC are likely to forget skill training and thus are unable to perform the skill correctly (Engle et al., 1991; Gathercole et al., 2008). Nonetheless, it is worth to stress that the lack of differences observed between the two groups of working memory capacities have accentuated the benefit of using customized equipment when training children to acquire new motor tasks irrespective of their working memory capacities.

Conclusion

The aim of the current study was to investigate the effect of modified equipment in motor task acquisition in children with different working memory capacities. It has been demonstrated from the present study that the employment of modified equipment could be a great technique of reducing the demand on working memory capacity for learning motor tasks. The importance of reducing work-related working memory, especially for children could have a positive impact on learning new motor skills regardless of their working memory capacity level. It is inferred from the findings of the present study that customizing learning experiences that do not rely on working memory capacity, could have a positive long-term effect for learning motor skills in children. It is, therefore, recommended that physical education teachers, trainers, as well as coaches, should consider modifying equipment and environment with respect to the children specific characteristics during practice in order to accelerate learning of motor tasks that would go a long way in enhancing skill acquisition as well as better execution of performance.

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