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The Effect of Blocked, Random, and Systematically Increasing Practice on learning of Different Types of Basketball Passes

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ABSTRACT

The purpose of the present research was to examine the effect of blocked, random, and systematically increasing practice on acquisition, retention, and transfer of different types of basketball passes (overhead pass, chest pass and sidearm pass). The participants of the research (N=45; 14.04±0.75) years old) were male, inexperienced junior high-school students who were assigned to blocked, random, and systematically increasing practice groups after performing the pre-test. The participants practiced the skills for 9 sessions (9 trials per session). Acquisition, retention, and transfer tests were conducted 24 hours after the training sessions. The results showed that the effect of training sessions was significant (α=0.05). While there was no significant difference in the acquisition performance of the groups, a significant difference was observed between the retention and transfer scores of the groups. These results support the theory of Magill and Hall (1990) and challenge-point hypothesis of Guadagnoli and Lee (2004).

Keywords: contextual interference, challenge- point hypothesis, blocked, random and systematically increasing

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INTRODUCTION

One of the most important issues in learning motor skills is the learning and training conditions. Learning without variability leads to good performance and poor retention, and variable learning conditions can lead to poor performance but more effective learning [22]. Contextual interference is one way to create variability in practice. Contextual interference (CI) refers to a learning benefit observed when the items to be learned are randomly intermixed across training blocks rather than repeated in blocks (Magill and Hall, 1990). High levels of contextual interference (random practice) require more attention to acquiring skills and employing problem solving techniques, thereby improving learning. Therefore, due to the complexity of random practice, the learners have the opportunity to repeat and refine their responses to trials of different tasks. Although this kind of interference does not create better immediate performance, it can enhance learning. According to this theory, high contextual interference (random practice) disturbs performance but improves retention and transfer, while low contextual interference (blocked practice) has inconsistent effects [21]. Guadagnoli et al. (1999) and Hebert et al. (1996) argued that high contextual interference may be overwhelming at early stages of learning and may lead to degraded performance on retention and transfer tests. Their result ssuggest that when a learner is presented with a challenging task the inefficiency of the information processing system may not interpret needed information which may hinder learning [1]. The stages of learning model proposed by Gentile (1972) suggests that learners need initial repeated trials for movement pattern exploration, trial-and-error correction, and the development of a basic movement pattern to achieve the action goal of the task being learned. A practice schedule offering initial blocked trials would facilitate the achievement of these goals [10, 12]. Seldom can we find consistent results regarding the effect of a particular practice design and usually contradictory results have been reported. Magill and Hall (1990) provided evidence that explained the poor results of CI effect in some studies. They considered the complexity of tasks for a novice as the reason for inefficiency of CI. They suggested that novice learners will learn more effectively if they begin with blocked practice and continue with random practice [7, 23]. Aloupis et al. (1995) proposed a theory based on the models of Miller (1956) and Newell and Rosenbloom(1981). These models suggest that one’s information processing ability is limited, and the amount of information that one is able to process at any given time cannot be increased but the efficiency of processing information can be improved. Hebert (1986) proposed the contextual interference continuum based on skill level as a guideline for more effective application of this method. He argued that inconsistency in findings can be attributed to characteristics of the subjects; contextual interference in less effective in early stages of skill acquisition, while higher levels of CI are very effective at higher skill levels. The motivation caused by success at early blocked practice can increase self-efficacy of the individual in practice [2]. The principle that a learner is inefficient at processing relevant environmental information early in the learning process is supported in the motor learning literature [6]. This inefficiency may be compounded when the tasks are practiced in a high CI schedule [] (Shea et al., 1990). Recently, an attempt has been made to provide an ideal practice method and to reduce the negative effects of blocked and random practice. One of these methods is systematically increasing CI which is a combination of blocked, serial, and random practice. In this method, the amount of CI gradually increases across training sessions. Porter and Magill (2007) examined the effect of blocked practice, random practice, and systematically increasing CI on acquisition, retention, and transfer of golf putting at three distances (0.90, 1.37, and 1.82 cm). The results showed that subjects who undergo systematically increasing CI have better performance in retention and transfer tests. Gentile (1972), Porter (2008), Jefferys (2006), Bjork (1994, 1999), and Guadagnoli and Lee (2004) suggested that gradual increase in CI leads to increased amount and speed of learning. Bjork (1994, 1999) proposed “desirable difficulties”andGuadagnoli and Lee (2004) proposed “challenge-point hypothesis”as important considerations for designing effective practice conditions. Challenge Point hypothesis suggest that consistently challenging learners at the appropriate level during practice creates an optimal learning environment. The practice environment should become progressively more difficult as the learner becomes more skilled. Offering gradual increases in CI is one way to progressively increase the difficulty of the practice environment which is needed to appropriately challenge the learner as their skill level is developed. Jefferys (2006) claimed that gradual increase in CI during practice enhances the subjects’ ability to process information. Lee (2005) argues that more studies are needed on practice scheduling. Magill and Hall (1990) argued that learning tasks controlled by the same or different generalized motor program influences the CI effect. They suggested that CI effect can be observed when the generalized motor program changes. On the contrary, Battig (1979) proposed that similarity of tasks increases the CI effect.There are also researchers who have shown that the CI effect can be observed when the parameters of the motor program changes [22, 23, 24, 5]. As mentioned earlier, one of the practice arrangements that have recently entered the literature on motor learning is systematically increasing CI. Considering the scant research on this practice method, the present research studies the effect of contextual interference on performance of three skills (basketball passes) and compares the effect of systematically increasing CI with blocked and random practice. Moreover, this research examines the predictions of Magill and Hall (1990) and Guadagnoli and Lee (2004) who showed that absence or presence of CI effect depends on the changes in task difficulty and practice method.

MATERIALS AND METHODS

Participants

The participants of the research were 45 male, right-handed junior high-school students of Marivan City (14.04± 0.75 years old) who were not familiar with basketball and who voluntarily participated in the research after providing consent forms.

Instruments
Basketball pass test was used for data collection. Scoring was based on the measured absolute error (the absolute difference between actual performance in each trial and the target). In this experiment, the targets of passes were 20 horizontal lines with 10 cm space between each two lines, drawn on a wall at a 4-meter distance from the subjects (during the acquisition stage). The lines were scaled from +9 to -9 from top to bottom, so that passing toward the space between the two uppermost lines and two lowermost lines would equal a score of 9 and -9 respectively [15].

Procedure
Before any intervention, an introductory session was held where a skilled coach explained different types of basketball passes to subjects (overhead pass, chest pass, and sidearm pass). The scoring procedure was also elaborated by one of the researchers. Although these three skills have different structures and thus the motor programs are different, the number of trials and distance from targets was equal for all the passes. The subjects were required to stand at a 4-meter distance from the wall and pass the ball toward the 0 score line without hitting the ball to the ground. The pre-test was conducted at the end of the introductory session and the subjects were randomly assigned to blocked, random, and increasing practice groups ($n1= n_2= n_3=15$). Each participant performed 27 trials for each pass which and a total number of 81 trials during 9 sessions of practice (9 trials per session). The blocked practice group performed 27 trials of one pass, 27 trials of the second pass, and 27 trials of the third pass. The increasing practice group performed trails 1-27 in a blocked schedule, trials 28-54 in a serial schedule, and trials 55-81 in a random schedulewith equal number of trials for each pass. The random practice group performed trials randomly. 24 hours after the practice period the retention test was conducted with 4 trials of each pass in a mini-blocked schedule (2 trials of overhead pass, followed by 2 trials of chest pass, followed by 2 trials of sidearm pass, and this pattern continues until 12 trials are performed). In the transfer test, the participants performed 4 trials of each pass at a 5-meter distance from the wall.

Statistical methods
Repeated measures analysis of variance was used to examine the effect of practice sessions in the acquisition stage on the performance of the subjects. One-way analysis of variance was applied to compare the performance of subjects in retention and transfer tests. The significance level was α=0.05 in all the tests.

RESULTS

The mean performance of the subjects in the blocked, random, and increasing groups in the basketball pass task is presented in Figure 1.

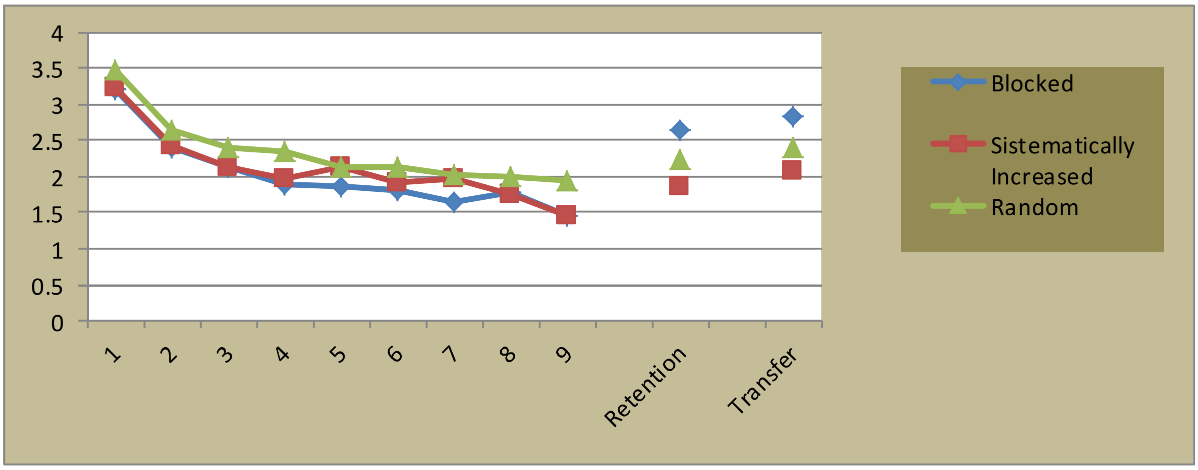

Figure 1. The absolute error scores of the subjects at different stages

Acquisition
Table 1 presents the results of repeated measures ANOVA for the effect of practice group (blocked, random, and increasing practice) by trial block (9 trials per session).

Table 1. The results of repeated measures ANOVA for comparing the performance of groups in the acquisition stage

Source of Variance	Measures	SS	df	MS	F	P
Within-Subject	Practice	87.334	8	10.917	24.69	0.001*
	Group × Trial	1.719	16	0.107	0.243	0.999
	Error	148.528	336	0.442		
Between-Subject	Group	0.829	1	0.412	2.480	0.096
	Error	6.974	42	0.166		

** α=0.05*

As can be seen in Table 1, the analysis shows that the effect of group and the interaction of group and trial block are not statistically significant ($F < 1$).Therefore, there is no significant difference between the practice groups in acquisition of skills. However, the effect of trial block is statistically significant.

Retention and transfer tests

Table 2. The results of one-way ANOVA for comparing the performance of groups in the retention and transfer tests

Tests	Source of Variance	SS	df	MS	F	P
Retention	Within-Group	4.716	2	2.358	8.681	0.001*
	Between-Group	11.405	42	0.279		
	Total	16.121	44			
Transfer	Within-Group	4.297	2	2.141	5.524	0.007*
	Between-Group	16.325	42	0.389		
	Total	17.915	44			

** α=0.05*

Table 2 shows that there is a significant difference between the groups in retention and transfer scores. Therefore, LSD post-hoc test was applied to determine which groups are significantly different (Table 3).

Table 3. The results of LSD test for comparing the performance of groups in retention and transfer tests

Test	Groups	Blocked	Increasing	Random
Retention	Blocked	-----	-----	-----
	Increasing	0.000*	-----	-----
	Random	0.037*	0.040*	-----
Transfer	Blocked	-----	-----	-----
	Increasing	0.002*	-----	-----
	Random	0.012*	0.015*	-----

** α=0.05*

DISCUSSION AND CONCLUSION

Acquisition stage

The findings revealed that there is no significant difference between the practice groups in acquisition scores. This is consistent with the findings of Shea and Morgan (1979), Goode and Magill (1986), French et al. (1990), and Lotfi (2004) who observed no CI effect in the acquisition stage. However, this finding was inconsistent with the results of Goode and Magill (1986), Wrisberg and Liu (1991), Bortoli et al. (1992), and Meira and Tani (2001). The reason for such an inconsistency could be the differences in applied and laboratory skills as well as differences in the number of practice sessions [15, 25]. Lotfi (2004) examined the effect of contextual interference on learning basketball skills in physical education students and showed that due to the appeal of applied tasks a considerable number of exercises are needed in order to create CI effect. On the other hand, Goode and Magill (1986) attributed the lack of significant difference between practice schedules in the acquisition stage to the lower sensitivity of scoring in applied research as compared to laboratory settings. The results related to the acquisition stage did not support the theory of Magill and Hall (1990) who argued that the CI effect emerges when tasks are controlled by different generalized motor programs. The effect of variability in program and parameter on CI effect was examined through laboratory studies [27, 15], but this effect has seldom been supported in applied settings [7, 26, 10].The findings of the acquisition stage do not support elaboration hypothesis and action plan reconstruction hypothesis. According to elaboration hypothesis, the more effortful mental processing engendered by random practice leads learners to appreciate the distinctiveness of the different tasksand results in more unique representations in long-term memory. However, in blocked practice the individual does not engage in intratask processing. Perhaps factors such as few trials and applied tasks are the reasons for significant differences between groups, but these variables largely depend on the nature of tasks and the experience of subjects.

Retention stage

The results showed that there is a significant difference between practice schedules in retention scores. The increasing practice group had the best performance and the blocked practice group had the poorest performance. In other words, the increasing and random practice groups had a better performance in the retention stage than the blocked practice group. Moreover, the superiority of systematically increasing practice suggests the importance of mixing blocked and random practice for reaping the advantages of both methods. Guadagnoli et al. (1999) and Hebert et al. (1996) argued that higher levels of contextual interference may not always be beneficial to learning, for high CI can be overwhelming at early stages of learning and may lead to degraded performance on retention and transfer tests.Their resultssuggest that when a learner is presented with a challenging task the inefficiency of the information processing system may not interpret needed information which may hinder learning [1]. The findings of the present research support the results of Porter (2008) who also reported the superiority of systematically increasing practice over blocked and random practice in a golf putting task. Subjects are faced with few challenges in the early stages of practice with blocked arrangement (low CI) and thus the learners are at an optimal performance environment.The results of the present research in terms of retention support the retroactive interference theory of Shea and Graf (1994).Unlike the action plan reconstruction theory that underlines the advantage of random practice, retroactive interference focuses on the disadvantages of blocked practice. Retroactive interference is a phenomenon where later experiences affect memory for earlier learned associations. In the present research, the blocked practice group had the poorest performance in the retention stage and the reason according to Davis (1988) and Poto (1988) is that later learned patterns in blocked practice tend to act backwards to attenuate the memory strength of earlier learned patterns. However, in random practice and in a part of increasing practice, the individual does not finish a skill before starting the next skill and thus is not subjected to the disadvantages of retroactive interference. In the present research, the CI effect was observed at the retention stage of the motor program which is consistent with the action plan reconstruction hypothesis of Lee and Magill (1983, 1985) and Magill and Hall (1990). Indeed it was the increasing group that again proved its superiority in the retention stage. Considering the significant difference of the increasing and random groups with the blocked group in the retention stage, it appears that these two schedules have similar levels of contextual interference. Some of these complexities were recently organized into a theoretical framework by Guadagnoli and Lee (2004). In their challenge-point hypothesis, they suggested that cognitive processing during practice depends on task difficulty. The nature of the task, practice conditions, and skill level of the learner interact to determine the difficulty of challenges in practice trials. For instance, random practice is more challenging that blocked practice and thus leads to higher levels of learning. This framework proposes that as a learner becomes more skilled during practice the functional difficulty of the practiced task is reduced. As a result, in order toappropriately challenge the learner, the practiceenvironment should change as the learner's skill level changes.

Transfer stage

The transfer task in the present research involved passing the ball at a different distance from the wall. The results of transfer test showed that there is a significant difference between the practice groups, such that the increasing group had the best and the block practice group had the poorest performance. The superiority of the random group vs. the blocked practice group support the findings of Shea and Morgan (1979), Shea and Titzer (1993), Shea and Zimny (1988), Green and Sherwood (2000), Sohrabi (2004), and Fooladian (2006). Since the CI effect in this research was observed by using different motor programs, the findings of the present research support the action plan reconstruction hypothesis of Lee and Magill (1983) and Magill and Hall (1990). One of the interesting results of the present research is the superiority of increasing practice group over blocked and random practice groups in both retention and transfer tests. That is, gradual increase in contextual interference improved learning. These findings show that when individuals begin practice in a blocked schedule, they understand the skill pattern and when this is followed by more contextual interference at later stages, they will have better performance in retention and transfer tests. These results are important, for they show that the possibility of performance decrement which is naturally caused by random practice is reduced without losing the benefit of long-term learning. The findings of the research were consistent with the results of Porter and Magill (2007) and Porter (2008). They argued that gradual increase in contextual interference can create better conditions for novice subjects in golf putting and basketball passing tasks. They also showed that blocked practice is more effective for novice individuals who are beginning to get familiar with the movements, for they are developing basic movement pattern to achieve the action goal of the task being learned. The literature on motor learningsuggests that a learner is inefficient at processing relevant environmental information early in the learning process [6]. This inefficiency may be compounded when the tasks are practiced in a high CI schedule [23]. Gradual increase in contextual interference that can be done by blocked practice at early stages followed by serial and random practice can create an ideal environment for the learner. The stages of learning model proposed by Gentile (1972) suggests that learners needinitial repeated trials for movement pattern exploration, trial-and-error correction, and thedevelopment of a basic movement pattern to achieve the action goal of the task being learned. Apractice schedule offering initial blocked trials would facilitate the achievement of these goals. Bjork (1994, 1999) and Guadagnoli and Lee (2004) suggested that gradual increase in CI facilitates and enhances learning. Consistently challenging learners at the appropriate level during practice creates an optimal learning environment.The practice environment should become progressively more difficult as the learner becomes more skilled. Offering gradual increases in CI is one way to progressively increase the difficulty of the practice environment which is needed to appropriately challenge the learner as their skill level is developed. Although the theory of Guadagnoli and Lee (2004) underlines the complex interaction between the learner, the task, and practice variables supported by many studies, it has its own limitations. This theory has not exactly specified which cognitive processes are being challenged and how they change during practice. It is also recommended that a similar research be carried out with laboratory tasks, different number of exercise trials, different age groups, and with female subjects. One way to properly challenge learners is to change practice arrangement, but the challenge-point hypothesis can be tested with other learning techniques.

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