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ORIGINAL ARTICLE

THE EFFECTS OF CONTEXTUAL INTERFERENCE ON LEARNING VOLLEYBALL MOTOR SKILLS

Abstract

The aim of the current study was to investigate the acquisition of three volleyball skills in three practice conditions (blocked, random and serial) to reveal their effects in three phases of acquisition, retention and transfer. 60 amateur male university students from university of Tehran (Iran) (mean age = 21.5 years, SD = 1.2) were voluntarily selected and randomly assigned to three practice groups: blocked, random and serial. A pretest was used to match the subjects. In the acquisition phase, the subjects of each group practiced three skills of forearm pass, set and overhead serve with 378 trials for 9 sessions. In three sessions in the practice phase, 45 acquisition tests were completed. 48 and 72 hours after the last session, subjects participated respectively in 15 retention and transfer tests. Analysis of variance (ANOVA) and TUKEY post hoc test were used to analyze data, to compare the means of pretest and tests of acquisition, retention and transfer phases of the three practice conditions. The results revealed a significant difference ($p<0.001$) in retention and transfer phases between random (with more interference) and serial (with moderate interference) practice methods with the blocked method (with lower interference) in all three skills. In the acquisition phase, blocked group had higher interference ($p<0.001$). There was no significant difference between random and serial methods in acquisition, retention and transfer phases.

Keywords: Contextual interference, blocked practice, random practice, serial practice

INTRODUCTION

A general viewpoint on contextual interference shows that a blocked practice schedule facilitates the acquisition of a skill while a random practice is more useful in the retention and transfer of that skill (4). Although William Battig (1966) invented the use of random practice schedule versus blocked practice, Shea and Morgan (1979) were pioneers to investigate and criticize motor skill learning. To explain the findings of random practice versus blocked practice, contextual interference was introduced and discussed (11). To verify the findings of random practice versus blocked practice, Shea and Morgan (1979) presented elaboration hypothesis: the effect is related to the elaboration of the skill variations that a learner is practicing. Shea and Zimny (1983) provided a more comprehensive version of the elaboration hypothesis and believed that during a random schedule, the individuals retain and compare all skill variations in their memory so that these variations can be recognized completely. The result of the involvement in this activity during practice is memorable retention which can be accessed easily in tests (13). Other hypotheses also were suggested; adaptive forgetting and action plan reconstruction hypotheses by Lee and Magill (1983) was the most famous hypothesis introduced in a research entitled "when forgetting helps memory" by Cuddy and Jacoby (1982) (19). Magill and Hall (1995) conducted a research on variability of practice and contextual interference in two parts: first, skill variations should include generalized motor programs and second, practice variations include statistical changes of a generalized program (12). Brady (1998) stated several other factors influencing CI: amount of practice (Shea, Kohl and Indermill), recognition effort (Smith), intrinsic interest (Lee and White), experience (Shea et al.), motivational/attentional process (Lee and White), task complexity (Hebert et al. and Wulf et al.), and trait anxiety/self efficacy (Shewokis et al.) (4). A number of researchers suggest that skill retention effects may not be as informative as skill transferability. For example, Shewokis and Snow (1997) suggested that transfer effects are consistently more robust than retention effects within CI research and therefore transfer conditions should be regarded as more reliable indicators of CI benefits (22). Marli and Clark (2004) showed that random practices resulted in a better performance in retention and transfer of handwriting skill acquisition (14). Joao et al. (2007) did not observe the effects of IC in lab versus applied setting while they observed a 60% reduction after skill manipulation in applied setting (7). Shewokis et al. (2003) did not find the effects of CI in a study entitled "Memory consolidation and contextual interference effects with computer games" (23). Menayo et al. (2010) did not observe the CI effects in learning four tennis shots. The results indicated an improvement in

the quality of shots for both practice conditions (blocked and random practice) during the learning phase (16). Emily et al. (2007) showed that behavioral performance between the two groups (blocked and random) was similar. However, toward the end of training, the random group showed greater activity in sensorimotor and premotor regions compared to the block group. These areas are associated with motor preparation, sequencing, and response selection (5). French and Rink (1990) investigated three volleyball skills (forearm pass, set and overhead serve) in three practice conditions (random, random-blocked, blocked). The results showed no significant effects of practice condition during acquisition or retention (6). Bortoli et al. (1992) studied the CI effect on learning skills of volleyball (volley, bump, serve) with high and low CI. The results showed that high contextual interference led to superior performance on retention and transfer tests (3). Laura et al. (2006) examined the contextual interference effect in ninth grade students using three different volleyball skills (underhand serve, forearm pass, and set). All groups improved performance during acquisition; however, there were no significant differences between groups at the end of acquisition or during retention (9).

Jones and French (2007) recognized the manipulation of the organization of practice conditions, through contextual interference of Brady (1998) again and stated that the generalizability of the amount of repetition versus the amount of change in task presentation is questionable and requires investigation. The purpose of their study was to explore explanations for the performance of learners practicing the AAHPERD volleyball skills test when the change in task presentation varied. While all groups significantly improved all three volleyball skills during acquisition, there was no significant CI effect in the retention phase (8). Sepasi et al. (2010) investigated the effects of low and high contextual interference on acquisition, transfer and retention of volleyball service skill of first grade female high school students. AAHPERD volleyball test was used to measure volleyball service. Subjects successively practiced one simple service and one tennis service. The results showed no significant effects the between two groups in acquisition and transfer phases. However, a significant effect was found between the two groups in retention phase (20). Michalopoulou et al. (2007) examined the effectiveness of random and variability of practice versus blocked and constant methods with regard to learning a complex volleyball skill in 120 students of the 9th grade (58 girls, 62 boys), aged 14-15 years. The results showed the significant effect of random and variability of practice (18). Michalopoulou et al. (2007) in another research examine the contextual interference effect on learning three volleyball skills of 26 novice

female volleyball players (M age= 12.4 yr., SD= 1.2) and found no significant difference between random and blocked methods. The findings suggested that either blocked or random practice could be effectively used in learning of volleyball skills by unskilled children (17). Antonius Travlos (2010) investigated the specificity and variability of practice, and contextual interference in acquisition and transfer of a simple volleyball serve in 72 middle-school students (M age = 14.1 yr., SD = 0.7). They were assigned to six groups: five experimental (random, serial, blocked, constant, specific), and one control group. The results showed that a) in the acquisition phase, the specific and constant groups performed better than the serial, random, and blocked groups, and (b) in the transfer phase, the specific and random groups performed better than the serial, blocked, constant, and control groups. He stated that practice in accord with the contextual interference hypothesis permits differentiations among varied practice schedules only during transfer (1).

Although two different theoretical interactions of the CI effect were achieved before (Shea and Morgan, 1979; Lee and Magill, 1983), the involvement of the recognition activity is observed during learning in both interactions (11). With regard to the advantages of CI effects in learning and various findings in volleyball skill studies, the researcher aimed to examine and compare the effects of blocked, random and serial practice schedules on the acquisition, retention and transfer of three volleyball motor skills (forearm pass, set and overhead serve).

METHODOLOGY

The aim of the present study was to examine and compare the effects of blocked, random and serial practice schedules on the acquisition, retention and transfer of three volleyball motor skills (forearm pass, set and overhead serve). The CI effect on learning the skills was designed based on variability of practice including generalized motor programs by Magill and Hall (12) and volleyball skills were designed by Bortoli et al. (3), French and Rink (6) and Jones and French (8). A quasi-experimental method was used in this study. The statistical population consisted of all students of faculties of University of Tehran who had taken ‘second course of physical education field (second semester 2006-2007). 60 male students (mean age 21.5$\pm$1.2 years) volunteered to participate in the study. Participants were selected by a questionnaire including individual characteristics, sport career and familiarity with volleyball skills. Those subjects with no volleyball practice experience were selected using the data obtained from the questionnaires. Then, they were randomly assigned to three

groups: experimental 1 (blocked), experimental 2 (random) and experimental 3 (serial). A pretest was conducted. Analysis of variance (ANOVA) and Tukey post hoc test were used to analyze the data, the compare the means of pretest and tests of acquisition, retention and transfer phases and blocked, random and serial practice schedules. In order to avoid the probable effects resulting from a change of practice condition or an interval in acquisition, retention and transfer phases, the trials of three skills in the blocked practice were as follows: set skill in the first, fourth and seventh session; forearm pass in the second, fifth and eighth session; overhead serve in third, sixth and ninth session. The acquisition test of the blocked practice method was conducted at the end of each practice session; the acquisition tests of the random and serial practice methods were conducted at the end of the third, sixth and ninth practice sessions and the reason was that the practice of 42 trials of each skill in the blocked method finished on that very day (each skill was practiced with 42 trials on one day out of three days) while in the random and serial methods, 42 trials were performed every day (all three skills and 14 trials for each skill) and finally each skill had 42 trials after three days. The same procedure happened in the second and third three-days.

Table1: The schedule of three practice methods in three phases

Pretest	Practice method	Acquisition	Retention	Transfer
T1	Blocked	T2	T3	T4
T1	Random	T2	T3	T4
T1	Serial	T2	T3	T4

Practice schedule:

Practice and skill method: the subjects of all three groups performed the three volleyball motor skills (set, forearm pass and overhead serve) in 12 sessions including instruction, practice and retention and transfer tests). Set, forearm pass and overhead serve in the blocked method were instructed respectively in the first day (set), fourth day (forearm pass) and seventh (overhead serve); all three skills in the random and serial methods were instructed in the first day because the subjects had to learn all the skills in the first day so that they could practice them by random and serial methods during the practice days. The skills were practiced with 378 trials with blocked, random and serial methods. 60 acquisition tests with blocked method was conducted for the three skills (set, forearm pass and overhead serve) following the practice sessions in the first, second and third three-days. 60 acquisition tests

with random method and 60 acquisition tests with serial method were conducted in the third, sixth and ninth days. 60 retention tests were conducted 48 hours after the practice; after the location of subjects had changed, 60 transfer tests were conducted 72 hours after the practice as follows:

Retention test of set: the subject is located in area 6 on the volleyball court; he passes the ball received from area 3 on the court of his team over a rope placed 2.40 meters above the 1/3 line to the targets (1.20 x 1.80 m) in area 2 and 4 on his own court; totally, there were 20 passes (10 passes for area 2 and 10 passes for area 4).

Retention test of forearm pass: the subject is located in area 6 on the volleyball court; he passes the ball received from area 3 on the court of his team over a rope placed 2.40 meters above the 1/3 line to the targets (1.20 x 1.80 m) in area 2 and 4 on his own court; totally, there were 20 passes (10 passes for area 2 and 10 passes for area 4).

Retention test of overhead serve: this test was randomly conducted for the three groups (blocked, random and serial) from a 10m distance and 1/3 of the right side and volleyball ground (they had practiced before).

Transfer test of set: the subject in area 6 on the volleyball court (1.50m x 1.50m, 1.50m from sideline and end-line of the volleyball court) and then in area 2 on the volleyball court (1.80m x 1.50m, 1.20m from central line and tangential with sideline of the volleyball court) passes the ball (20 passes, the subject's location and the location of receiving pass changed in the last 10 passes) to area 4 on the volleyball court (1.80m x 1.20m, tangential with central line and sideline of the volleyball court).

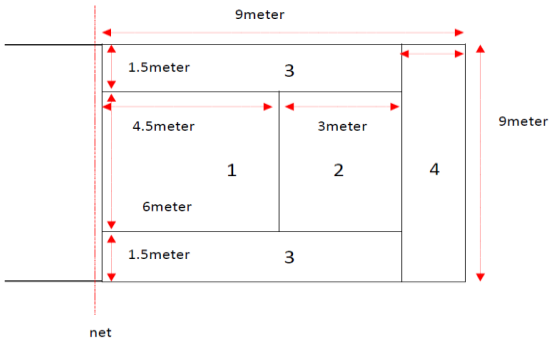
Transfer test of forearm pass: it was the same as transfer test of set.

Transfer test of overhead serve: it was conducted from behind the net and 1/3 of the left side of the court considering the fact that the location was different from the practice location for all groups.

20 trials were performed for each skill (set, forearm pass and overhead serve) in each practice method (blocked, random and serial) (totally 60 trials) and retention and transfer tests were randomly performed.

Scoring subjects' performance:

The scoring procedure was designed based on the accuracy of receiving and directing the ball in the set and forearm pass as well as the accuracy of the area in which the ball lands in overhead serve by AAHPERD-2 test (1). (2,15).



1	Ball landing in area 1 (AAHPERD-2)	4score
2	Ball landing in area 2 (AAHPERD-2)	3score
3	Ball landing in area 3 (AAHPERD-2)	2score
4	Ball landing in area 4 (AAHPERD-2)	1score
5	The ball does not pass or it lands off-court	

Figure 2: scores of subjects' performance and score ranks in volleyball court (AAHPERD-2 test)

FINDINGS

As the aim of this study was to compare the blocked, random and serial practice methods, the effects of each practice method in the acquisition, retention and transfer phases of volleyball skills were analyzed. The results were as follows:

Acquisition phase: there was a significant difference among set, forearm pass and overhead serve skills in blocked, random and serial practice schedules ($p<0.001$) and the priority belonged to the blocked practice schedule while there was no significant difference between random and serial practice methods.

Retention phase: in this phase, this priority belonged to random and serial practice schedules compared with the blocked method. The comparison of blocked, random and serial practice schedules showed a significant difference among set, forearm pass and overhead serve skills in blocked, random and serial practice schedules ($p<0.001$) and the priority belonged to the random and serial practice schedules while there was no significant difference between random and serial practice methods.

Transfer phase: in this phase, this priority belonged to random and serial practice schedules compared with the blocked method. The comparison of blocked, random and serial practice schedules showed a significant difference among set, forearm pass and overhead serve skills in blocked, random and serial practice schedules ($p<0.001$) while there was no significant difference between random and serial practice methods.

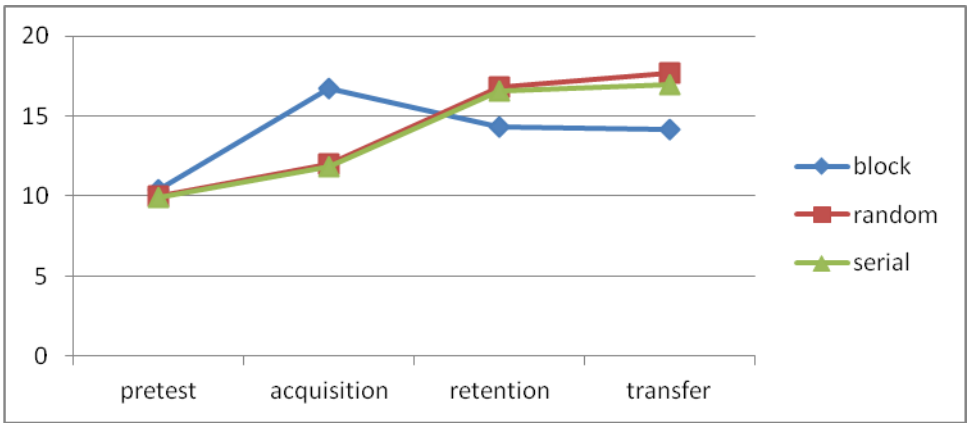


Figure 3: Performance of blocked, random and serial practice methods in volleyball set

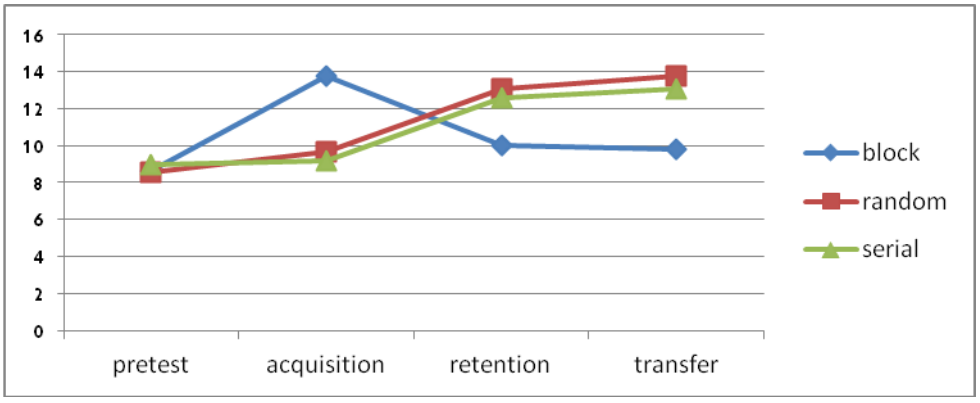


Figure 4: performance of blocked, random and serial practice methods in forearm pass

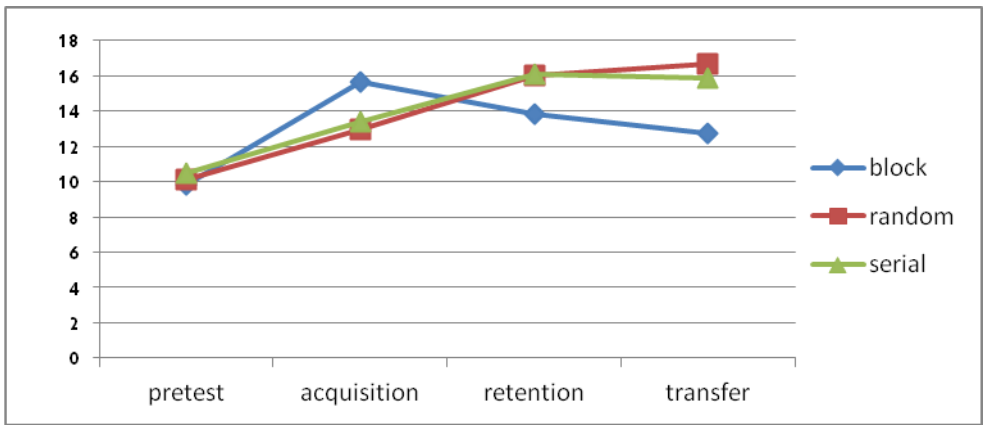


Figure 5: performance of blocked, random and serial practice methods in overhead serve

DISCUSSION and CONCLUSION

The aim of the present study was to examine the CI effects on organizing instruction and practice of volleyball skills in three practice schedules: blocked (low CI), serial (moderate CI) and random (high CI) so that the learning of 60 university students could be evaluated in the acquisition, retention and transfer phases of the above mentioned schedules. The findings of this study showed a significant difference ($p<0.001$) in favor of blocked practice schedule in the acquisition phase compared with random and serial schedules in all three volleyball skills of set, forearm pass and overhead serve; therefore, this finding is in line with the findings of Shea and Morgan (1979), Lee and Magill (1983, 1985) and Lee et al. (1985) (4, 10, 21). The better performance of the blocked group is due to the fact that interfering trials did not exist and that the subjects could perform the skills without a need for new processing. So, a previously prepared action plan readily available from trial to trial is used by their short-term memory and as a result, their performance improves. But in random and serial practice groups, based on adaptive forgetting and action plan reconstruction hypotheses, they should plan a new skill and therefore the performance drops. In other words, CI resulted in the weak performance of random and serial methods in the acquisition phase as it involves the subject in intratrial and intertrial processing. Therefore, such perceptive processing and recognition attempts in the acquisition sessions improve performance in the retention and transfer phases.

The finding of this study are also in line with the findings of Bortoli et al.(2005) Michalopoulou et al. (2007) and Antonius Travlos (2010). They concluded that complex skills in random practice condition increases the complexity of practice in acquisition sessions (i.e. the subject's involvement in recognition processing related to skill nature results in the weak performance in the acquisition phase (1, 3, 17). But this finding is not in line with Goode and Magill (1983), French and Rink (1990), Laura et al. (2006), Jones and French (2007), Michalopoulou et al. (2007), Emily S. et al. (2007), Menayo et al. (2010) and Sepasi et al. (2010) (6, 8, 9, 16, 18, 20). They did not observe a significant difference in the performance of practice groups. Laura et al. (2006) stated that volleyball skills might be too complex for ninth grade students to utilize CI. The reason why these findings are not in line with the above mentioned findings is probably skill complexity, subjects' skill level and practice duration, especially this relationship is not robust in the acquisition phase as this effect should appear in the retention and transfer phases. This difference in the retention phase was in favor of random and serial practice methods. This finding is in line with CI studies of Shea and Morgan (1979), Wright and Black (2000) and the first part of Magill and Hall (1990)

hypothesis: the priority of the practice with high interference (random) over the practice with low interference (blocked) and Brady (1998) hypothesis: the priority of the practice with high interference over the practice with low interference in learning similar and different skills (13, 21, 4). Wright and Black (2000) provided support for the claim that random practice not only leads to improvements in the completion of intratrial movement planning processes but also affects the structure of the memory developed during practice (24). Magill and Hall and Brady stated that to develop high CI, task variations should be governed by different generalized motor programs (GMPs). Michalopoulou et al. (2007) suggested that the combination of random and variable practice contributed in the acquisition and retention of a complex volleyball skill, only when it was preceded by variable and random practice of the three volleyball skills (17). This finding is also in line with Emily et al. (2007) study which indicated that the random group showed greater activity in sensorimotor and premotor regions compared to the block group (20). The results of Michalopoulou, Emily and Sepasi showed that the practice with high CI would result in better learning due to the more significant perceptive process of the learned task. The findings of the present study are in line with some researchers who suggested that the retention effects are not as effective as skill transfer. For example, Shewokis and Snow (1997) suggested that transfer effects are consistently more robust than retention effects within CI research and therefore transfer conditions should be regarded as more reliable indicators of CI benefits (22). Bortoli et al. (1992) found significant differences among the groups on a transfer test (long transfer) for the serve (3). Also, Shewokis (2003) in her study to calculate the amount of the effects of retention and transfer tests concluded that there was a large effect with random practice schedule during transfer (25).

Antonius Travlos (2010) stated that practice in accord with the contextual interference hypothesis permits differentiations among varied practice schedules only during transfer (1). The above mentioned results show that the effect of transfer test is more than retention test and it can be used as a stronger index. The above researchers approved the positive effects of high CI in the transfer phase. They also provided support for the claim that the practice with high CI improves both action plan reconstruction and memory elaboration (4). The findings of the present study are not in line with the following researches: Sepasi et al. (2010) used AAHPERD volleyball test to measure volleyball service. The results showed no significant effects the between two groups in acquisition and transfer phases (20); Michalopoulou et al. (2007) stated that such volleyball practice comparison may be too complex for the students

aged (M age= 12.4 yr., SD= 1.2). They also stated that a combination of random and variable practice schedules is useful in the acquisition and retention of complex task only if the subjects have experience of random and variable practice career in three volleyball simple skills (18). The present study examined and compared CI in organizing three volleyball skills and the results showed the effectiveness of blocked practice schedule (low CI) in the acquisition phase in all three volleyball skills (forearm pass, set and overhead serve) and its reduction in long retention and transfer phases in the blocked group. This effectiveness was reverse in random and serial practice schedules with high and moderate CI. It means that in the acquisition phase, random and serial practice groups did have this effectiveness while in retention and transfer phases, random and serial groups showed the CI effectiveness in all three skills (forearm pass, set and overhead serve) ($P<0.001$) and supported the claim that practices with high CI improves performance in elaboration hypothesis, adaptive forgetting hypothesis and action plan reconstruction hypothesis.

It can be concluded that blocked practice schedule in the first stages of learning and later random and serial practice schedules as well as a combination of blocked-random and/or blocked/serial practice methods are useful and enhances learning. As CI researches show different results, it is suggested that more researches into different ages, genders, high, moderate and low CI and their combination with various issues such as tasks with different complexities, feedback and mental practice be conducted.

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