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The Effect of Practice Arrangement (Contextual Interference) on Acquisition, Retention and Transfer of Generalized Motor Program and Parameter

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Abstract: The aim of this study was to analyze the effect of various practice arrangements on acquisition, retention and transfer of generalized motor program and parameter. In this study two single experiments were used and the researcher selected 120 subjects (5 groups, each 12 subjects). Subjects performed the first experiment with the aim of light pursuing on monitor screen with stable motor program and variable parameter. In second experiment which was the same as the first one, light pursuing with stable parameter and variable motor program was used. Subject performed the pursuing of light for 20 seconds and time-on-target (TOT) was recorded by the computer as performance score. The subjects after participating in pretest practiced 9 sessions in acquisition phase and in the end, they participated in retention and transfer experiments. Data were analyzed by statistical methods: ANOVA, co-variance, repeated measure and Duncan test. The results showed that practice arrangement of various methods in acquisition and transfer of parameter had significant differences. There was no significant difference in retention phase. Also, differences among practice arrangement of various methods in acquisition, retention and transfer of generalized motor program were significant.

Key words: Practice arrangement % Acquisition % Retention % Transfer % Generalized motor program % Parameter

INTRODUCTION

Motor skills constitute a great part of human life. Scientists and coaches have been trying for years to recognize the factors determining and affecting the skill performance and skillful movements. It seems that motor learning is affected by two main processes: learning generalized motor program (GMP) and learning parameter.

Various factors affect the acquisition, retention and transfer of motor skills. Practice conditions, feedback, type of the task, etc. as the factors stabilizing the response and consequently developing generalized motor program on the one hand and other factors modifying the response and consequently increasing the learner's capacity to precisely parameterize the movements on the other hand result in challenges and disputes. One of the existing challenges is practice condition and arrangement (contextual interference and practice modification) which variously affect generalized motor program and parameter learning.

There are various viewpoints on the contextual interference and its processes. Shea and Morgan (1979) and Shea and Zimny (1983 and 1988) proposed that when practice is performed in a random order, it has some advantages to learn via interaction between the working memories of two or more similar tasks. An increase in the interference in working memory during practice results in an increase in a distinctive and vast processing and ultimately facilitates retention [1, 3]. Lee and Magill (1983 and 1985) and Magill and Hall (1990) proposed that interference results in unteach of practice paradigms in working memory. Therefore, these paradigms are randomly reconstructed in each novel attempt. This reconstruction process results in an increase in retention and transfer.

Lee and Magill believe that the contextual interference effects will be clear when using various generalized motor programs. In other words, a change in the parameter cannot result in the incidence of great effects of contextual interference. Based on this theory, a

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parametric change at a generalized motor program level cannot facilitate the performance in different phases of practice [1-3].

The results of several studies such as Magill and Anderson (1996) and Shea et al. (1990) point out that the contextual interference effect can be created through a change in a similar motor program. Contrary to the first viewpoint, Battig (1979) reports the similarity of tasks as the factor to increase the level of interference [3]. Shea (2001) investigated the effects of consistent and variable practice conditions on relative and absolute timing in four practice methods of consistent, variable, chain and random. He found out that blocked and consistent practices were more ideally performed than chain and random practices during acquisition phase and observed the opposite effects of the acquisition phase during retention and transfer [4].

Sekiya *et al.* (1996) found out that chain practice did not improve generalized motor program learning in comparison with the blocked practice [5]. In many researches related to the contextual interference, only the two ends of contextual interference continuum were considered and these researchers considered the blocked practice as the low interference and random practice as the high interference. These researches did not consider the medium point of the continuum and other interference phases [3].

In regard to the above mentioned information and contradictions, there will be a question: can parametric changes in a motor program result in a deeper processing? Can parametric changes result in contextual interference? Or are the effects of deeper processing and interference effects possible only if there are various generalized motor programs? Do various methods of practice arrangement (blocked, random, chain, random blocks, etc.) create different phases of contextual interference and processing effects? Do the mentioned practice methods equally affect the acquisition, retention and transfer of generalized motor program and parameter? Ultimately, in what order are the continuum and the levels of interference effects adjusted in the generalized motor program and parameter? The present study is designed to answer these questions.

MATERIALS AND METHODS

Subjects: The statistical population of the present research was right-handed male university students of Ferdowsi University of Mashhad (age range 18-28 years). They were not familiar with the considered tasks. 120 students were randomly assigned to 10 groups (5 groups each experiment and 12 members each group). The method was quasi-experimental. There were two separate experiments in this research, involving 5 groups: blocked, chain, random, random blocks and control.

Procedures

First Experiment: The practice used in this research was a tracking task by a digital rotary pursuit which measured time-on-target in each attempt. It examines the coordination between the eyes and hands and was designed based on the Lafayet model and consisted of two parts (software and hardware). The reliability of this instrument was calculated by the retest (Cronbach's alpha=86%). Subjects tried to pursue the light in each attempt to perform the task. In the first experiment, the generalized motor program (circle) was the same for all groups and only speed parameter was different (A=20 rpm, B=30 rpm and C=40 rpm). 18 attempts were performed in two 9-repetition blocks in each session (the time-on-target was 20 seconds in each attempt): three attempts with the speed of 20 rpm, three attempts 30 rpm and three attempts 40 rpm (3x3x3=18). The time interval between each two attempts was 5 seconds and the total time allocated to each subject in each block was 3 minutes and 40 seconds.

Second Experiment: This experiment was the same the first one. The difference was that speed parameter (30 rpm) was the same for all groups and all attempts and the generalized motor program was different (A=circle, B=square and C=triangle). Other experiment methods such as the experimental groups of practice arrangement, number of attempts, etc. remain unchanged.

Data Collection

Pretest: Pretest in each experiment consisted of a 9-attempt block (3x3) in order to ascertain the homogeneity of the groups randomly assigned.

Acquisition Phase: After the pretest, the subjects performed for 9 sessions (9 days), two 9-attempt blocks (18 attempts) in each session and totally 162 practice attempts. The time-on-target was 20 seconds. The time interval between each two attempts was 5 seconds and the total time allocated to each subject in each block was 3 minutes and 40 seconds.

Posttest and Retention Phase: In the posttest (acquisition test), the subjects performed a 9-attempt block (3x3x1) in each experiment like the practice attempts of the pretest immediately after the last attempt of the acquisition phase.

In the delayed retention phase, the subjects performed a 9-attempt block (3x3x1) in each experiment like the practice attempts of the pretest after 72 hours. Before the delayed retention phase, three attempts (3x1) were performed to omit warp–up decrement effect.

Transfer Phase: After the delayed retention phase, transfer phase was performed separately in each experiment. In the first experiment, the speed of 50 rpm (new parameter) and in the second experiment, the figure "8" (new generalized motor program) were considered as transfer tasks. The subjects performed the required task in a 9-attempt block in each experiment.

Statistical Analysis: As the subjects of each experiment were divided into 5 groups, each experiment consisted of acquisition, instant retention, delayed retention and transfer phases. Therefore, descriptive statistics were used to classify the data, to average the performance, to draw figures, etc. as well as ANOVA, Leven test, repeated measure and Dunkin post hoc test to analyze data, to statistically inference the hypotheses at different experiment phases to observe the difference among different groups. Repeated measure was used to compare the changes of each group during different practice phases. SPSS and Excel software were used to revise and analyze data.

RESULTS

Repeated measure ANOVA assessed the average performance of groups during different phases of the experiment (pretest, acquisition phase, posttest, delayed retention and transfer). As shown in Table 1, there is a significant difference in the average performance scores among groups during experiment phases, groups and phases + groups (P<0.001).

As the differences among groups were significant, Dunkin post hoc test was used to determine the points of differences. The results showed that there was a significant difference between subgroup 1 (control group) and other subgroups and sub-subgroups. There was no significant difference among the sub-subgroups of subgroup 2 (blocked and chain groups) as well as no significant difference among the sub-subgroups of subgroup 3 (blocked, random and random blocks groups). But there was a significant difference among the sub-subgroups of subgroup 1, 2 and 3. In other words, among practice groups, chain and blocked groups performed weaker than random and random blocks groups (Table 2). Other information is presented in Fig. 1 and 2.

Second Experiment: Repeated measure ANOVA assessed the average performance of groups during different phases of the experiment. As shown in Table 3, there is a significant difference in the average performance scores among groups during experiment phases, groups and phases + groups (P<0.001).

As the differences among groups were significant, Dunkin post hoc test was used to determine the points of differences. The results showed that there was a significant difference in the average performance score between subgroup 1 (control group) and other subgroups and sub-subgroups. There was no significant difference among the sub-subgroups of subgroup 2 (chain and blocked groups) as well as no significant difference

Table 1: Repeated measure ANOVA for performances in different phases

	Index			
Phase	DF	F	P	Result
Experiment phases	3	5.118	0.001	A significant difference
Groups	4	7.021	0.001	A significant difference
Phases + groups	12	11.861	0.001	A significant difference

Table 2: Dunkin post hoc test for groups' performances in different phases

		"=0.05		
Groups	N	1	2	3
Control	12	13.0917		
Chain	12		14.4513	
Blocked	12		14.6688	14.6688
Random	12			14.8833
Random blocks	12			14.9643
Significance level		1.000	0.118	0.067

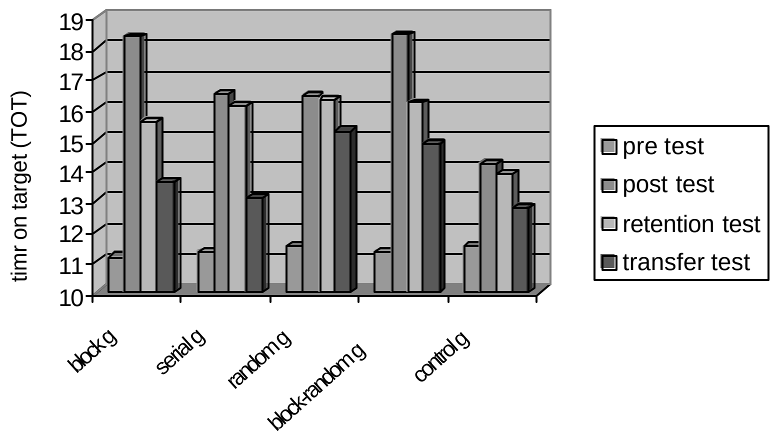

Fig. 1: The performance of different groups in various phases

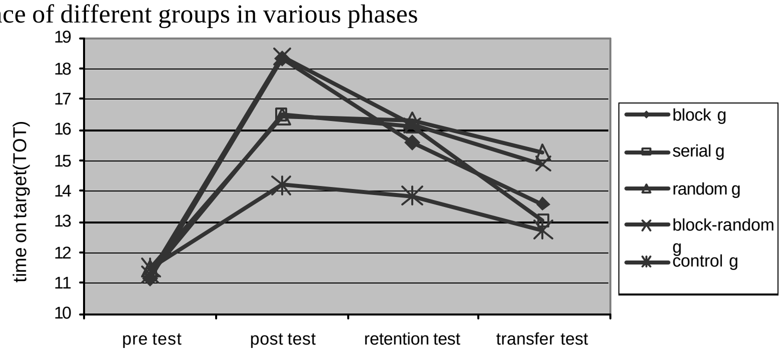

Fig. 2: The performance (parameter) of the groups in various phases

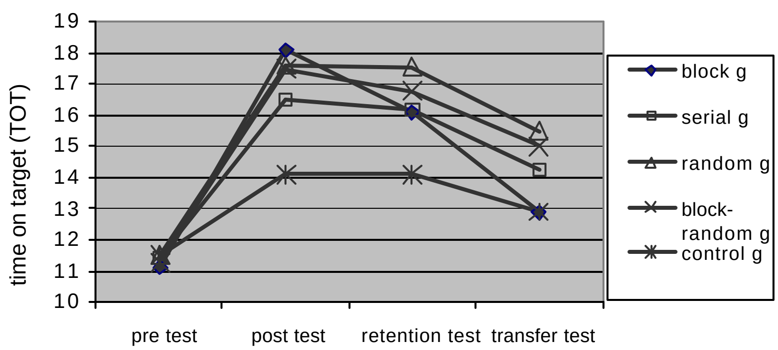

Fig. 3: The performance of different groups in various phases

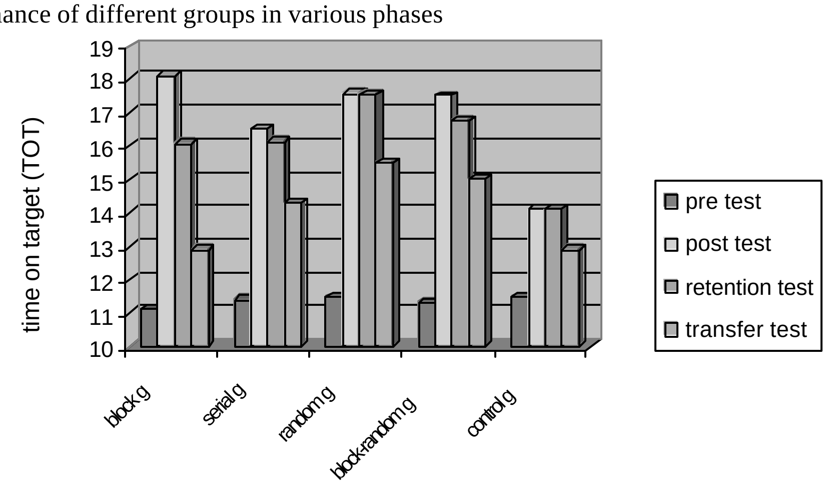

Fig. 4: The performance of GMP of the groups in various phases

Table 3: Variance analysis through repeated measure of performances in different phases

	Index			
Phase	DF	F	P	Result
Experiment phases	3	7.814	0.001	A significant difference
Groups	4	8.101	0.001	A significant difference
Phases + groups	12	12.486	0.001	A significant difference

Table 4: Dunkin post hoc test for groups' performances in different phases

		"=0.05		
Groups	N	1	2	3
Control	12	12.2358		
Chain	12		14.7074	
Blocked	12		15.1406	
Random	12			15.2339
Random blocks	12			15.5667
Significance level		1.000	0.053	0.072

among the sub-subgroups of subgroup 3 (random and random blocks groups). But there was a significant difference among the sub-subgroups of subgroup 1, 2 and 3. In other words, control group performed weakest. Among practice groups, chain and blocked groups performed weaker than random blocks and random groups (Table 4). Other information is presented in Fig. 3 and 4.

DISCUSSION AND CONCLUSION

In the posttest, a significant difference was observed among various practice methods of the acquisition phase. In the first experiment, the random practice group performed most weakly and random blocks group performed most ideally in this phase. In the second experiment, chain group performed most weakly and there was no significant difference in the performance among other groups. The results of the first and second experiments showed that contextual interference affected the acquisition of parameter and the generalized motor program. The following researches support the present findings: Shea and Morgan (1979), Shea and Zimny (1983 and 1988), Lee and Magill (1983 and 1985), Lee et al. (1985) and Delrey (1994) as cited in Brady (1998). They concluded that there was a significant difference between blocked and random groups in the acquisition phase. In other words, low contextual interference and high contextual interference resulted in more ideal performance. Low contextual interference group (blocked group) performed more ideally [3]. On the other hand, the present results contradict the results by Goode and Magill (1986) and Liu and Wrisberg (1991) [6, 7]. They found no difference in performance between blocked and random groups in the acquisition phase. In other words, in both experiments of the present research, random and chain groups included proactive inhibition effects in the acquisition phase due to other tasks and the random and chain arrangement of the tasks and therefore, performed weaker than other groups.

In the first experiment, the differences in the acquisition phase were not observed in the retention phase. In fact, the differences of acquisition phase were temporary and there was a significant difference in performance between control group and other groups. In other words, various practice arrangements (blocked, chain, random blocks and random) performed the same in this phase.

The findings by Boyce and Delrey (1990), Fishman and Vili (2003) and Moreno (2003) supports the present findings. They believe that there is no significant difference in performance between blocked and random groups in the retention phase [8, 9]. The studies by Crampton, Abendorth, Smith and Chamberlain (1990) support the present findings as well. They also believed that contextual interference did not affect the retention and transfer [10]. The studies by Lee and Wulf (1992) and Vera and Granda (2003) confirm the present findings of the first experiment [11, 12]. The researches by Poto (1988), Davis (1988), Sekiya et al. (1996) and Sherwood (1996) do not support the present findings. The contradiction among the researches is due to the differences between experimental and field tasks and task natures as well as the difficulty of the tasks [5, 13-15].

In the second experiment, a significant difference was observed among various practice arrangements in the retention of the generalized motor program. In fact, the difference was minimal among blocked, chain and random blocks groups but there was a significant difference between the mentioned groups and random group. In other words, random group performed more ideally than other groups in the retention phase and blocked group performed most weakly. Random blocks group performed nearly the same as the random group. It means that random and blocked groups can be combined and utilized in the retention phase.

Yuhua (1994) confirmed the present findings. He believes that subjects pay more attention to the details in random practice as compared with the blocked practice [16]. In the second experiment of the present research, a contextual interference was observed in the acquisition and retention of the motor program and Lee and Magill (1983 and 1985) and Magill and Hall (1990) support it. They also pointed out that contextual interferences appear when the tasks are arranged under various motor programs. The results of the second experiment in the retention phase confirm the Shea and Graff's (1994) proactive inhibition viewpoint. Their viewpoint contrary to the expansion and reconstruction pointing to the advantages of random practice, emphasize the disadvantages of the blocked practice. In this research, the blocked practice group performed most weakly in the retention phase. The reason according to Davis (1988) and Poto (1988) is the interference resulting from the blocked practice in a consecutive practice of a skill [13-16].

On the other hand, as one in the blocked practice does not finish each task before the beginning of the next task in practice sessions, he alternately practices various patterns of motor programs (circle, square and triangle) during the practice. Therefore, he does not suffer from the disadvantages of proactive inhibition. Studies by Landin and Herbert (1997) and Maslovat et al. (2004) did not support the present research. They believed that parametric modifications sufficed to create the contextual interference effects [17-18]. Meira et al. (2003) did not support the present findings. They did not observe the contextual interference effect in the tasks under study. They mentioned one of the main reasons as the number of the practice attempts and the nature of the field tasks [19]. In the transfer phase, the findings showed that the there was a significant difference among various practice arrangements in the two experiments. Landin and Herbert (1997) confirmed the present findings. They concluded that parameter modifications (distance and angel) suffice to infer the contextual interference effects [17]. The following researchers supported the present findings: Shea et al. (1990), Sekiya and Anderson (1996), Yung Cohen and Hasak (1993), Sherwood (1996) and Shewokis and Snow (1997) mentioned in Brady's (1998) review study. They also believed that contextual interference effects can modify the parameters of a motor program [3]. Also, based on Brady’s (1998) review study, Lee and Magill (1983), Magill and Hall (1990) and Lee and Wulf (1992) did not support the results of the first experiment.

In the first experiment, there was no significant difference among the methods of practice arrangement in parameter experiment, while the difference was significant in the transfer phase. Shewokis and Snow (1997) supported these findings. They reviewed and determined the amount of the contextual interference effects in transfer and retention phases in different studies and found out that the amount of the effects was higher in the transfer phase. It means that the results of transfer phase were more ideal than those of retention phase and they can be considered as a more ideal index [20-21].

The second experiment showed a wider domain of contextual interference effects in the transfer phase. In fact, program transfer revealed more interference effects compared to parameter transfer as the post hoc tests showed that blocked and chain groups created minimum interference in the transfer phase. Chain and random blocks groups created average interference and random blocks and random groups maximum interference in this phase.

The findings by Shapiro (1984), Pollock and Lee (1977), Plato et al. (1997) and Hall and Dominguez (1994) mentioned in Brady’s (1998) review study support the findings of the second experiment [3]. Battig and Delrey (1990) observed the interference effects just in transfer phase [8]. These results support Shewokis and Snow’s (1997) study. They believed that transfer phase is more reliable than the retention phase [20]. As interference effects following various motor programs were observed in the second experiment, the following researches support the present findings: Brady’s (1998) review study, Lee and Magill’s (1983) reconstruction theory and Magill and Hall (1990). The following researchers contradict these findings: Shea et al. (1990), Sekiya and Anderson (1996), Kuhesh and Hasak (1996) and Sherwood (1996) [3].

Generally, the comparison of the performances in both experiments shows that the contextual interference effects were observed in parameter and motor program in different phases of the research. Ultimately, the contextual interference effects on speed parameter can be interpreted as follows: As the parameter modification increases (the difference in speed), the learner experiences more intra task difference when performing the movement. This difference like various tasks can result in the contextual interference effect. A decrease in intra task differences results in a decrease in contextual interference effect. Of course, we should be careful about the difference of intra task parameter to create contextual interference effects and we need more researches to determine this difference.

It is suggested that coaches take the similarities and differences of the movements into consideration when instructing motor skills. It seems that random blocks practice method is advantageous due to the combination of blocked and random methods and the utilization of the advantages of the two methods particularly in the primary levels of practice and within a short time limit.

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