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# The effect of mass & distributed practice on performance and learning of discrete simple and complex skills in volleyball

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**Abstract.** The present study has been carried out to examine the effect of mass and distributed practice on performance and learning of discrete simple and complex skill in volleyball. The subjects included 40 female participants in the summer training classes in 2011 with the average age of 14-17, after carrying out the pretest they were divided into four equal groups. The simple group performed the massed practice in 30 consequent attempts, and for the distributed practice carried out 30 attempts with the rest of 60 second between every 10 attempts. And the complex group carried out the massed practice with the rest of 60 second and for distributed practice with 3 minutes rest between every 10 attempts. The duration of the course was supposed to be 4 weeks and 3 sessions for a week. The average score of the 12 sessions of practice, the acquisition test and 48 hours after the test of retention and transfer were recorded. The results of repeated measures analysis of variance and bilateral variance with the significance level alpha 0/05 indicated that the four groups showed progress in acquisition, retention and transferring of both simple and complex skill in volleyball. On the other hand, concerning the kind of skill and the method of practicing there was a significant difference in the retention and transfer test, so that expressed progress in learning the simple group skill in massive from and in learning the complex group skill which was practiced in an interval from, and in progress was significant in the retention and transferring the progress. In conclusion, the effect of massed and distributed practice in retention and transferring the discrete skill was different concerning to the kind of skill.

**Keywords.** Complexity of task, discrete skill, distributed practice, mass practice, motor learning, volleyball.

## Introduction

Practice distribution is a main issue of importance not only in sport environments, but also in rehabilitation and education. The most important decision the teacher, therapist or coach has to make is on how to distribute a certain skill during practice. Two points seem to be of great significance in this process: the first is to determine duration and sequence of practice sessions in a week and the second is to determine the interval between activities and rest times (Magill, 2007).

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In planning physical educational curriculums, practice planning is the main issue and time is considered as a very important factor. The planning involves the following points:

- How often should the skill be practiced?
- How long should it be practiced every day?
- Is it necessary to specify a period for rest during practice to avoid problems caused by fatigue?

The balance between practice effect and its efficiency is a considerable point in distributing practice sessions. Practice effect means learning with less error scores, motion pattern improvement, acquisition and better transfer to motor skills. These are usually evaluated in learning and transfer tests. But, on the other hand, efficiency means practice leading to economic and time savings, less injuries and other practice costs. Although most teachers and coaches tend to reduce educational costs and save more time, but not only they have problems with choosing practice type (mass or distributed) for different skills, but also always face and loss and profit-like transaction in this selection process. That is, distributed practice with an extended period of practice and rest leads to more time loss and vice versa.

As mentioned earlier, practice and rest distribution is a main and important issue to be considered in practice planning. This is usually performed through distributing time intervals between attempts and distributing between sessions. Debate on the amount of rest between every attempt to provide a better practice environment has received considerable attention. Thus, the questions is "is mass practice or distributed practice better for motor learning?" Some researchers claim that distributed practice is better than mass practice while others believe that distributing the practice makes no difference in learning (Trimac, 2007).

Shea et al. (2000) reported that distributing the practice on weekdays enhances learning and improves subjects' performance in delayed learning test. Moreover, Sea Brook et al. (2005) recently suggested that increasing

lessons and sessions distribution degree leads to a significant enhancement in teaching efficiency.

Schmitt (1999) found that reduction of rest time during practice sessions results in a considerable variation in motions because of frequent generation, especially in lower levels, and strengthens learning a certain task so that the negative effect of fatigue is compensated. Oxendine (1984) states that practice distribution is effective on both performance and learning. Newl et al. (1985) and Lee & Genovese (1989) suggested that task type is significantly effective on influences of practice distribution on performance and learning.

Most researcher show that continuous motor skills are more considered by researchers that discrete motor skills. The reason may be its relative definition. If there is no rest interval between mass practice periods, the rest time will be equal in both plans since the discrete skill is short and performing a short attempt of it does not take too long. Therefore, when studying a discrete activity, operational definitions of mass and distributed terms become important. A reason why researchers do not face difficulty (except in a couple of cases) is that they never use discrete tasks to compare mass and distributed practices (Magil, 2007).

Lee & Genivese (1989) examined the effect of distribution on learning a discrete skill including typing. Their findings revealed that mass practice slightly improves performance in both acquisition and keeping steps.

Shea et al. (2000) used a discrete task in their research. Subjects had to push a button results indicated that whenever subjects used distributed practice plans, had considerably lower error rates in retention tests (one day after the last practice session) that the group using mass practice plans.

Dail et al. (2004) performed a research on Golf Putt and found that individuals practicing in distributed mode express better performance that those practicing with mass modes. But, no significant difference was observed between the two groups on retention tests. However, Garcia et al. (2008) compared effects of mass and distributed practice on acquisition and retention of discrete and continuous skills and found that distributed practice acts better on acquisition but those practicing with mass plans expressed better results on delayed retention tests.

Taylor et al. (2010) compared the effect of two distributed practice types on increasing performance at the end of practice session and after an 8-week practice plan. They found that longer practice periods (10 hours during 2 weeks) lead to higher levels of skill at the end of practice session and shorter intervals (10 hours of practice during a week) after the non-practice period.

All findings mentioned above along with inconsistency between researchers may be explained by a look at Wulf & Shea's research (2000). Results of Wulf & Shea (2000) show why some test manipulations considered for complicated tasks lead to different results from those of laboratory simple tasks. The reason may be the fact that complicated tasks require longer time to be learnt. They finally state that some motor learning principles first developed based on simple task do not seem to be capable of using for complicated tasks, too (Wulf & Shea, 2000).

Previous research revealed that skills discreteness and continuity are not the only measures of deciding in mass or distributed practice and different results are obtained because of neglecting other factors such as task complexity. Hence, the researcher tries to answer this question: "whether simplicity or complexity of a skill affects decisions on practice type (mass or distributed)?"

Therefore, the present paper is of great importance from two points: first, in theoretical terms, it answers many questions about effects of distribution on acquisition, retention and transfer of discrete skills. Second, since the influence of practice distribution on discrete skills is less investigated, the researcher tries to perform his research based on two types of discrete skills, respecting task simplicity and complexity.

## Methods

This is a semi-experimental research. Research plan involves pre-test, acquisition, retention and transfer. Research population is composed of all individuals attending volleyball classes of Chaloos city during summer 2011. Research sample involves 40 healthy female subjects (14 – 17 years old) who experience of playing volleyball. Participants consented to take part in the research. they were classified into four same groups including 10 individuals based on their pretest scores.

### Data collection tool

Evaluation of accuracy and precision were measures of scoring simple and complicated skills (over-head set and jumping serve, respectively). Various articles and investigations confirm validity and reliability of scoring measures of set and serve precision.

The researcher gave every subject's precision score based on precision evaluation list after each serve. To do this, the opponent field was longitudinally divided into different zones and a score of 0 – 5 was given to the ball's landing point as follows McCullagh & Meyer (1997):

Score 5 for the middle zone, score 4 for the ball landed on the right or left side of the middle zone, score 3 for the ball touched the net and landed on the opponent field, score 2 for the balls touched the net or the antenna and landed outside the opponent field and score 1 for balls not reaching the net and score 0 for throwing the ball into the air and not hitting it (Weeks & Anderson, 2000).

*Over-head set test*

The objective is to determine participants' capability in performing an effective free throw. Participants were located in a 1.5 × 1.5m square (0.5m distant from the net and 2.5m distant from the sideline of the field). They received a ball thrown by the assistant (standing on the middle of the field), the ball moved toward left, passed over a rope and landed on the target zone. The throw not reaching participants is repeated. Every participant tries 10 attempts each considered correct when the ball passed over the rope or landed on the target zone (Bartlett et al., 1991; Zetou et al., 2002).

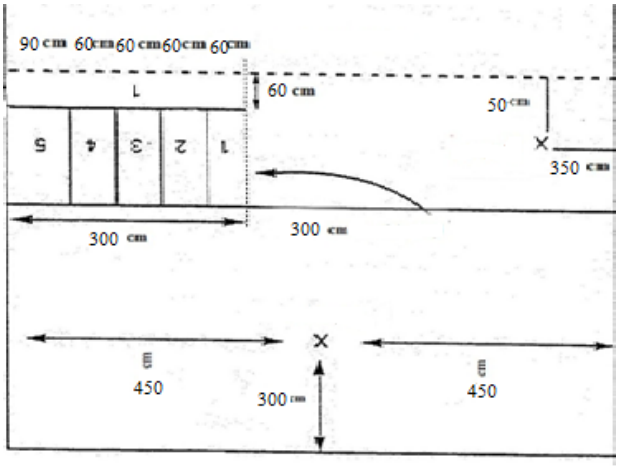


Figure 1. Set test of Bartlet et al. (1991) in volleyball.

*Execution method*

First, 40 competent participants were divided into 4 groups of 10 individuals based on their pretest scores and dedicated to 4 practice groups: 1) mass practice in simple skill; 2) distributed practice in simple skill; 3) mass practice in complex skill; and 4) distributed practice in complex skill.

The considered tasks included set for the simple task and jumping serve for complex skill. Practice steps included 360 attempts during 4 weeks (3 sessions each week, totally 12 session and 30 attempts each session). Number of session and attempts were equal for both groups but the rest rime was different between 10 attempts. The group of mass practice in simple skill performed the practice in 3 parts with 10 repetitions in each session (4 weeks), without any rest time. Rest time for distributed practice group was two times the practice time (1 min). The group of mass practice in complex skill practiced as same as the simple skill with the only difference being the rest time between 10 attempts for mass and distributed practice groups (60 sec and 3 min).The last 10 performs of subjects were recorded in each session. Retention test was also performed 2 days after the last practice session and transfer test was performed by changing the playing field.

**Statistical analysis**

Collected data was analyzed by SPSS16. Significance level of all tests was considered to be $p < 0.05$. Kolmogorov – Smirnov test was first performed to specify normality assumption of samples' scores. Results indicated normal data distribution. Then, in inferential statistics part, 2×2 factor variance analysis with frequent measurements and two-way ANOVA were used to inter-group and intra-group comparison and group comparison in acquisition, retention and transfer test, respectively. While facing significant results, Bonferroni and Tukey's tests were used for difference identification

## Results

Descriptive and inferential findings are presented sequentially in Table 1.

Table 1. Average age, weight, height and dominant hand of subjects.

| Variables | Age (Year) | Weight (kg) | Height (m) | Dominant hand |
|---|---|---|---|---|
| Mass-simple skill | 15.3 | 46.3 | 1.49 | Right |
| Distributed-simple skill | 15.3 | 48.25 | 1.49 | Right |
| Mass complex skill | 15.3 | 48.9 | 1.50 | Right |
| Distributed complex skill | 15.3 | 49.6 | 1.48 | Right |

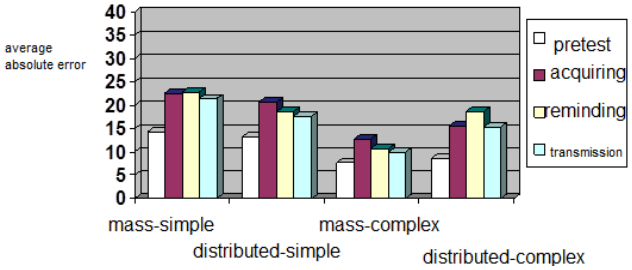


Figure 2. Average precision scores in performing simple (set) and complex (jumping serve) skills in pretest, acquisition, retention and transfer tests.

**Inferential findings**

First, factor variance analysis was used to investigate the effect of practice sessions, practice type, skill type and their correlations. Because of significant results of Mauchly Sphericity test of multivariable normal distribution of data and wrong Sphericity assumption, Greenhaus-Gizer's corrective method was employed.

As the Table indicates, results of ANOVA with repeated measurements show that interactive effects of sessions and practice type, sessions and skill type and interactive effect of sessions, practice type and skill type are not significant ($P \geq 0.05$). This means that variations of the four participant groups during various practice sessions are identical or, in other words, all groups have

same progress. But, the main effect of practice sessions was significant (P ≤ 0.05). This indicates that participant groups had a significant progress during different practice sessions and, as illustrated in Fig. 3, score of all groups significantly increased for pretest to acquisition, retention and transfer (P ≤ 0.05). In other words, all groups learnt considered skills (simple and complex) under different practice conditions. But, significance of the effect of skill type * practice type suggests that the effect of mass and distributed practices differs with skills type. That is, although all groups learnt practiced skills, but there is a significant difference in learning level among groups. In order to investigate differences between groups, they are compared in acquisition, retention and transfer tests. It is noteworthy that performance of different practice groups in similar skills is compared to that of others.

**Comparison of groups of mass and distributed practice on acquisition of simple and complex skills**

At Table 3 shows, no significant correlation is observed between practice type and skill type (P ≥ 0.05). This means that no significant difference exists between participant groups in acquiring simple (set) or complex (serve) skill. Results of Tukey test suggest this in Table 4.

Table 2. Results of factor variance analysis with repeated measurements in different practice groups using simple and complex skills during various sessions.

| Variation Resource | Sum of Squares | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Practice Sessions | 3892.04 | 8.32 | 467.32 | 35.67 | 0.000 * |
| Sessions*Type of Practice | 33.32 | 8.32 | 4.00 | 0.30 | 0.69 |
| Sessions*Skill Type | 181.51 | 8.32 | 21.79 | 1.66 | 0.10 |
| Skill Type*Practice Type | 1350 | 1 | 1350 | 11.21 | 0.002 |
| Sessions*Practice Type*Skill Type | 192.55 | 8.32 | 23.12 | 1.76 | 0.08 |

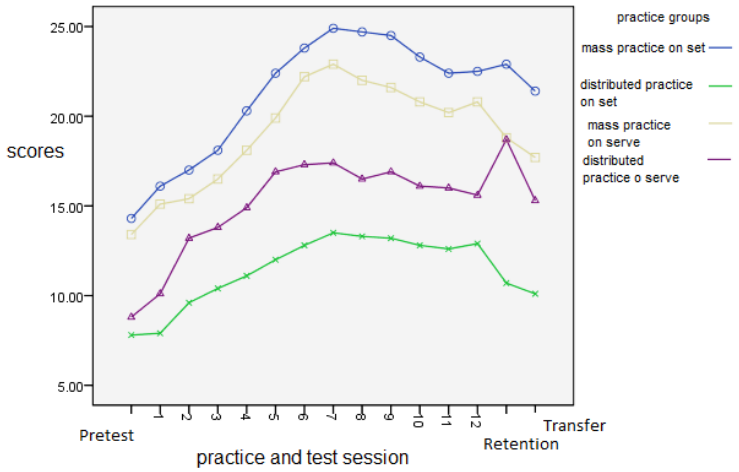


Figure 3. Linear graph representing score progress in acquisition, retention and transfer steps.

Table 3. Results of two-way ANOVA on the effect of practice groups and skill type on acquisition test.

| Variation Resource | Sum of Square | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Practice Type | 2.50 | 1 | 2.50 | 0.13 | 0.72 |
| Skill Type | 547.60 | 1 | 547.60 | 28.67 | 0.00 |
| Practice*Skill Correlation | 48.40 | 1 | 48.40 | 2.53 | 0.12 |
| Error | 687.40 | 36 | 19.09 | - | - |

Table 4. Results of Tukey test for group comparison in acquisition test.

| Variables | Mean Difference | Standard Error | P |
|---|---|---|---|
| Mass practice, set-distributed practice, serve | 1.70 | 1.95 | 0.82 |
| Mass practice, serve-distributed practice, set | -2.70 | 1.95 | 0.51 |

Table 5. Results of two-way ANOVA on the effect of groups and skill type on retention test.

| Variation Resource | Sum of Square | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Practice Type | 38.02 | 1 | 38.02 | 5.05 | 0.03 * |
| Skill Type | 378.22 | 1 | 378.22 | 50.30 | 0.00 * |
| Practice*Skill Correlation | 366.02 | 1 | 366.02 | 48.67 | 0.00 * |
| Error | 270.70 | 36 | 7.51 | - | - |

Table 6. Results of Tukey's test for group comparison on retention test.

| Variables | Mean Difference | Standard Error | p |
|---|---|---|---|
| Mass practice, set-distributed practice, serve | 4.10 | 1.22 | 0.01 * |
| Mass practice, serve-distributed practice, set | -8.0 | 1.22 | 0.00 * |

Table 7. Results of two-way ANOVA on the effect of groups and skill type on transfer test.

| Variation Resource | Sum of square | df | Mean square | F | p |
|---|---|---|---|---|---|
| Practice Type | 5.62 | 1 | 5.62 | 0.63 | 0.43 |
| Skill Type | 469.22 | 1 | 469.22 | 52.54 | 0.00 * |
| Practice*Skill Correlation | 198.02 | 1 | 198.02 | 22.17 | 0.00 * |
| Error | 321.50 | 36 | 8.93 | - | - |

Table 8. Results of Tukey's test for group comparison on transfer test.

| Variables | Mean Difference | Standard Error | P |
|---|---|---|---|
| Mass practice, set-distributed practice, serve | 3.70 | 1.33 | 0.04 * |
| Mass practice, serve-distributed practice, set | -5.20 | 1.33 | 0.002 * |

**Comparison of groups on retention of simple and complex skills**

As Table 5 illustrates, there is a significant correlation between practice type and skill type ($P \leq 0.05$). In order to specify the significant difference between various groups, Tukey's test results are examined. Respecting Tukey's results (Table 6), there is a significant difference between retention of simple and complex skills among the two groups (mass and distributed practice groups) ($P \leq 0.05$), so that groups practicing simple skill in a mass form and complex skill in a distributed form had better retention.

**Comparison of groups on transfer of simple and complex skills**

As Table 7 shows, there is a significant correlation between practice type and skill type ($P \leq 0.05$). The significant difference between groups was determined by examining the result of Tukey's test. Respecting Tukey' test results (Table 8), there is a significant difference in transfer of simple and complex skills between the two groups ($P \leq 0.05$) so that groups practicing simple skills in a mass form and complex skills in a distributed form expressed better progress. In other words, these groups showed better generalizability.

## Discussion

The main objective of this paper was to determine whether mass or distributed practice leads to better performance and learning of discrete simple (set) and complex (jumping serve) in volleyball. Different aspects of collected data were analyzed statistically. Results of ANOVA with repeated measurements to compare pretest scores and scores of acquisition, retention and transfer tests of studied groups revealed that performance of all groups improved after 14 sessions of active participation in practices and they all expressed progress from pretest to the acquisition, retention and transfer tests.

This means that after 360 attempts, subjects learnt to perform considered motor task. This consistent with findings mainly mentioned in behavioral sciences recognizing practice and repetition as the main factor in skill acquisition (Schmitt, 2005; Alijani, 1992; Magil, 2007; Kerry, 1982; Shea et al., 2000).

Moreover, research suggests that although groups had a similar path of progress and no significant difference existed between them in acquisition test, but there is significant difference between studied groups in retention and transfer (or, in other words, in acquired learning level based on skill type and practice style). In learning the simple and complex skills, groups practicing in mass and distributed styles expressed more progress in retention and transfer scores, respectively.

Research has shown that mass practice of discrete motor tasks does not postpone learning and, in fact, is beneficial (Rahmani, 2003) and this is consistent with findings of this paper. So that discrete simple and complex skills were generated under mass practice conditions but the mass practice style was more beneficial for the discrete simple skill group than discrete complex groups. In this way, their performance in retention and transfer was better than the group with distributed practice. These findings are consistent with Oxendine (1984) and Donavan (1999) and inconsistent with results of Dempster (1996) and Edward (2003). Dempster stated that mass repetitions receive less process and coding variables in mass practice is less diversified. Therefore, weaker performance is observed in mass practice. Edward and Lee suggested that mass practice does not lead to learning and along with more mass practice, learning progress will be less considerable. The reason of contradiction between these studied and the present paper may be the timing between relative motor tasks since they used a relatively longer timing than that of the present research. Of course, is a part of this paper, we found that a complex discrete motor activity benefits more from distributed practice and mass practice harms this type of discrete skill. Furthermore, Shea et al. (2000) and Linton (2003) found that distributed practice plan has no effect on retention and transfer scores of learners. This is inconsistent with results of the present paper (Linton, 2003; Shea et al., 2000), but in consistency with Goodwin (1971) who found that distributed practice increases practice variability and this leads to stronger learning of the considered task.

a. Respecting results of the present paper concerning discrete simple skill, no significant difference was observed between mass and distributed practice groups in the precision of set performance in acquisition stage. But, retention and transfer tests showed significant differences so that the groups practicing the simple skill in a mass form had more progress. This is consistent with Lee & Genivese (1989) and inconsistent with Dail et al. (2004). Dail et al. (2004) used Golf Putt as a discrete simple skill and reported that individuals practicing in distributed style expressed considerable progress in both performance and retention test. The consistency may result from the fact that golf putt is more complicated than the set. Results of the present research are consistent, in some cases, and inconsistent, in some others, with Garcia et al. (2008) including discrete and continuous skills. In acquisition and retention tests, distributed and mass groups expressed considerable progress, respectively. Results of retention test are consistent with those of the present research.

b. Respecting results of the present research concerning complex discrete skill, no significant difference was observed in precision of jumping serve performance between mass and distributed groups in the acquisition step. But, the difference was significant in retention and transfer tests so that the group practicing the complex skill in a distributed style expressed considerable development. This is consistent with Dail et al. (2004), Shea et al. (2000), Taylor et al. (2010) and inconsistent with Garcia et al. (2008) and Hosseini (2006). Hosseini (2006) found that in discrete skills, there is no significant difference between the performance of mass and distributed practice groups on retention and transfer tests. The reason for this inconsistency is Hosseini examined mass sessions in one day and distributed sessions in several days and hence, physiological and anti-fatigue factor were influential on distributed sessions.

Perhaps, the cause of this significant difference in employing the two practice methods for discrete skills teaching concerns the essence of considered skill since, according to literature, the distribute style is the most effective when the skill and performance lead to severe fatigue and this is not only limited to physical and muscular fatigue but also involves cognitive and nervous depression (Sij, 1996). Moreover, skill complexity is an effective factor on selecting practice type (Christina & Kouros, 2004).

Finally, it should be noted a very small number of studies are performed on the subject worldwide. Results of these studies indicate that mass practice is useful for learning and retention of discrete motor skills, but precautions must be considered while employing and generalizing the findings since the research and findings are not abundant enough to be used to present certain recommendations, with certainty, on the relationship between practice method and these categories of skills.

Results demonstrated that both practice methods help participants improve their performance but respecting the stronger effect of mass practice for simple skills and distributed practice for complex skills, coaches and instructors are suggested to follow this rule to enhance learners' capabilities.

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