PHYSICAL EDUCATION OF STUDENTS

Effect of model's skill level and frequency of feedback on learning of complex serial aiming task

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Abstract

Purpose: Modelling in observational learning and feedback are most important sources of information for learning of a new task. This study aimed to investigate the effect of model's skill level and feedback frequency on learning of complex serial aiming task.

Material: 48 female students aged 19 to 25 years old were selected as sample; based on pre-test scores, they were divided into four groups of 12 subjects: expert model and 100% feedback, expert model and 50% feedback, novice model and 100% feedback, and novice model and 50% feedback). In acquisition phase, the groups performed 80 times the serial aiming task according to specific instructions. The immediate retention test was conducted 15 minutes after completion of acquisition phase and the delayed retention test was conducted 24 hours later.

Results: In acquisition stage, the results of analysis of variance with repeated measures showed that the expert model observation group had less spatial error and longer movement time. In immediate and delayed retention stages, the results of two-way analysis of variance showed that the expert model observation group had less spatial error and longer movement time. In delayed retention test, also, the main effect of feedback frequency on spatial error was significant. The 100% feedback group had less spatial error than 50% feedback group.

Conclusions: According to Fitz's speed-accuracy trade-off law, the results are justified as following: since the expert model observers focus on error reduction and increased accuracy in executing complex tasks, their movement time gets longer. Also, the 100% feedback frequency in complex tasks leads to stronger memory consolidation.

Keywords: Model's skill level, Observational learning, Feedback Frequency, Serial Aiming Task, Complex Task.

Introduction

The learning, especially motor learning, plays a vital role in human life and accomplishment of tasks [1, 2]. The coaches and practitioners use different methods to train motor skills and transfer information to individuals [3]. Many coaches emphasize the display of motions as a means of transferring information to learners [4]. The modelling or observational learning is a process in which the individuals replicates the actions of others to obtain the necessary information of a skill [5]. Bandura showed that the observation provides an opportunity for performer to develop a cognitive representation for initial performance of skill [6]. It has been argued that the observation causes engagement in cognitive processes [7] and improves learner's perceptual abilities [8]. In addition, the researchers suggest that the model display is more profitable in early stages of motor learning; in this period, the learners look for better ways to perform the skills [9].

There are two views on effectiveness of observational learning. According to Adams's closed-loop theory, the motor model is selected and started through a memory trace; i.e. a motor program which is organized based on previous experiences. During movement, a comparison is made between perceptual trace and response and the sensory feedback is obtained from movements. Any symptom of error will be as a stimulus for conducting corrective action. According to Adams' theory, the educational model should be presented in a correct way to develop a strong perceptual trace. Accordingly, the expert model should be used to develop a strong perceptual trace [10].

Considering Schmidt's schema theory, however, when individuals provide an answer, they store information in four parts at their memory [11]. Instead of being explicitly stored, these four sources are stored implicitly and the learner obtains information in two generalized schemas: the recall schema which is responsible for initiation and implementation of movement and recognition schema which is responsible for assessing and correcting motor error. According to Schmidt, these two schemas are basis for learning and performing movements. According to Schmidt's theory, both correct and incorrect answers (of novice) help learning; both play a role in development of schemas [12].

The video tutorials are one of the most commonly used modelling techniques in physical education. In all modelling methods, the model display by expert and novice individuals may be used; in expert modelling, the correct skill model is displayed. Landers and Landers [13] argued that according to general principle of skill display, the performer should perform the skill correctly. The expert model demonstrates desired features of skill and the learner may observe the desired performance and obtain information for learning of skill. The use of novice model is another strategy. Hebert and Landin [14] argued that the expert model would provide less information to observer about error in processing information; but, the involvement of individual in cognitive activities would facilitate learning. In this regard, research has shown that the combined use of both expert-novice models may lead to better learning outcomes than using any model individually [15-17].

Martens et al. [18], Hebert and Landin [14], and Want and Harris [19] showed that the observational learning is an effective factor in acquiring motor skills. Sabbaghi et al. [20] showed that the model gender does not impact on acquisition, retention, and transfer stages; the skill level of model is important. In general, several studies

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have shown the beneficial effect of using expert model. However, some research shows contradictory results. Pollock and Lee [21] compared observation of expert models through video and non-expert models; the results showed no significant difference in performance of groups. Shayan Noushabadi et al. [22] studied the dart throw skill learning and found that there was no difference between learning and expert modelling in any stages of learning.

The learning mostly occurs when individuals are in mutual relationship with coach. The relationship and feedback are inextricably interconnected. The coach's feedback is an essential element in the learning process to diagnose, correct, reinforce, and refine students' perceptions of their skills and physical actions. The feedback is not only a way to determine the quality of education, it is but also a concept for development of education and performance. The term "feedback" refers to all information which is obtained from response during or after movement [23]. The knowledge of result (KR) is one of the most important categories of augmented feedback. The KR feedback is often provided as a verbal and final augmented feedback that informs the learner about outcome of movement and serves as a basis for correcting errors in subsequent trials. It is also a good guide to achieve an effective performance [24, 25]. Adams [26] states that the learning occurs when the learner uses KR to improve his or her next response. He also believes that if feedback is removed, the learner will only reinforce what has been learned from previous response with KR. Therefore, according to this view, it is expected that repetition of 100% KR will lead to better learning. In recent processing perspective, however, it is suggested that KR 100% or KR with high frequency will have destructive effect on motor learning; some of this KR will serve as a guide to response [27, 24].

In their research on children, Butki and Hoffman [28] found that the 100% feedback group had a better performance in acquisition test and 50% feedback group had a better performance in retention test. Chiviacowsky et al. [29] conducted a study among normal children and showed that the children who received 100% feedback had better performance than those who received less feedback. Hemayattalab and Rashidi Rostami [30] studied the learning of a motor skill among individuals with cerebral palsy and found that the subjects who received 50% feedback had better performance at retention stage.

Therefore, the modelling in observational learning and feedback are most important sources of information for learning of a new task. The study of these two important variables involvement in learning of a complex task is the main objective of this research. Since the task information may be used by learner, the results of this study may be used to optimize the training of motor skills. These information resources also improve performance of motor skills, especially complex skills. The learner, through these resources, acquires necessary information to get close to performance of others. This may help teachers, coaches, and therapists to design a more effective training process.

Material and Methods

Participants: The sample consisted of 48 female students at Shahid Rajaee Teacher Training University in 2017-2018; they participated voluntarily in this study. Based on pre-test scores, they were homogeneously distributed in four groups of 12 subjects. The independent variables included model's skill level (novice and expert) and feedback frequency (100% relative frequency, 50% relative frequency). The dependent variables included movement time and spatial error (pre-test, acquisition, immediate retention, and delayed retention).

Research Design: This was a quasi-experimental study; the data were collected in laboratory. The factorial design was used in this study. The research tools included demographic characteristics questionnaire, Edinburgh's Handedness Inventory, and Serial Aiming Task Software.

After determining sample, Edinburgh's Handedness Inventory and demographic characteristics Questionnaire were distributed among participants. It should be noted that the individuals were not familiar with intended task and they were all right-handed. First, the participants were provided with explanations about performing serial aiming task. In pre-test stage, the participants completed 10 complexes eight-part training exercises and their points were recorded. Then, the subjects were homogenously divided into four equal groups of 12 subjects (expert model and 100% feedback, expert model and 50% feedback, novice model and 100% feedback, novice model and 50% feedback). In acquisition stage, each group performed 80 trials with right hand (8 blocks of 10 trials). However, the expert model groups observed expert performer performance in 10 complex training trials and the novice model groups watched novice performer performance in 10 complex training trials. After observation, both groups performed desired training trials. The mean movement time and mean spatial error were provided as feedback to 100% feedback group after each training trial and 50% feedback group alternatively after each training trial. After completing each 40 trials, the participants rested for two minutes; during this period, they also watched the intended film. The immediate retention test was conducted 15 minutes after completion of acquisition session and the delayed retention test was conducted 24 hours later. In each stage, the participated conducted 10 complex trials.

Statistical Analysis: The descriptive (mean and standard deviation) and inferential statistics were used for analysing the data. The Levene's Test was used to examine the equality of variances. The Shapiro- Wilk's Test was used to examine the normality of data distribution. In pre-test, the one-way analysis of variance was used to compare the means. At acquisition stage, the mixed ANOVA with repeated measures was used to compare the means. At retention stages, the two-way analysis of variance was used to compare the means of groups.

Results

The demographic characteristics of participants including height, weight, and age are presented in table 1.

The Shapiro- Wilk's Test showed that the distribution of data is normal in movement time and spatial error of complex serial aiming task at different measurement stages (P>.05).

The Levene's Test confirmed the equality of variances for movement time and spatial error of complex task at different measurement stages (P>.05). The one-way ANOVA was used to evaluate the mean of pre-test movement times of groups before beginning of training. The results showed that there was no significant difference between groups ($F_{(3.44)}$ = 1.362, P =.267).

A. Movement time

The mean of movement time at performing a complex task in different measurement stages in shown in figure 1.

At acquisition phase, 2 (model's skill level) * 2 (feedback frequency) * 8 (training block) and analysis of variance with repeated measures were used to compare the mean of movement time. The results showed that none of interactive effects of studied factors was significant; at acquisition stage, the model's skill level and feedback frequency had no significant impact on movement time at conducting complex serial aiming task (P>.05). However, the effect of model's skill level was significant (F =18.24, P =.001, η2 =.293). Comparing the means at acquisition stage, it was found that the groups that observed expert model had longer movement time than observers of novice model.

At immediate retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of model's skill level * feedback frequency, was not significant; however, the main effect of model's skill level was significant (F =15.82, P =.001, η2 =.265). Comparing the means at immediate retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

At delayed retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of (model's skill level * feedback frequency) was not significant; however, the main effect of model's skill level was significant (F =20.9, P =.001, η2 =.322). Comparing the means at delayed retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

B: Spatial error

The mean of spatial error at performing a complex task in different measurement stages in shown in figure 2.

At acquisition stage, 2 (model's skill level) * 2 (feedback frequency) * 8 (training block) and analysis of variance with repeated measures were used to compare the mean of spatial error. The results showed that none of interactive effects of studied factors was significant; at acquisition stage, the model's skill level and feedback

Table 1: Demographic characteristics of participants including height, weight, and age

Model's skill level	KR Frequency	Height (cm)	Weight (kg)	Age (year)
expert	100%	166.25 ± 5.31	58 ± 9.195	22.17 ± 4.529
	50%	164 ± 5.721	63.75 ± 12.381	22.58 ± 2.275
novice	100%	166.17 ± 5.859	59.5 ± 8.618	21.67 ± 2.498
	50%	165.58 ± 3.942	60.83 ± 8.233	21.92 ± 1.379

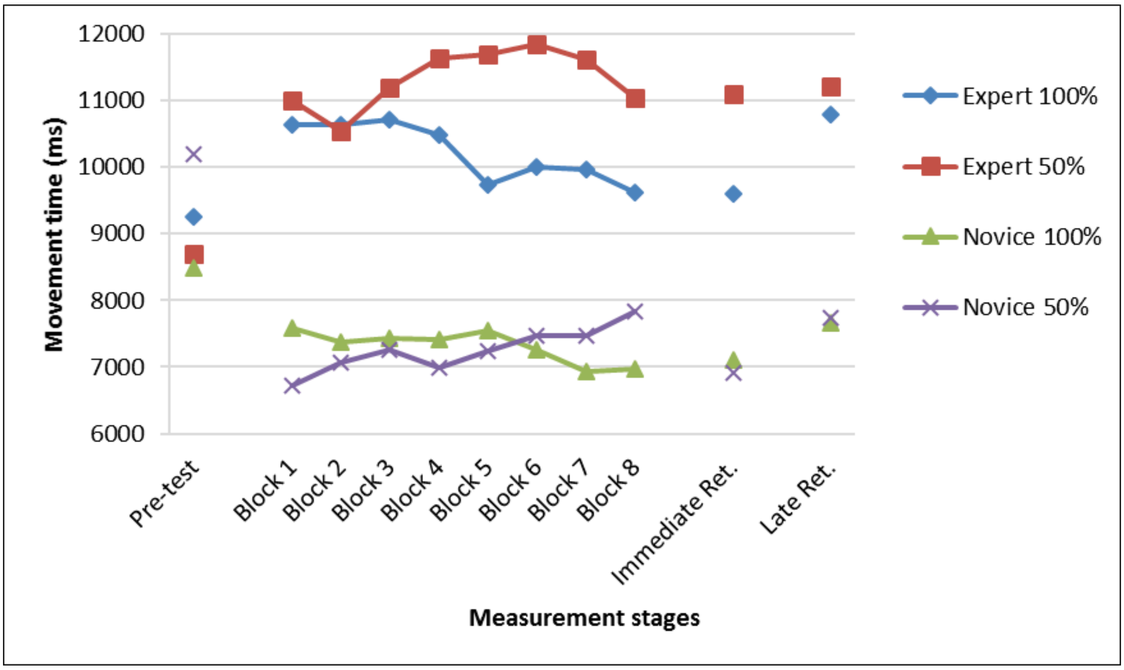

Figure 1. Mean of movement time of complex task at different measurement stages

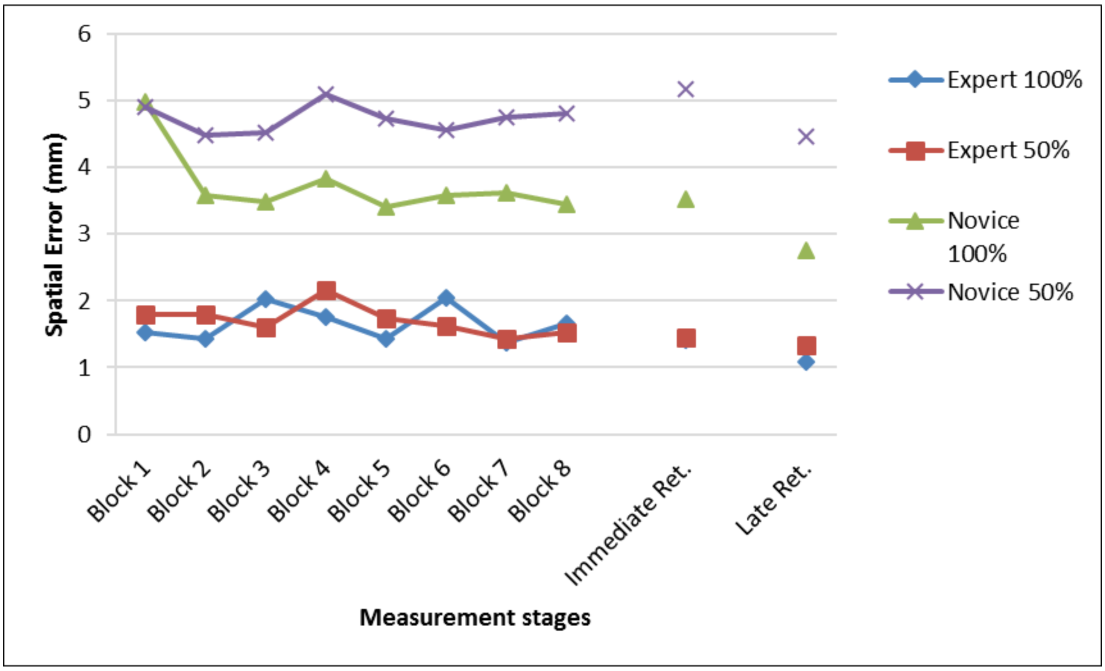

Figure 2. Mean of spatial error of complex task at different measurement stages

frequency had no significant impact on spatial error at conducting complex serial aiming task ($P>.05$). However, the effect of model's skill level was significant ($F=32.313$, $P=.001$, $\eta 2=.423$). Comparing the means at acquisition stage, it was found that the groups that observed expert model had less spatial error than observers of novice model.

At immediate retention stage, the two-way analysis of variance was used to compare the mean of spatial error. The results showed that the main effect of feedback frequency and interactive effect of (model's skill level * feedback frequency) was not significant; however, the main effect of model's skill level was significant ($F=39.08$, $P=.001$, $\eta 2=.47$). Comparing the means at immediate retention stage, it was found that the groups who observed expert model had less spatial error than novice model observers.

At delayed retention stage, the two-way analysis of variance was used to compare the mean of spatial error. The results showed that the main effect of feedback frequency and interactive effect of (model's skill level * feedback frequency) was not significant; however, the main effect of model's skill level was significant ($F=30.61$, $P=.001$, $\eta 2=.41$). Comparing the means at delayed retention stage, it was found that the groups who observed expert model had less spatial error than novice model observers. Also, the main effect of feedback frequency was significant ($F=5.137$, $P=.028$, $\eta 2=.105$). Comparing the means at delayed retention test, it was found that the groups who received 100% feedback had less spatial error than those who received 50% feedback.

Discussion

This study examined the effect of model's skill level and feedback frequency on learning of complex serial aiming task among right-handed and novice female students. At acquisition stage, the analysis of variance with repeated measures was used to compare the means. The results showed that the main effect of model's skill level was significant. Comparing the means, it was found that the groups that observed expert model had less spatial error and longer movement time than observers of novice model. The results of two-way analysis of variance at immediate and delayed retention stages showed that the interaction of (model's skill level * feedback frequency) had no significant impact on immediate and delayed retention of complex serial aiming task; however, the main effect of model's skill level was significant at both stages. Comparing the means, it was found that the groups who observed expert model had less spatial error and longer movement time than novice model observers. At delayed retention stage, also, the main effect of feedback frequency was significant. The groups who received 100% feedback had less spatial error than those who received 50% feedback.

The findings of this study about model's skill level are consistent with some previous studies. Hatami et al. [31] examined the effect of model's skill level on performance and learning of simple volleyball service, Sabbaghi et al. [20] examined the effect of model's skill level (with an emphasis on model and learner gender) on learning of a motor skill, Hatami et al. [32] studied the effect of model's skill level on suppression of mu rhythm in three-step basketball shoot, Abdoli et al. [33] examined the effect of self-control observational exercise and model's skill level on learning of Badminton's long-distance service, and Hung [34] studied the effect of various displays on performing motor skills during video tutorials; they all showed that the individuals may learn motor skills through observation and the observation of expert model is better for learning. Also, it seems that the individuals who observed expert model tried to increase their accuracy. According to Fitz's speed-accuracy trade-off law, most of hand-held aiming skills require the individuals perform the skill with high speed and accuracy. The exchange between speed and accuracy is one of the most fundamental principles which is observed in performance; i.e. when the individuals emphasize speed, the accuracy decreases, and vice versa.

Shayan Noushabadi et al. [22] studied the effect of modelling interaction (expert model and self-modelling) and kind of feedback on performance and learning of dart throwing skill, Ghavami et al. [35] studied the effect of observing animation model, fixed images, and combined model on balance skill learning, Lotfi and Mohammadpour [36] studied the effect of three observational learning methods on acquisition and learning of archery skill, and Pollock and Lee [21] compared the effect of observing expert model through video and expert model; these all did not report any significant difference between performance of different groups. This result is inconsistent with findings of this study; this was mostly due to different types of task, participants' training background, number of training sessions, and modelling type.

The findings of this study on effect of feedback frequency are consistent with findings of Aslankhani et al. [37], Shayan Noushabadi et al. [22], Nezakat alhosseini et al. [38], Mohammadi et al. [39], Rezaee et al. [40], Guadagnoli and Kohl [41], Patterson and Carter [42], Butki and Hoffman [28], and Chiviacowsky and Wulf [29]; all of these studies showed that the high frequency of feedback helps to learn motor skills. On the other hand, this finding is not consistent with results of Wrisberg and Wulf [43]; this inconsistency is due to using simple tasks in that study.

This finding supported Adams' closed loop theory. Adams [26] states that the learning occurs when the learner uses KR to improve his or her next response. He also believes that if feedback is removed, the learner will only reinforce what has been learned from previous response with KR. Therefore, according to this view, it is expected that repetition of 100% KR will lead to better learning.

Conclusions

Regarding the fact that the model's skill level has a significant effect on learning of complex serial aiming task, it is recommended that coaches and teachers use expert modelling in teaching complex motor tasks to novices. The use of expert model in tasks that require speed-accuracy exchange makes learners focus on increasing accuracy. Also, since 100% feedback frequency impacts on long-term memorization of complex serial aiming tasks (delayed retention), it is suggested to provide 100% feedback to novices in training and teaching complex motor tasks.

Conflict of interest

The authors declare no conflict of interest.

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