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Comparison of the effects of feedback frequency reduction procedures on capability of error detection & learning force production task

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Abstract

The main purpose of this research was the comparison of the effect of feedback Frequency Reduction procedures (bandwidth, summary and faded) on the performance improvement and error detection capability of force production task. The necessary data for the present research was gathered in 4 phases: pre-test, acquisition, retention and transfer. In pre-test phase, the subjects were supposed to produce a force equivalent to 20% of maximum force in a 10-trial block. The acquisition phase consisted of seven 10-trial blocks in which 30% of maximum force in were used as a target force. In retention phase in the next 24 hours, production force procedure based on 30% of maximum force was used and in transfer phase, 40% of maximum force was used as the target force. For Data analysis, one-way analysis of variance and one-way analysis of co-variance in significant level $P \leq 0.05$ for spss-11.5 software were used. Results revealed that there was no significant statistical difference in accuracy variable, consistency variable, and error estimation accuracy variable of production force in acquisition, retention and transfer phase in three kinds of these manipulations, and they (manipulations) led to the improvement of learning and error detection capability.

Keywords: feedback, accuracy, consistency, error estimation accuracy;

1. Introduction

Undoubtedly, feedback is one of the most important issues in motor learning discussion (Schmidt & Lee 1999). For many years, the feedback frequency manipulation and different planning for its presentation are all concerns of different motor learning researches. According to guidance hypothesis, the individual guidance direct toward right performance is one of the roles that is referred to as feedback, and so when this feedback is presented, leads to performance promotion. But in other hand, presenting frequency feedback results in blocking procession procedure of the performer in error detection and correction, decreasing their motor consistency, and results in performer dependency to feedback (Salmon et al, 1984 & Schmidt1991). There are many methods used for preventing the influence of frequency feedback that cause feedback dependency, including bandwidth feedback, summary feedback, faded feedback and average feedback that are as the end of feedback reduction in some trial (Schmidt & Lee 1999).Although many studies being done for indentifying different feedback presentation procedures with positive effect on learning, but yet there are great numbers of questions regarding to the best possible procedure for presenting feedback to enhance learning remained to be considered. Which of these feedback frequency reduction

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procedures of feedback is more suitable for learning? Is there any difference between feedback frequency reduction procedures? The research results in this regard show that 10% bandwidth feedback, 5-trial summary feedback and also faded feedback result in more learning and capability of error detection. The researchers in the present research are going to answer the following questions as: Which of the feedback presentation procedures (10% bandwidth, 5-trails summary and faded) have more influence on acquisition, learning and capability of error detection and finally, identify and introduce the most preferable procedure and contribute in clarifying feedback influence on motor learning and take a step toward completing previous researches.

2. Method

The present research is semi-experimental and is performed by participation in four stages as pre-test, acquisition, retention and transfer. The research design is as pre-test - post-test with 3 experimental groups.

2.1. Participants

The Participants of research consisted of 36 non-athlete volunteer students with the average of 25.41±1.6 age that were right-handed and were randomly divided in to three groups, including 10% bandwidth feedback, 5-trial summary feedback, and faded feedback. None of the subjects were aware of the research aim and had no previous experience in such a test.

2.1.1. Apparatus and task

Measuring apparatus is a manual dynamometer. The above device has a display plate and a grip that the participant produces target force by pressing this grip.

2.1.1.1. Procedure

The necessary data for this research are collected in 4 steps including pre-test, acquisition, retention and transfer. After being familiar with this device, the participant is requested to do 2 maximum repetitions to register maximum force. In pre-test, the participant is requested to produce force equivalent to 20% maximum force, without see the dynamometer plate, in a 10 trial block. The rest time between these trials are 15s.The acquisition phase includes of seven 10- trail blocks, in which 30% of maximum force that is produced by the subject being used as a target force. 3 seconds before each performance, the subject is being told to produce some kilogram force (30% of maximum force). 3 seconds after the participant performs the trial, the quantity knowledge of results (KR) feedback is presented to him verbally, that is actually produced force about 0.1 kg. The rest time between each block is 120s. The retention and transfer test is performed after 24 hours in a 10- trial block. In retention phase, force production is based on 30% maximum force. In transfer phase, 40% of maximum force is used as target force. In pre-test, retention and transfer phases, the participant is requested to verbally estimate the amount of his force production during 2 seconds after each trial. The data are registered for consistency analysis and force accuracy in the form of variable error (VE) and overall variability error (E), and for error estimation in pre-test, retention and transfer these data is registered in the form of the difference between error estimation and actual error.

3. Results

According to kolmogorov-smirnov test, the distribution of consistency variables, accuracy and precise estimation of force production error are normal among all groups ($p>0.5$).

As it is showed in table 1, force production consistency in acquisition, retention and transfer phases is being improved comparing to all the 3 groups of summary, bandwidth and faded.

Table 1. Mean & standard deviation Consistency of force production

Groups	Pre-Test	acquisition	retention	transfer
5-trial summary	3.86±1.32	1.37±0.24	1.78±0.65	1.89±0.46
10% bandwidth	4.29±1.70	1.61±0.29	1.93±0.61	2.04±0.81
faded	4.02±1.54	1.34±0.50	1.91±0.49	2.14±0.61

Table 2 shows that comparing to pre-test phase; force production accuracy in acquisition, retention and transfer phases is being improved in all groups.

Table 2. Mean & standard deviation Accuracy of force production

Groups	Pre-Test	acquisition	retention	transfer
5-trial summary	7.91±1.41	1.66±0.45	2.85±0.89	3.53±1.26
10% bandwidth	8.16±1.16	1.63±0.31	2.46±0.83	3.06± 0.90
faded	6.07±1.73	1.51±0.47	2.15±0.40	2.69± 0.86

According to table 3, it is indicated that in comparison with pre-test phase, force production error estimation accuracy in retention and transfer phases is being improved.

Table3. Mean & standard deviation error estimation accuracy of force production

Groups	Pre-Test	retention	transfer
5-trial summary	7.18±1.91	2.85±1.40	3.49±1.25
10% bandwidth	8.58±0.84	2.42±0.92	3.17±1.08
faded	5.20±1.75	2.26±0.34	2.73±0.99

Pre-test Comparison: The results of one -way variance analysis test show that there is no significant or meaningful statistical difference in the variable of force production consistency in these 3 groups, but the significant difference is being seen in accuracy variable and error estimation accuracy variable of force production in these 3 groups (table4). So, in testing hypotheses related to accuracy variable and error estimation accuracy variable of force production, the pre-test is considered as a random auxiliary variable and covariance analysis is applied.

Table4. Comparison of variables between groups at pretest

variables	Degrees of Freedom	Mean Square	F	P
Consistency		0.57	0.24	0.77
accuracy	2,33	15.59	7.38	0.002∗
error estimation accuracy		34.60	14.04	0.0005∗

∗p<0.05

The one -way variance analysis results indicate that there aren't any significant statistical differences between the 3 feedback groups in terms of force production consistency variable and all these 3 manipulating result in performance consistency in the acquisition test (table5).

Table5. One-way analysis of variance between groups at acquisition test

Groups	M±SD	df	F	P
5-trial summary	1.37±0.24			
10% bandwidth	1.61±0.29	2,33	2.00	0.15
faded	1.34±0.50			

One of the research results is that there aren't any significant statistical differences between the 3 feedback groups terms of accuracy variable of force production, and all these 3 planning will lead to performance accuracy in the acquisition test. As there aren't any meaningful differences in force production accuracy between these 3 groups (table4), so, the one - way covariance analysis is applied. (table6).

Table6. One-way analysis of co-variance at acquisition test

	df	F	P
Groups * pre-test	3,32	0.55	0.66
Groups	2,32	0.62	0.54

Another test result is that there isn't any significant statistical difference between 3 feedback groups in variable of force production consistency in retention phase (table7, p>0.05).

Table7. One-way analysis of variance between groups at retention test

10% bandwidth	1/93±0/61	2,33	0.23	0.79
faded	1/91±0/49			

The other test result is no meaningful statistical difference between 3 feedback groups in terms of variable of force production accuracy during retention phase. And all these 3 manipulating will result to performance accuracy improvement in retention test. The results of reviewing interaction, between group and pretest, support regression homogenous default for covariance analysis (table8, p>0.05).

Table8. One-way analysis of co-variance at retention test

	df	**F**	**P**
Groups * pre-test	3,32	2.14	0.12
Groups	2,32	1.61	0.22

Again another test result is that in retention phase ,no significant statistical difference indicated between 3 feedback groups in terms of error estimation accuracy variable of force production in retention phase, and all these 3 manipulating result in improvement of error estimation accuracy in retention test (table9, p>0.05).

Table9. One-way analysis of co-variance at retention test

	df	**F**	**P**
Groups * pre-test	3,32	1.69	0.19
Groups	2,32	1.16	0.32

One other test result is that during transfer phase, no meaningful statistical difference between 3 feedback groups of 10% bandwidth, 5-trials summary and faded indicated in consistency variable of force production, and all these 3 manipulating lead to performance consistency improvement in transfer test (table10, p>0.05).

Table10. One-way analysis of variance between groups attransfer test

Groups	**M±SD**	**df**	**F**	**P**
5-trial summary	1.89±0.46			
10% bandwidth	2.04±0.81	2,33	0.48	0.63
faded	2.14±0.61			

Another finding result is that there isn't any significant statistical difference between 3 feedback groups in force production accuracy variable during transfer phase, and all these 3 manipulating lead to performance accuracy improvement in transfer test (table11, p>0.05).

Table11. One-way analysis of co-variance at transfer test

	df	**F**	**P**
Groups * pre-test	3,32	2.28	0.1
Groups	2,32	1.12	0.34

Another test result is that in transfer phase, no significant statistical difference between 3 feedback groups of 10% bandwidth, 5-trials summary and faded is indicated in estimation accuracy variable of force production, and all these 3 manipulating lead to performance improvement in error estimation accuracy in transfer test (table12, p>0.05).

Table12. One-way analysis of co-variance at transfer test

	df	**F**	**P**
Groups * pre-test	3,32	2.84	0.06
Groups	2,32	1.10	0.34

4. Discussion& Conclusion

The research results show there isn't any significant statistical difference between 3 feedback groups of 10% bandwidth, 5-trials summary and faded in terms of force production consistency, accuracy and error estimation accuracy variables, and all these 3 manipulating lead to performance improvement. The researches being done by Lee & Maraj (1994), Yao et al (1994), Weeks & Sherwood (1994), Goodwin & Meeuwsen (1995), Shea et al (2000), Lisa et al (2003), Badets & Blandin (2004) also confirmed these research result. The result indicates that to eliminate feedback and reducing its frequency make the performer don't change his response after each trial. Schmidt & Lee (1999) state that frequency feedback presentation lead to variability in movement performance. That is in each trial, an individual has to bring a change in movement for error correction, and this prevents movement redisplay development. But gradual elimination of feedback in the form of bandwidth, summary and faded associated with performer performance level during acquisition phase will decrease feedback indecency, that intern increase learning consistency in transfer phase. According to guidance hypothesis, frequency feedback increases performance variability, because presenting frequency feedback prepares accurate information and courage individual to correct least errors. So, accuracy will confuse movement but decreasing feedback frequency in the form of bandwidth, summary or faded manipulation result in accuracy improvement. According to Adams closed loop hypothesis (1972), the incitements due to internal feedback have an effect on central nervous system that is known as perceptual trace and this trace become stronger by movement repetition in acquisition phase. Due to approximate correct perceptual trace in bandwidth, faded and summary feedback groups, more accurate performance of groups in this phase is being seen. KR, presents information to solve movement problem. After a trail, KR will present information regarding to the next movement characteristic, that how next movement will lead to task purpose. According to Lee & Maraj (1994), when the feedback regarding error presented repeatedly, it led to the blockage of process procedures for error detection and it is important in retention stage. On the other hand, reduced frequency of the feedback draw more attention to "response resulted from feedback" and improve "detection mechanism and error correction" independently. Lai at al (2000) state that frequency feedback only leads to increasing performers capabilities for producing the same parameters and couldn't be helpful in producing new parameters. But the methods of decreased feedback frequency in the form of bandwidth, summary and faded lead the performers to generalize their performance to the new parameter in transfer phase. Schmidt (1975) relates this generalization capability to a new situation due to enhanced influences of designation that is produced during acquisition phases.

In general, according to the current research results it should be noted that decreased frequency feedback play a important role in learning; because presenting frequency feedback lead to response change in each trial, this make motor program development and consistency to be weak.

Therefore, redisplaying motor pattern in eliminate feedback will be confused. But feedback fading and decreasing its frequency in some trials, make more opportunity for an individual to focus on internal feedback processing and on error identifying and correction. Also as the performer doesn't change his response after each trial, movement consistency is also increased, so this research supports guidance theory. Wrisberg & Wulf (1997) believe that what lead to learning increase in a situation without feedback is uncertainties in this situation. That is when an individual receive less feedback, there isn't any reliability regarding to receiving information after each task trial and try to estimate his error with using his internal feedback information. So, process mechanisms are involved and the error detection capability in an individual increase and finally the development in error detection mechanism and in turn learning is increased. So, the results of this research are also compatible with this theory.

As the current research task has a simple structure and most of sport skills also enjoy of complex in structure and while Sherwood (2008) believe that error detection capability is a special ability and couldn't generalized it to other tasks, so only when tasks have a same movement pattern or are based on a sensing feedback resource, could be generalized, so its suggested to accomplish the same research for other movement task with complex structure.

Finally, these researches results show that each of these feedback presenting methods aren't preferable on others and generally are efficient in task error detection of force production. Choosing suitable methods and presenting feedback added with decreased frequency, in addition to efficient learning, is also time consuming.

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