



Contributions of External Attentional Focus, Enhanced Expectancies and Autonomy Support to Enhance Learning Skills of Throwing Darts

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Abstract

Objective: This study aimed to investigate the effect of the combination of attention (external focus) and internal motivation (autonomy support and enhanced expectancies) on learning the skill of throwing darts.

Methods: For this purpose, 60 women participated in the study. our study included 4 groups: a) autonomy support - external focus (AS-EF); b) enhanced expectancies - external focus (EE-EF); C) enhanced expectancies - autonomy support (EE-AS); and d) enhanced expectancies - autonomy support - external focus (EE-AS-EF). Participants were asked to throw darts at a target with their non-dominant arm. In the EE conditions, they received (false) positive social-comparative feedback. In the AS conditions, they were allowed to throw 5 of 10 trials in each block with their dominant arm chosen by them. In the EF conditions, participants were asked to focus on the target. on the post-test after the end of the training period and retention and transfer test 24 hours after practice, the AS-EE-EF group had the highest accuracy scores and outperformed all other groups.

Results: The results of the between-group comparison for throwing accuracy showed that the EE-AS-EF group was a significant difference compared to the other groups.

Conclusions: The findings provide evidence that enhanced expectancies, autonomy support, and an external focus can contribute in an additive style to optimize motor performance and learning.

Introduction

In the past, learning was not very important in human life, many non-technical and non-specialist people think so, it was assumed that a person would learn science and art through experience, apprenticeship and work with a master, and except that there was no problem. But today learning has found special importance among different communities as considers one of the main goals in the discussion of education. When it comes to learning, the main question is what is considered for learning? Motor skills are one of the most

important skills that an alive creature depend on for their survival. Therefore, motor skills are a major part of human life, and humans need to use these skills to interact with their environment (TaheriTorbati, Bahrn, Khorami, & Shafizadeh, 2005).

Effective motor function is important for survival and development. One of the goals that people try to achieve in sports environments is to improve performance. In sports, better performance is determined by who wins or loses, and there are many techniques to help it. Recently,

three key variables for optimal motor learning have been identified (Wulf & Lewthwaite, 2016): two motivational variables (enhanced expectancies for positive experience and outcome and autonomy support) and one attention variable (ie, external focus).

Our first motivational variable is learner expectations that can be increased in various ways. In various studies, enhanced expectancies result of feedback that provided in trials with rather small errors compared to trials with larger errors, thereby facilitating learning (Badami, Vaez Mousavi, Wulf, & Namazizadeh, 2012; Chiviawsky & Wulf, 2007; Clark & Ste-Marie, 2007; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Maleki, 2012). Also, inductive-social feedback has been found to enhance motor learning that leads learners to believe that their performance is better and superior to their peers (Ávila, Chiviawsky, Wulf, & Lewthwaite, 2012; Lewthwaite & Wulf, 2010). Even statements indicate that all those who are under the circumstances inductive-social feedback usually do well a learning task (Wulf, Chiviawsky, & Lewthwaite, 2012) or increasing learners' perceptions of success during practice can be sufficient to enhance learning (Chiviawsky & Harter, 2015; Chiviawsky, Wulf, & Lewthwaite, 2012; Palmer, Chiviawsky, & Wulf, 2016; Trempe, Sabourin, & Proteau, 2012). Autonomy is another motivational variable that is important for optimal learning. It is a practice condition that supports the learner's request for autonomy (usually in the motor learning literature called self-control practice (Sanli, Patterson, Bray, & Lee,

2012)), that consistently shown with a positive effect on learning motor skills. For example, learners with feedback delivery control (Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997), use the auxiliary device (Hartman, 2007; Wulf & Toole, 1999), amount of exercise (Post, Fairbrother, Barros, & Kulpa, 2014) and Repeat demonstration skills, among other factors, led to more effective learning. These findings are likely motivational bases (Lewthwaite, Chiviawsky, Drews, & Wulf, 2015). The existence of autonomy or control over actions is a fundamental psychological requirement (Deci & Ryan, 2000, 2008). Conditions in support of autonomy are quoted by choice or verbally that has been shown to increase motivation, performance, or individuals learning (Reeve & Tseng, 2011; Wulf, Freitas, & Tandy, 2014). Importantly, even random choices that are not directly related to task performance have also been shown to provide learning benefits (Lewthwaite et al., 2015; Wulf, Chiviawsky, & Cardozo, 2014). For example, in the Lutzewitz study (Experiment 1), allowing participants to choose the color of golf balls in a hit-ball task than when they were not given the right choice led to more effective learning (Lewthwaite et al., 2015). A potential mediator of learning under autonomy-supportive conditions is self-efficacy. Self-efficacy reflects a person's confidence in their ability to perform a certain task successfully in the future (Bandura, 1977). In a few studies, self-efficacy is correlated with perceptions of autonomy. Autonomy-supportive task instructions, which implied that participants had some freedom in how

they performed or practiced a given task, resulted in higher self-efficacy (Hooyman, Wulf, & Lewthwaite, 2014) or perceived competence (Reeve & Tseng, 2011) than did controlling-language instructions that left participants with no choices. Granting learners the opportunity to make their own decisions may convey a sense of trust in their capability that increases their own confidence in being able to do well on a given task. Thus, there is reason to believe that supporting learners' need for autonomy, by giving them relatively insignificant choices, might enhance their self-efficacy and in turn learning (Wulf, Chiviacowsky, et al., 2014).

Learners' expectancies have been enhanced through various manipulations. For instance, by providing feedback after relatively successful trials, as opposed to less successful ones, learning is facilitated (Badami, Vaez Mousavi, Wulf, & Namazizadeh, 2011; Chiviacowsky & Wulf, 2007; Saemi et al., 2012; Saemi, Wulf, Varzaneh, & Zarghami, 2011). Even simple statements suggesting that peers typically do well on a task to be learned can lead to learning benefits (Experiment 2) (Wulf et al., 2012). Therefore, (bogus) positive social-comparative or normative feedback leading-learners to believe that they are performing better, or improving more than their peers has been demonstrated to enhance the learning of balance (Lewthwaite & Wulf, 2010), throwing (Ávila et al., 2012) or timing tasks (Wulf, Chiviacowsky, & Lewthwaite, 2010). Compared with negative social-comparative feedback implying below-average performance, or no social-

comparative feedback (control conditions), positive normative feedback led to superior retention or transfer test results in those studies (Wulf, Chiviacowsky, et al., 2014).

Finally, the focus of attention is extensively used as a training method which benefits during practice help to improve the performance of a skill, and This focus orientation is in two ways internal and external (Abdar, Zarghami, & Varzaneh, 2016). In general, the external focus of attention means that participants focus their attention on the effects of their movement on the environment, While the internal focus of attention they focus their attention on the parts of their body that are involved in the movements (Keller, Lauber, Gottschalk, & Taube, 2015). For example, in Wolf's paper (2013), he found that using an external focus of attention was more useful than using the internal focus of attention or non-instruction conditions (Wulf, 2013). Focus increases the planned outcome of the movements (eg, on the performance), the effectiveness of the movements (eg, balance, accuracy, and stability) and the efficiency of the movements (e.g., force, muscle activity, heart rate, and oxygen consumption). External focus automatically depends on focusing on body movements. Wolf et al. (2001) proposed a constrained action hypothesis to explain the positive effects of external attention (Wulf, McNevin, & Shea, 2001). A study by them was one of the first researches to test the prediction of the constrained action hypothesis. This hypothesis provides a plausible explanation of the benefits of an external focus of attention compared

to an internal focus of attention and suggests that the use of internal focus sings leads to a controlled focus on movements control and a limitation on task performance without consciousness or an automatic level of neural motor control. The automatic effect is greater than the fluidity (being fluent) of the movements (Land, Frank, & Schack, 2014). Thus, the external focus increases the motion control process and in turn, task-independent learning and performer skill levels. In fact, by adopting external focus, they achieve higher skill levels in less time (Land et al., 2014; Wulf, 2007).

While three factors individually have shown increasing incidence, three recent studies examined whether combining two factors, enhanced expectancies and autonomy support)Wulf, Chiviacowsky, et al., 2014(, enhanced expectancies and external focus (Pascua, Wulf, & Lewthwaite, 2015), or autonomy support and external focus (Wulf, Chiviacowsky, & Drews, 2015) is it more effective than just one of these factors? In each study were found additive effects of two factors. The presence of each pair of factors produces more learning benefits than just one factor. These findings suggest that enhanced expectancies, autonomy support, or external focus help to learn at least different pathways or mechanisms.

In the optimal motor learning theory (optimal performance through internal motivation and focus of attention to learning) (Wulf & Lewthwaite, 2016), It is suggested that three factors - enhanced expectancies (EE), autonomy support (AS), and

external focus (EF) - each one helps to learn skills. In the effects of autonomy, part of it is manifested by enhanced expectancies. Experimentally, it has been shown that Support for autonomy conditions can influence expectations self-efficacy (Hooyman et al., 2014; Wulf, Chiviacowsky, et al., 2014; Wulf et al., 2015). In the same way, for focusing attention and hope, successful performance created by external focus and enhanced expectancies can influence self-efficacy, most likely through the path of performance (Bandura, 1977; Pascua et al., 2015). So, we hypothesized that the presence of all three factors together is the most effective learning compared to practice conditions that include only two factors (Pascua et al., 2015; Wulf, Chiviacowsky, et al., 2014; Wulf et al., 2015). The present study is designed to experiment with this hypothesis that practice conditions containing all three factors of learning optimization Theory together are the most effective agent for learning compared to practice conditions include only two factors. Practicing a new movement task (eg, dart throwing with a non-superior hand) includes combining two factors for three groups and combining three factors for one group (EE-EF-AC). We assume that the latter group will show the most effective learning than the other three groups.

Method

Participants

Sixty women Takhti Club members of Ilam city with a mean age of 21.51 years (SD=2.32) and in an available way, participated in the study. None of them were ambidextrous (6 were left-handed). All

were naive as to the purpose of the experiment. Before participating in the study, all participants signed an informed consent form.

Apparatus and task

Participants' task was to throw darts arrow with their non-dominant arm at a target. The target consisted of darts backboard (is scored from 1 to 10) (figure 1) and was hung in wall 2.5 m from the participant. If the ball hit the bull's eye, 10 points were awarded by the experimenter. 9 points were given for hitting the next circle, and so forth. If a ball hit a line separating two zones, the higher score was awarded. Throws that completely missed the target were given 0 points.

Procedure

At the beginning of the research, written consent was received from all participants to participate in this research. Then, personal information form and top-notch questionnaire to determine the dominant arm with a reliability of 86% were given to them (Ahmad & Agah, 2001). Participants were first given basic instructions for the Dart Throwing skill with the non-dominant arm (e.g., stay behind the line, throw with the left arm, how to get the arrow and Scoring) and a demonstration by the experimenter. Then, each participant performed three experimental throwing darts. After that, Participants performed a pre-test consisting of 10 trials which no instructions were provided. Participants were randomly assigned to one of four groups: Autonomy support - external focus (AS-EF), enhanced expectancies - external

focus (EE-EF), enhanced expectancies - autonomy support (EE-AS), and enhanced expectancies - autonomy support - external focus (EE-AS-EF). This was followed by the practice phase (6 consecutive training sessions), which consisted of 6 blocks of 10 training trials. There was a two Minutes rest in between training blocks (Borhani, Mohammadzadeh, & SadatHosseini, 2006). Before each block, special instructions were given to each group. All participants, in addition to the special instructions for their groups, received feedback on their average accuracy score after each block of 10 trials (Wulf, Chiviakowsky, et al., 2014; Wulf et al., 2015). In the autonomy-supportive conditions (EE-AS, AS-EF, EE-AS-EF group), participants were able to choose blocks of 5 trials in which they could use their dominant arm (Wulf, Chiviakowsky, et al., 2014; Wulf et al., 2015). Performance expectancies were enhanced (in the EE-AS, EEEF, EE-AS-EF groups) by providing positive social-comparative feedback, in addition to veridical scores after each 10-trial block. The social-comparative feedback was a bogus score, allegedly the average score participants in previous experiments had produced on the respective block. It was 20% lower than the participant's score. Thus, participants were led to believe that their performance was above average (Lewthwaite & Wulf, 2010; Pascua et al., 2015; Wulf et al., 2012). Finally, in the external focus conditions (EE-EF, AS-EF, EE-AS-EF groups), participants were asked to focus on the target. They were reminded to maintain that focus before each 10 trial block (Pascua et al., 2015; Wulf et al.,

2015). Participants were informed, before the beginning of practice, that they would only use their non-dominant arm on the practice phase. At the end of the sixth day of the training, participants performed a post-test consisting of 10 trials. Two days later, after 48 hours of no practice, participants performed retention and transfer tests, which consisted of 10 trials each. No instructions or feedback were provided, and participants only used their non-dominant arm on the retention and transfer tests. In the transfer test, throw distance of 2.5 m to 3 m increased. They used only their non-dominant arm on the retention and transfer test, and they were not given feedback or any instructions (Pascua et al., 2015; Wulf, Chiviawowsky, et al., 2014; Wulf et al., 2015).

Information analysis method

In non-dominant arm dart-throwing learning analysis, Shapiro-Wilk test to ensure the normal distribution of data, analysis of variance with repeated measures to evaluate in-group progression process from pre-test to transfer, Bonferroni post hoc test to identify the place of difference was used. Also, a mixed model analysis of variance to compare between groups, multivariate analysis of variance and Tukey post hoc test to see significant differences between groups and to determine differences in different stages were used.

Data analysis was performed at a significant level $P < 0.05$ using SPSS version 25 and Excel software 2016.

Results

Pre-test

All groups had similar accuracy scores on the pre-test (see Figure 1). There were no differences among groups, $F_s(3, 56) = 0.05, p = 0.985$.

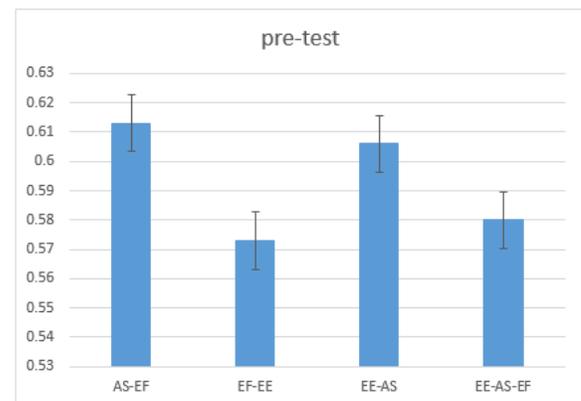


Figure 1. Difference between research groups in the pre-test. * The significance level $P \leq 0/05$.

Practice

During the practice phase, throwing accuracy generally increased across different stages (see Figure 2). The main effect of different stages, $F(3, 168) = 374.569, p = .0001, \eta p^2 = 0.78$, was significant. Also, the group main effect was significant, $F(3, 56) = 126.769, p = .001, \eta p^2 = 0.424$. Moreover, the interaction of group and different stages was significant, $F(3, 52.659) = 7.059, p = .0001, \eta p^2 = 0.274$.

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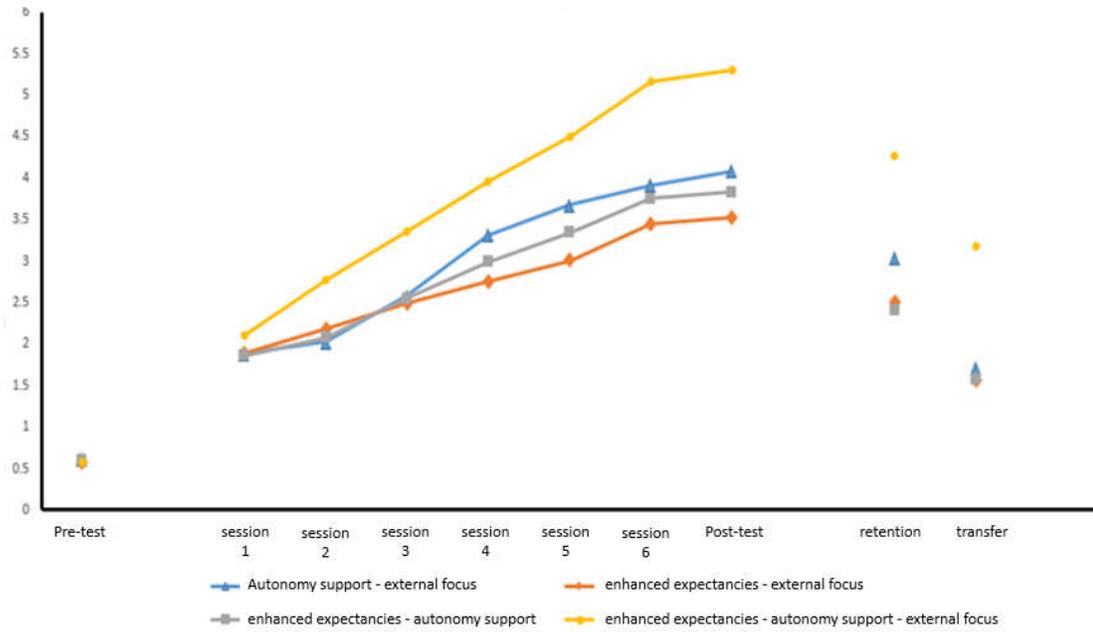


Figure 2. Averages of dart-throwing scores during the study in 4 groups.

Post-test

Planned comparisons for the post-test revealed that throwing accuracy was significantly higher for the EE-AS-EF condition ($M = 5.306, SD = 0.903$) compared with the EE-AS ($M = 3.826, SD = 0.84$), AS-EF ($M = 4.086, SD = 0.893$), and EE-EF ($M = 3.52, SD = 1.007$) conditions, $F(3, 56) = 11.023, p = 0.0001, \eta^2 = 0.371$ (see Figure 3).

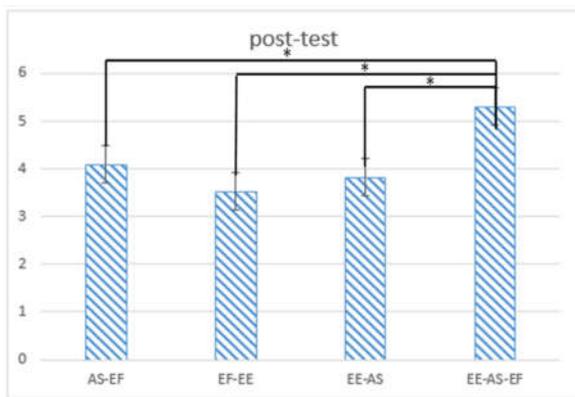


Figure 3. Difference between research groups in the post-test. * The significance level $P \leq 0/05$

Retention

Planned comparisons for the retention test revealed that throwing accuracy was significantly higher for the EE-AS-EF condition ($M = 4.265, SD = 0.973$) compared with the EE-AS ($M = 2.406, SD = 1.157$), AS-EF ($M = 3.04, SD = 0.944$), and EE-EF ($M = 2.506, SD = 0.99$) conditions, $F(3, 56) = 10.486, p = 0.0001, \eta^2 = 0.36$ (see Figure 4).

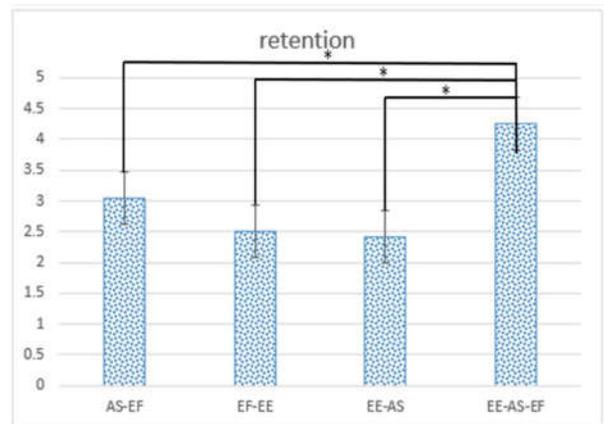


Figure 4. Difference between research groups in the retention. * The significance level $P \leq 0/05$.

Transfer

Planned comparisons for the transfer test revealed that throwing accuracy was significantly higher for the EE-AS-EF condition ($M = 3.193$, $SD = 1.11$) compared with the EE-AS ($M = 1.566$, $SD = 0.77$), AS-EF ($M = 1.706$, $SD = 0.77$), and EE-EF ($M = 1.56$, $SD = 0.62$) conditions, $F(3, 56) = 13.404$, $p = 0.0001$, $\eta^2 = 0.418$ (see Figure 5).

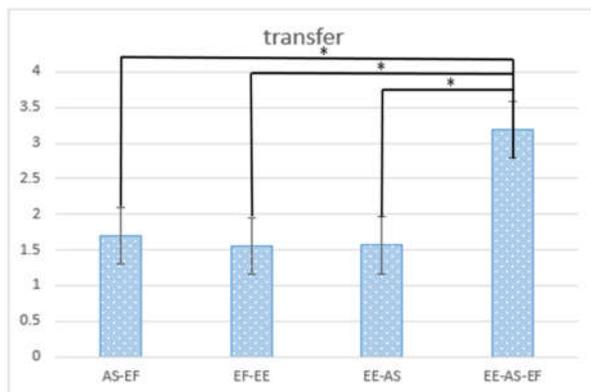


Figure 5. Difference between research groups in the transfer. * The significance level $P \leq 0/05$

Thus, learning was enhanced by the presence of all three factors relative to only two. This learning advantage for the EE-AS-EF group was confirmed by the fact that this group showed higher throwing accuracy on the post-test ($M = 5.306$), retention test ($M = 4.265$) and transfer test ($M = 3.193$) relative to the pre-test ($M = 0.58$). The interaction of group and different stages was significant, $F(3, 52.659) = 7.059$, $p = .0001$, $\eta^2 = 0.274$. Post-hoc tests indicated that there was a significant difference between the EE-AS-EF group with EE-AS ($p = 0.000009$), AS-EF ($p = 0.0005$) and EE-EF ($p = 0.000003$) group. But there was no significant

difference between the EE-AS, AS-EF and EE-EF group ($P > 0.05$).

Discussion and Conclusion

This study aimed to investigate the effect of the combination of attention (external focus) and internal motivation (autonomy support and enhanced expectancies) on learning the skill of throwing darts. Enhanced expectancies, autonomy support, and an external focus of attention are considered key factors in a new theory of motor learning (Wulf & Lewthwaite, 2016). The results showed that all the groups (AS-EF, EE-AS, EE-EF, and EE-AS-EF) improved in all three stages of learning (post-test, retention, transfer) than the pre-test for the skill of throwing darts with the non-dominant arm. Therefore, it can be concluded that the attention variable and two internal motivational variables lead to increased learning in interaction with each other. These results had been consistent with previous research. Pascua, Wulf & Lewthwaite (2015), expressed that the benefits of each factor (external focus and enhanced expectancy) for learning were similar and that their combination yielded additive effects (Pascua et al., 2015). Wulf, Chiviawosky & Cardozo (2014), discussed the high benefits of autonomy support and enhanced expectancies in motor learning by examining the individual and combined influences of these factors. The results showed the greatest throwing accuracy in the autonomy support and enhanced expectancies group than each variable individually and control group (Wulf, Chiviawosky, et al., 2014). Also, Wulf,

Chiviacowsky & Drews (2015) examined whether the combination of two factors that have consistently been found to enhance motor learning (of three important learning variables in optimal motor learning theory) – an external focus (EF) of attention and autonomy support (AS) – would produce additive benefits than the effect only one factor. The combination of two factors external focus and autonomy support group showed the greatest throwing accuracy. They concluded that promoting an external focus of attention and supporting learners' need for autonomy seems to independently influence learning (Wulf et al., 2015). Wulf & Lewthwaite (2016), expressed The OPTIMAL theory of motor learning based on that intrinsic motivation and attention for learning lead to optimal performance (Wulf & Lewthwaite, 2016). Abdollahipour et al. (2017) examine the combined effects of external focus instructions and autonomy support on the motor performance of children. The results showed that, within the same individuals, instructions to adopt an external focus and the provision of a small choice contributed independently to enhance motor performance in children (Abdollahipour, Nieto, Psotta, & Wulf, 2017).

To determine the effect of the combination of optimal motor learning theory variables compared between the groups. Comparison between groups of AS-EF, EE-AS and EE-EF (combining two of the three learning variables) in non-dominant dart-throwing accuracy showed that between these groups There were no significant differences between the three groups, but all three groups were

significantly different from group AS-EF-EE. The group that the combination of external focus - raising expectations - supporting autonomy leads to more effective learning than other groups that only combine two of these variables. External focus -expectations-support-autonomy-performance was significantly better than other groups in all three post-test, retention and transfer tests. In the three groups that contained two variables, apart from which pair of variables, the learning rate was similar. Perhaps this increase in learning is due to motivational factors that may provide expectations of valuable experience through neuro-activation and dopaminergic responses, and the focus of attention has been on the success of the task and may directly or indirectly influence the brain response effect of motor learning. The dopaminergic response is an acceptable mechanism by increasing or decreasing the effects of reactive dose, memory fixation, and nerve pathway development (Wulf & Lewthwaite, 2016).

Concerning the last group that included all three variables, one can ask the question, what in external attention, raising expectations, and supporting autonomy help to make learning and makes them valuable? The benefits of external focus are related mainly to automate the control of movements caused by focusing on the effects of certain movements and away from body movements (Wulf, 2013). Without unique external focus attention instructions, learners tend to internal focus attention (Pascua et al., 2015). In a recent study by Russell, Porter, and Campbell

(2014), external focus on the main task of the throwing darts was essential to increase performance. To produce more successful performance results, the external focus attention is on assisting and collaborating on the success that raises expectations (Russell, Porter, & Campbell, 2014).

Enhanced expectancies predict and prepare individuals for positive outcomes or experiences and the effects of cognitive, emotional, and primary motor activity (Wulf & Lewthwaite, 2016). Positive socio-economic feedback has also been found previously to increase perceived skills (Ávila et al., 2012) and satisfaction with their performance (Wulf, 2013) and to reduce anxiety and anxiety-related abilities (Wulf et al., 2012).

Control practice provides internal rewards (Karsh & Eitam, 2015; Leotti & Delgado, 2011). Supporting autonomy may raise personal expectations for a positive outcome (Chiviacowsky, 2014; Hooyman et al., 2014; Wulf, Chiviacowsky, et al., 2014; Wulf et al., 2015). Therefore, supporting autonomy may indirectly facilitate learning by raising expectations of the performer (Wulf & Lewthwaite, 2016). On the other hand, allowing learners to make their own decisions probably means trusting their abilities, and as a result, their confidence in their ability to perform skills increases their efficiency. Particularly interesting is that even random selection has shown that it increases confidence related to task and motivation (Wulf, Chiviacowsky, et al., 2014) as well as performance and learning (Wulf & Adams, 2014; Wulf,

Chiviacowsky, et al., 2014). Hereof, Langer (1975) showed that even the illusion of choice can increase people's confidence in their abilities to produce optimal results, even if that result was accidental and by chance. People's perception of their ability to control the environment enhances their sense of competence (Santrock, 2006). Sense of competence or self-sufficient can in turn increase performance and learning. The relationship between autonomy support and motor learning was seen in a recent study by Hooyman et al. (2014) as well as a study by Rio (2011), Which autonomy support instruction indicate that those who have the right to choose lead to higher learning than the control group (Hooyman et al., 2014; Reeve & Tseng, 2011).

Conclusion

In the end, this study confirmed and replicated the results of previous research on the effect of the combination of attention (external focus) and internal motivation (raising expectations and supporting autonomy) on enhancing motor learning. In general, according to the results it can be stated that combining all three variables effective in motor learning in optimal motor learning theory can lead to more learning benefits than each combination in pairs. Therefore, it is suggested that to optimize motor learning skills in sitting of practice, the trainer can use the benefits of these effects by finding an appropriate external focus for the task, highlighting positive aspects of performance, and ensuring that they can experience success and finally, giving the right to choose to

support their need for autonomy.

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