FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 399 - 408
https://doi.org/10.22190/FUPES200628037C

Research article

COMPARISON OF THREE TYPES OF KNOWLEDGE OF PERFORMANCE ON THE LEARNING OF ROUNDHOUSE TAEKWONDO KICK OF INEXPERIENCED ADULT LEARNERS

UDC 796.85

Isabella Rachel Cavazana[1], Eduardo Varejao Díaz Placencia[2], Josiene de Lima Mascarenhas[3]

[1]Faculty of Clube Náutico Mogiano, University of Mogi das Cruzes Mogi das Cruzes, São Paulo, Brazil
[2]Albert Einstein Israelite Hospital, São Paulo
[3]Anhanguera Faculty, Hortolândia, Brazil

Abstract. *The Roundhouse kick (RHK) is one of the most employed techniques in taekwondo competitions to score on the opponent, since it provides a fast and a powerful attack. However, its effectiveness depends on high technical accuracy. To polish an athlete's technique, trainers generally provide movement-related information via augmented feedback. Feedback is provided in two different ways, knowledge of result (KR) and knowledge of performance (KP). KR is about the accuracy score of a trial, whereas KP concerns the movement pattern that produces the result. Few studies have focused on understanding which moment of providing feedback on martial arts movement patterns is the most efficient. The purpose of this study was to analyze whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials or when requested by the learner. Eighteen undergraduate students with no prior experience with martial arts were assigned to different groups: a group that received feedback after performing good trials (GOOD), a group that received feedback after poor attempts (POOR) and a group that decided when to receive feedback (SELF). Four blocks of tests were performed, including a pre-test, post-test, retention and transfer. The subjects had to hit a higher amount of RHK on a kick pad according the movement pattern. The ANOVA revealed that the SELF group showed a higher score than the GOOD and POOR groups, while no differences were found between the GOOD and POOR groups.*

Key words: *Motor Skill; Learning; Knowledge of Performance; Taekwondo; Roundhouse Kick*

Received June 28, 2020 / Accepted September 16, 2020
Corresponding author: Eduardo Varejao Díaz Placencia
Albert Einstein Israelite Hospital, Avenida Albert Einstein, 627, São Paulo 05652-900, Brazil
Phone: +55 11 99199-1020 • E-mail: edusanbr@hotmail.com

INTRODUCTION

Taekwondo competition is a free-fighting combat sport that implicates the usage of high and fast kicks to repel an opponent (Zar, Gilani, Ebrahim, & Gorban, 2008). Although the rules allow the use of hands and feet in a taekwondo competition to strike an opponent, generally, athletes prefer to use kicking rather than hands techniques. One of the most employed kick during a taekwondo match is the roundhouse kick (RHK), since it provides a fast and a powerful attack (Luk, Hong, & Chu, 2001; Li, Yan, Zeng, & Wang, 2005; Matsushigue, Hartmann, & Franchini, 2009; Falco, Estevan, & Vieten, 2011). Furthermore, RHK is a highly adaptable technique that allows taekwondo athletes to perform minimal changes in technique to hit the target, such as the head and torso across different distances (Falco et al., 2011). Basically, to perform the taekwondo RHK, the kicking leg is elevated in an arc in the direction of the front of the body and the knee is extended up until the instep hits the target (Park, Park, & Gerrard, 2009). Although taekwondo RHK is considered a very efficient technique during a taekwondo match, it is crucial that athletes improve and have their technique execution polished in order to fit the kick and score successfully. To improve athlete techniques performance, trainers usually provide movement-related information to their learners via verbal feedback (Fishman & Tobey, 1978; Landin, Hebert, & Cutton, 1989).

The term feedback is classified into two subcategories, intrinsic feedback and augmented feedback (Schmidt & Lee, 1999). Intrinsic feedback is the sensory-perceptual information that is perceived by the performer while executing a movement, while augmented feedback is performance-related information from an external source. Augmented feedback has been long recognized as an important influential variable in the acquisition of a motor skill. Moreover, feedback plays two fundamental roles on motor skill acquisition, including, motivating and providing proper information about technique execution (instruction and corrections) (Magill, 1993). The positive effects of augmented feedback have been studied in several situations such as rehabilitation afterward a stroke (Langhorne, Coupar, & Pollock, 2009), learning of medical skills (Porte, Xeroulis, Reznick, & Dubrowski, 2007), in physiotherapy (Winstein, 1991), and physical education and sports (Lauber & Keller, 2012).

For sport motor skills, the development of appropriate technique is essential for individual performance and the prevention of movement-related injuries. For example, it is well known that the inappropriate jumping landing technique is associated with a high risk of lower limbs lesions (Arendt, Agel, & Dick, 1999). Thus, a study showed that augmented feedback reduced jump landing forces, suggesting a reduced risk of lower limb lesions. Also, in some sports, such as gymnastics, a successful performance is based on the athlete's movement pattern. However, in others sports, such as ball games and combat sports, success is based on outcomes that can be dependent on technique. Thus, trainers commonly focus on movement patterns when training their athletes. Therefore, depending on the situation, augmented feedback can be provided in two different ways, knowledge of result (KR) and knowledge of performance (KP). The first consists of information provided to a performer about the accuracy score of a trial, whereas KP concerns the movement pattern that produces the result (Schmidt & Lee, 2005). Lauber and Keller (2012) exemplify KR as feedback given when a trainer tells a high jump athlete, whereas KP is concerned with the movement pattern that the learner made, for example, when the coach tells the learner that his hip is not extended enough when crossing the bar. In addition, divergences concerning the ideal moment of providing feedback are found in the literature. Three basic types of feedback, considering the moment of providing feedback, can be found in the literature,

including feedback given after good trials, feedback given after poor trials and self-controled feedback. Feedback after good trials is provided by the trainer when the learner performs the technique properly; however, feedback after poor trials is given when the learner performs a technique in an unsuccessful way. Finally, self-controlled feedback is provided when the learner requires it (Chiviacowsky & Wulf, 2007; Chiviacowsky, Wulf, Wally, & Borges, 2009).

Prior studies reported that feedback after poor trials is more important than after good trials, since the information provided after a poor performance is able to guide the learner to the correct movement (Salmoni, Schmidt, & Walter, 1984; Schmidt & Young, 1991). These results differ from more recent studies that observed that feedback after good attempts is more efficient than after poor attempts (Chiviacowsky & Wulf, 2007; Chiviacowsky et al., 2009). However, Chiviacowsky, Medeiros, and Kaefer (2007) found no differences in the motor skill learning of children when comparing the moment of providing feedback. Another method of feedback has been found in the literature, self-controlled feedback. Unlike the mentioned types of feedback, self-controlled feedback is given when requested by the learner (Chiviacowsky & Wulf, 2005).

The contradiction found in the literature is the reason for further studies in the field of motor skills learning. Furthermore, studies designed to investigate the effects of augmented feedback on combat sports motor skills are still scarce. So, in an attempt to establish the most appropriate moment to provide KP, we conducted this study by assessing the universal characteristics that occur during motor skill learning, including improvement, consistency, persistence and adaptability (Magill, 2000). The improvement of a motor skill occurs when a subject improves the learned skill after a period of training. Consistence is observed when the learner presents little variability in his movement patterns. Persistence occurs when an individual remains presenting good performance in the learned skill over a long period in the absence of practicing the task. And, finally, adaptability describes the capacity of an individual transferring the learned movement to a new task or other context (Magill, 2000).

The purpose of this study was to investigate whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials, or when requested by the learner.

METHODS

Sample

Graduate students of both sexes were recruited from the student population enrolled in physical education courses. The subjects were interviewed regarding their prior sport experience. The major inclusion criteria for participation in this study was absence of prior experience in any martial art. Eighteen subjects aged 19-39 years were selected and gave informed consent before beginning the study. The subjects were randomly assigned to 3 groups. A group that received KP after good trials (GOOD, n=6), a group that had KP provided after poor trials (POOR, n=6) and a self-controlled group (SELF, n=6) that received KP only when the individual requested.

Task

The subjects had to perform the taekwondo roundhouse kick with their dominant leg. The purpose of the task was to hit the highest number of RHKs using the dominant leg on a kick pad following the proper movement pattern (table 1).

Table 1 Criteria for movement pattern analysis of RHK

Performance Criteria	Chance 1	Chance 2	Chance 3	Score (Sum)
1. The dominant leg (strike leg) should be positioned back with the feet apart at a distance equivalent to the width of the hip and the feet should point to the right side.				
2. To keep the guard high, right arm protects the thoracic-lumbar region and the left arm protects the face.				
3. To bend the hip and knee of the strike leg at approximately 90 degrees.				
4. To perform pelvic axial rotation and hip abduction.				
5. To extend the knee (strike leg) simultaneously deferring the kick with the back of the foot in plantar flexion.				
6. To bend the knee of the attack leg, also performing a rotation of the hip with the supporting leg and ending with a hip extension leg attack.				
			Skill Score (Sum)	

Note: The subjects had 3 attempts to perform the tasks. Successes were marked with number "1", while un-successes were marked with "0". The score of each movement was the sum of all 3 attempts, and the Skill Score was calculated

The RHK is characterized by a horizontal and vertical shift of the center of mass towards the target, and is coupled with a fast forward pelvic axial rotation, abduction in the hip joint, flexion in the hip joint, and extension in the knee joint (Gavagan & Sayers, 2017).

Procedure

Before intervention, the subjects were submitted to a pretest, and after the intervention, they were submitted to a posttest, retention test and transfer test. Our tests and assay methods were adapted from the Test of Gross Motor Development (TGMD) proposed by Ulrich (2000). However, we provided the subjects with 3 attempts to perform the task, unlike TGMD that suggests only two chances for each participant. Furthermore, six performance criteria were stipulated to assay the movement pattern. During the tests all the subjects were videotaped. And, following the same assay methodology of TGMD, the number of successes of each participant were registered and summed up. Each performance criteria executed correctly resulted in one point (see table 1). The intervention/classes consisted of 3 sessions of 60 minutes each. The content of the lessons was the same for all groups and it consisted of drills for the correct learning and execution of the task. Each group was designated to receive KP at a specific moment. Thus, the GOOD group received KP after relatively good attempts, while the POOR group received KP when they performed relatively poor attempts. Finally, the SELF group received KP when the participants requested. After the end of the intervention, a posttest was performed in order to assess the subject's improvement on the learned skill. The posttest followed the same procedures as the pretest. Six days later, when the subjects did not practice at all, a retention test (the same as the pretest and posttest) was performed to verify whether they were able to retain the learning.

To assess bilateral adaptability, the subjects were submitted to a bilateral transfer test. To do that, the subjects were asked to perform the task using the untrained leg. The criteria of score adopted for movement pattern assessment is described in table 1. The score obtained from each set was summed up. All the tests were videotaped (Camera JVC Everio GZMGOOD30 30GB Hard Disk Drive Camcorder with 34x Optical Zoom) for data collection.

Statistical analysis

GraphPad Prism 7 was used to analyze the results. The Shapiro-Wilk test was performed for normality verification. Intra-groups differences were verified with a One-Way repeated measures ANOVA. An alpha level of $p<.05$ was considered significant. Effect size is expressed through partial ETA-squared ($\eta p2$).

RESULTS

Knowledge of performance

The ANOVA revealed a significant effect of the test for the groups ($F(2, 15)=5.353$, $p=.018$, $\eta p2=.41$), block of tests ($F(3, 45)=205.2$, $p<.0001$, $\eta p2=.93$) and Group x Block interaction ($F(6, 45)=2.479$, $p=.04$, $\eta p2=.25$). Post hoc analyses using the Tukey test showed significant differences between the pretest and the posttest for all groups, indicating that all of them improved the RHK skill. The consistence was assessed comparing the results from the pretest and the retention test and from the posttest and the retention test. Significant differences between the pretest and the retention test were found, while no significant differences between the posttest and the retention test were observed. These results show that the skill persisted in all groups. To assess adaptability, we compared the transfer test results with the pretest and posttest outcomes. So, since the performance in the transfer test was significantly higher than in the pretest, and no significant differences were found for the posttest, we found that all groups bilaterally transferred their learning of the taekwondo RHK (table 2).

Table 2 Mean±standard deviation intra-groups outcome scores on trials of KP feedback

	GOOD	SELF	POOR
Pre	5.83 ± 1.47	4.66 ± 1.50	4.5 ± 0.83
Post	14.14 ± 1.67 *	17 ± 1.09 *	11 ± 5.54 *
Retention	14.42 ± 1.71 *	17 ± 1.54 *	14.83 ± 1.32 *
Transfer	13.85 ± 2.03 *	16.83 ± 1.60 *	13 ± 3.22 *

Note: (*) Significant difference *($p<0.05$)* when comparing pre-test with post-test, retention and transfer test

Post hoc comparisons also indicated that all groups presented no significant differences on the kicks in the pretest. However, in the posttest, we found that the SELF group presented a significantly higher performance than the GOOD and POOR groups concerning the movement pattern of kicks. No significant differences were found between the GOOD and POOR groups in task performance. Retention test results also showed that the SELF group presented better performance than the GOOD and POOR groups; however, no significant differences were observed between the GOOD and POOR groups. The transfer

test revealed that the SELF group was significantly better than the GOOD and POOR groups, but no significant differences were detected between the GOOD and POOR groups.

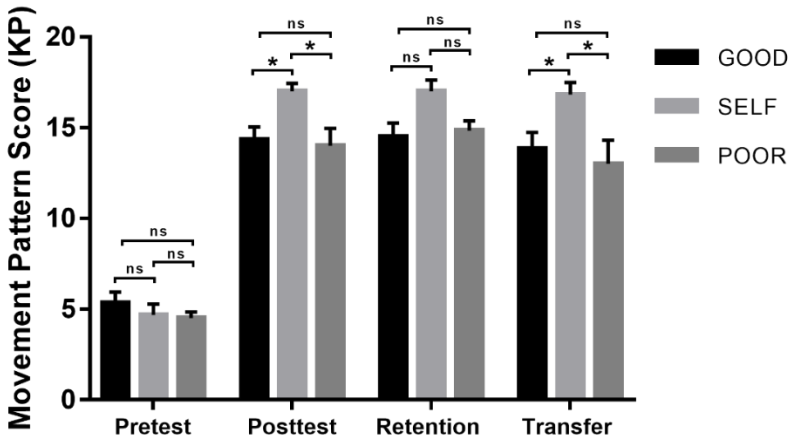

Fig. 1 Comparison between groups pertaining to the movement pattern score of knowledge of performance (KP)
Note: (*) Significant difference ($p<0.05$); (ns) No significant difference

DISCUSSION

The purpose of this study was to investigate whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials or when requested by the learner. Before comparing the most effective moment of providing feedback, we checked whether all three experimental groups were able to learn the skill. An intra-group comparison revealed that all groups were able to improve, retain, and transfer the taekwondo RHK skill, independently of the moment (after good trials, after poor trials or when requested by the learner) they received the feedback. We also observed that all groups achieved consistence upon learning the skill. Indeed, other studies have found that subjects who receive either self-controlled and externally controlled feedback improve and retain the learning of different types of skills, such as strength enhancing (Chiviacowsky, Medeiros, & Kaefer, 2007), golf shooting (Chiviacowsky, Pinho, Alves, Schild, 2008), disc flying (Siqueira, Henrique, Beltrão, Cattuzzo, 2010), ball throwing in rhythmic gymnastics (Lemos, Chiviacowsky, Ávila, Drews, 2013), and crawl swimming. (Katzer, Schild, Meira, Corazza, & Chiviacowsky, 2015). However, we would like to emphasize that the main goal of our study was not to investigate the impact of feedback on the learning of RHK, but the most ideal moment of offering KP feedback.

Our main results showed that the group that received self-controlled KP achieved higher scores on the movement pattern than feedback after relatively good and relatively poor trials in post, retention and transfer tests. In line with our results, Chiviacowsky and Wulf (2005) found that feedback is more effective when the learner is allowed to make a decision about receiving it after the trial. In addition, the same group verified, through a questionnaire, that most learners prefer receiving feedback after a good performance

(Chiviacowsky, Wulf, & Ávila, 2013). This preference may be associated with psychological and motivational factors. In fact, Saemi, Wulf, Varzaneh, & Zarghami (2011) reported that motivational factors are associated with feelings of aptness, that is, a positive feedback improves the intrinsic motivations of an individual. For instance, Badami, Vaezmousavi, Wulf, & Namazizadeh (2011) reported that positive feedback plays an important role in stimulating the learning of a motor skill. Corroborating with Badami's study, West, Bagwell, & Dark-Freudeman (2005) observed increased performance in subjects that received positive feedback when compared to control conditions. Thus, positive feedback has been effective in motivating subjects to raise their goals, while negative feedback seems to adjust their goals in a downward manner (Ilies & Judge, 2005). Moreover, Nieuwenhuis, Slagter, Alting von Geusau, Heslenfeld, & Holroyd (2005) showed that subjects who received positive feedback after performing a time estimation task showed more activation in certain brain areas, including the posterior cingulate cortex, the right superior frontal gyrus, the rostral anterior cingulate cortex, and the striatum.

Although the literature has showed a similarity between feedback after good attempts and when requested by the learners (self-controlled) (Chiviacowsky & Wulf, 2005), curiously, here we observed that KP feedback after relatively good attempts did not differ from KP feedback after relatively poor trials. Indeed, investigation describing the effects of feedback about KP on movement performance is sparce, especially in the combat sport field, since most of the studies have been focusing on feedback on KR. Moreover, martial arts movements, such as the kick, may be a compound of several complex movement patterns; consequently, the performance of the learner will possibly depend on the integration of some individual basic physical capabilities, such as balance, flexibility, speed and strength. So, individuals of the same sample can present dissimilar physical capability levels as mentioned before. This factor might be considered a limitation of our study. In fact, no differences were detected in the pretest between the groups, indicating that all participants presented a similar score in the pattern of movement. However, we can speculate that this similar result may have occurred due to a lack of knowledge of and experience with the task; however, along the training, individual physical capabilities, such as flexibility and motor coordination, may have been a key factor that influenced the performance, and consequently the results. So, we suggest that further investigations about KP should assess the mentioned capabilities in order to normalize this important variable in baseline tests and select participants with similar physical capabilities when assessing complex movements. An interesting way to do this is to use advanced learners, as athletes, for example, since they may present similarities in physical capabilities. Yet, in future studies, it might be interesting to assess whether there is interaction between the type of feedback and the complexity of the task. For example, learning a skill of low complexity, as the frontal taekwondo kick, can require less frequency of feedback, or the moment of providing feedback about KR or KP may be more irrelevant than when learning a task of high complexity. Furthermore, it should be noted that this study recruited a relatively small sample that may be considered as a limitation of our study. So, more studies with an larger sample size should be carried out in order to explore the efficiency of providing different types of KP in Olympic combat sports such as taekwondo.

Despite the indicated limitations, our study brings interesting practical implications to the motor skill learning and sport psychology field, since motivational aspects can be considered and improved by providing feedback properly (Saemi et al., 2011). So, we believe that our results can influence coaches and draw their attention to the importance of

the proper coach-athlete relationship on the learning of a martial art motor skill like in other sports. Furthermore, considering the efficiency of KP on the learning, we expect to arouse the interest of physical education professionals and researches for the development of studies that aim to investigate several other methods of feedback, such as verbal and visual feedback. In fact, beyond conventional methods, other types of feedback found in the literature, such as a virtual reality simulation system, and their effectiveness on improving a taekwondo athlete's performance should be investigated, since this might contribute to the growth of the sport.

In summary, our findings suggest that providing KP feedback when requested by the learners may influence the learning of taekwondo RHK more positively than it is provided by the trainer.

CONCLUSION

Although all groups improved, retained and bilaterally transferred the taekwondo RHK, it was found that self-controlled KP is the most efficient type of feedback on the learning of the kick. Based on this, it is our belief that the results obtained have a great potential in contributing to the optimization of the training process, especially in martial arts learning.

REFERENCES

Arendt, E.A., Agel, J., & Dick, R. (1999). Anterior cruciate ligament injury patterns among collegiate men and women. *Journal of Athletic Training*, *34*(2), 86-92.

Badami, R., Vaezmousavi, M., Wulf, G., & Namazizadeh, M. (2011). Feedback after good trials enhances intrinsic motivation. *Research Quarterly for Exercise and Sport*, *82*(2), 360-364.

Lauber, B., & Keller, M. (2012). Improving motor performance: Selected aspects of augmented feedback in exercise and health. *European Journal of Sport Science*, *14*(1), 36-43.

Chiviacowsky, S., Medeiros, F.L., & Kaefer, A. (2007). 'Feedback' autocontrolado e aprendizagem de uma tarefa motora com demanda de força (Self-controlled feedback and the learning of a motor task with force demand). *Revista Brasileira de Educação Física e Esporte*, *21*(1), 27-33. In Portuguese

Chiviacowsky, S., & Wulf, G. (2005). Self-controlled feedback is effective if it is based on the learner's performance. *Research Quarterly for Exercise and Sport*, *76*(1), 42-48.

Chiviacowsky, S., & Wulf, G. (2007). Feedback after good trials enhances learning. *Research Quarterly for Exercise and Sport*, *78*(*2*), 40-47.

Chiviacowsky, S., Medeiros, F. L., & Kaefer, A. (2007). 'Feedback' autocontrolado e aprendizagem de uma tarefa motora com demanda de força (Self-controlled feedback and the learning of a motor task with force demand). *Revista Brasileira de Educação Física e Esporte*, *21*(1), 27-33. In Portuguese

Chiviacowsky, S., Pinho, S.T., Alves, D., Schild, J.F.G. (2008). 'Feedback' autocontrolado: efeitos na aprendizagem de uma habilidade motora específica do golfe (Self-controlled feedback: Effects on learning a golf-specific motor skill). *Revista Brasileira de Educação Física e Esporte*, *22*(4), 265-271. In Portuguese

Chiviacowsky, S., Wulf, G., & Ávila, L.T.G. (2013). An external focus of attention enhances motor learning in children with intellectual disabilities. *Journal of Intellectual Disability Research*, *57*(7), 627-634.

Chiviacowsky, S., & Wulf, G. (2007). Feedback after good trials enhances learning. *Research Quarterly for Exercise and Sport*, *78*(2), 40-47.

Chiviacowsky, S., & Wulf, G. (2005). Self-controlled feedback is effective if it is based on the learner's performance. *Research Quarterly for Exercise and Sport, Reston*, *76*(1), 42-48.

Chiviacowsky, S., Wulf, G., Wally, R., & Borges, T. (2009). Feedback after good trials enhances learning in older adults. *Research Quarterly for Exercise and Sport*, *80*, 3, 663-668.

Falco, C., Estevan, I., & Vieten, M. (2011). Kinematical analysis of five different kicks in taekwondo. *Portuguese Journal of Sport Sciences*, *11*(Suppl. 2), 219-222.

Fishman, S., & Tobey, C. (1978). Augmented feedback. In: W.G. Anderson & G.T. Barrette (Eds.), *What's going on in gym: Descriptive studies of physical education classes*. *Motor Skills: Theory into Practice,* (pp. 51-62). Monograph 1.

Gavagan, C.J., & Sayers, M.G. (2017). A biomechanical analysis of the roundhouse kicking technique of expert practitioners: A comparison between the martial arts disciplines of Muay Thai, Karate, and Taekwondo. *PloS one*, *12*(8), e0182645.

Ilies, R., & Judge, T.A. (2005). Goal regulation across time: The effects of feedback and affect. *Journal of Applied Psychology*, *90*(3), 453-467.

Katzer, J.I., Schild, J.F.G., Meira, C.M.J., Corazza, T., & Chiviacowsky, S. (2015). Conhecimento de performance com base no teste do desempenho motor do nado crawl na aprendizagem do nado crawl (Knowledge of performance based on the swimming crawl motor performance test in the learning of swimming crawl). *Revista Brasileira da Ciência do Esporte*, *37*(3), 245-250. In Portuguese

Landin, D. K., Hebert, E., & Cutton, D. (1989). Analyzing the augmented feedback patterns of professional tennis instructors. *Journal of Applied Research in Coaching and Athletics*, *4*, 255-271.

Langhorne, P., Coupar, F., & Pollock, A. (2009). Motor recovery after stroke: A systematic review. *Lancet Neurology*, *8*(8), 741-754.

Lemos, A., Chiviacowsky, S., Ávila, L.T.G., & Drews, R. (2013). Efeitos do 'feedback' autocontrolado na aprendizagem do lançamento da bola de ginástica rítmica (Effects of self-controlled feedback on the learning of ball throwing in rhythmic gymnastics). *Revista Brasileira de Educação Física e Esporte*, *27*(3), 485-492. In Portuguese

Li, Y., Yan, F., Zeng, Y., & Wang, G. (2005). Biomechanical analysis on roundhouse kick in taekwondo. In: Q. Wang (Ed.), *Proceedings of the 23 International Symposium on Biomechanics in Sports*, (pp. 391-394). Beijing, China

Luk, T., Hong, Y., & Chu, D. (2001). Analysis of strategy used in taekwondo competition. *Proceedings of the International Symposium on Biomechanics in Sports*, (pp. 166-169). San Francisco: University of San Francisco

Magill, R.A. (2000). *Aprendizagem motora: Conceitos e aplicações* (*Motor learning: Concepts and applications*). São Paulo: Edgard Blucher. In Portuguese

Magill, R.A. (1993). Augmented feedback in skill acquisition. In: R.N. Singer, M. Murphey, & L.K. Tennant (Eds.), *Handbook of research on sport psychology*, (pp. 193-212). New York, NY: Macmillan.

Matsushigue, K.A., Hartmann, K., & Franchini, E. (2009). Taekwondo: Physiological responses and match analysis. *The Journal of Strength & Conditioning Research*, *23*(4), 1112-1117.

Nieuwenhuis, S., Slagter, H.A., Alting von Geusau, N.J., Heslenfeld, D.J., & Holroyd, C.B. (2005). Knowing good from bad: Differential activation of human cortical areas by positive and negative outcomes. *European Journal of Neuroscience*, *21*(11), 3161-3168.

Park, Y.H., Park, Y.H., & Gerrard, J. (2009). *Tae kwon do: the ultimate reference guide to the world's most popular martial art*. New York: Infobase Publishing.

Porte, M.C., Xeroulis, G., Reznick, R.K., & Dubrowski, A. (2007). Verbal feedback from an expert is more effective than self-accessed feedback about motion efficiency in learning new surgical skills. *American Journal of Surgery*, *193*(1), 105-110.

Saemi, E., Wulf, G., Varzaneh, A.G., & Zarghami, M. (2011). 'Feedback' após boas versus más tentativas melhora a aprendizagem motora em crianças (Feedback after good versus poor trials enhances motor learning in children). *Revista Brasileira de Educação Física do Esporte*, *25*(4), 673-681. In Portuguese

Salmoni, A.W., Schmidt, R.A., & Walter, C.B. (1984). Knowledge of results and motor learning-a review and critical reappraisal. *Psychological Bulletin*, *95*(3), 355-386.

Schmidt, R.A. & Lee, T.D. (1999). *Motor control and learning*: *a behavioral emphasis* (*3rd Ed*.). Champaign, IL, USA: Human Kinetics.

Schmidt, R.A. & Lee, T.D. (2005). *Motor control and learning* (*4th Ed*.). Champaign. IL: Human Kinetics.

Schmidt, R.A., & Young, D.E. (1991). Methodology for motor learning - a paradigm for kinematic feedback. *Journal of Motor Behavior*, *23*(1), 13-24.

Siqueira, A.K.M., Henrique, R.S., Beltrão, N.B., Cattuzzo, M.T. (2010). Efeito do autocontrole de conhecimentos de resultados na aquisição de uma habilidade motora (Effect of self-control of knowledge of results on the motor skill acquisition). *Revista da Educação Física/UEM*, *21*(4), 593-601. In Portuguese

Ulrich, D. (2000). *The test of Gross Motor Development* (*2nd Ed*.). Austin: Prodinc.

West, R.L., Bagwell, D.K., & Dark-Freudeman, A. (2005). Memory and goal setting: The response of older and younger adults to positive and objective feedback. *Psychology and Aging*, *20*(2), 195-201.

Winstein, C.J. (1991). Knowledge of results and motor learning implications for physical therapy. *Physical Therapy*, *71*(2), 140-149.

Zar, A., Gilani, A., Ebrahim, K.H., & Gorbani, M.H. (2008). A survey of the physical fitness of the male taekwondo athletes of the Iranian national team. *Facta Universitatis Series Physical Education and Sport*, *6*(1), 21-29.

KOMPARACIJA TRI VRSTE ZNANJA O PERFORMANSAMA UČENJA TEKVONDO NOŽNOG UDARCA NEISKUSNIH BORACA

Kružni udarac zamahom nogom (RHK) jedna je od najkorišćenijih tehnika na tekvondo takmičenjima, obzirom da omogućuje brz i moćan napad. Međutim, njegova efikasnost zavisi od tehnike, tj., tačnosti udarca. Da bi poboljšali tehniku sportista, treneri uglavnom pružaju sportistima znatan broj povratnih informacija vezanih za kretanje. Povratne informacije se pružaju na dva različita načina, znanjem o rezultatu (KR) i znanjem o učinku (KP). KR se odnosi na ocenu tačnosti tehnike, dok se KP odnosi na obrazac kretanja koji daje rezultat. Nekoliko studija se fokusiralo na razumevanje najefikasnijeg trenutka pružanja povratnih informacija o obrascima pokreta u borilačkim veštinama. Cilj ove studije bio je da se istraži da li bi KP bio efikasniji za učenje taekvondo RHK ukoliko se pruža nakon relativno dobrih izvođenja, nakon relativno loših izvođenja ili na zahtev učenika. Osamnaest studenata osnovnih studija, bez prethodnog iskustva u borilačkim veštinama, raspoređeni su u različite grupe: grupu koja je dobijala povratne informacije nakon dobrih izvođenja (GOOD), grupu koja je dobijala povratne informacije nakon loših izvođenja (POOR) i grupu koja je odlučivala kada će dobiti povratne informacije (SELF). Izvršena su četiri bloka ispitivanja, uključujući pre-test, post-test, retention i transfer ispitivanje. Bilo je neophodno da ispitanici izvedu veći broj RHK u jastuk, prema odgovarajućem obrascu kretanja. Metodom ANOVA je utvrđeno da je SELF grupa ostvarila bolji rezultat od GOOD i POOR grupa ispitanika, dok između GOOD i POOR grupe ispitanika nisu utvrđene statistički značajne razlike.

Ključne reči: *motorička veština, učenje, znanje o učinku, tekvondo, kružni udarac zamahom nogom*