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THE ACUTE EFFECTS OF DUAL-TASK ON THE MOTOR AND COGNITIVE PERFORMANCES IN TAEKWONDO PLAYERS

AKUTNI UČINKI DVOJNE NALOGE NA MOTORIČNE IN KOGNITIVNE ZMOGLJIVOSTI PRI ŠPORTNIKIH TAEKWONDOJA

ABSTRACT

Dual-task paradigms are typically used for two different aims. The first aim is to investigate the demands of attention of a motor task, and the other aim is to examine the effects of simultaneous cognitive or motor tasks on motor performance. The purpose of the current research is to determine the changes in motor performance times of national (experts) and non-national players (novices) during motor tasks including cognitive cues. Fifteen male national taekwondo players, who are active in taekwondo (age=17.8±1.65 years; training experience=6-13 years; training frequency=5-6 day\week, 2-3 hour\day) and 15 male non-national taekwondo players (age=16.8±1.68 year; training years=3-9 years; training frequency=1.86 ± 0.22 hour\day and 4.33 ± 0.61 day / week) were voluntarily included in the study. FitLight Trainer™ system was used to determine the dual-task performance of participants. The performance time of expert players was statistically and significantly lower compared to novice players (Random Test: t=3.884, p <0.05; Cue Test: t=3.155, p <0.05; Mixed Cue Test: t=3.013, p<0.05). This study reveals; (1) expert players automatically make postural control adjustments during the motor task, and they put less cognitive effort than they are minimally considered, (2) they show a positive development in regular physical activities and training, and other systems, especially in the proprioceptive system, involved in balance control. We conclude that performances of novices suffer considerably in motor-cognitive dual-task situations. Therefore, training with dual-tasks might be useful working memory skills and attentional control of novice players. We conclude that dual-tasks acutely impacts motor and cognitive performance. Therefore, training with dual-tasks might be useful working memory skills and attentional control of novice players. We conclude that dual-tasks acutely impacts motor and cognitive performance. In future studies, dual-task paradigms between different combat sports and comparisons of postural control strategies should be measured.

Keywords: postural control, motor skill, hearing impaired, cognitive performance, dual-task, working memory, attention, dual-process theory.

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IZVLEČEK

Paradigma dvojne naloge se običajno uporabljajo za dva različna cilja. Prvi cilj je raziskati zahteve po pozornosti motorične naloge, drugi cilj pa je preučiti učinke sočasnih kognitivnih ali motoričnih nalog na motorično zmogljivost. Namen te študije je bil raziskati, ali so izkušeni taekwondoisti (državna reprezentanca) boljši od taekwondoistov začetnikov pri ohranjanju svoje motorične in kognitivne zmogljivosti v situaciji dvojne naloge. V študijo je bilo prostovoljno vključenih 15 reprezentantov (starost = 17.8±1.65 let; leta vadbe = 6-13 let; pogostost vadbe= 5-6 dni/teden; količina vadbe = 2-3 ure/dan) in 15 začetnikov (starost = 16.8 ± 1.68 let; leta vadbe = 3-9 let; pogostost vadbe = 4.33 ± 0.61 dni/teden; količina vadbe = 1.86 ± 0.22 ure/dan) v taekwondoju. Za ugotavljanje uspešnosti pri dvojni nalogi je bil uporabljen sistem FitLight Trainer™. Izkušeni taekwondoisti so bili pri dvojni nalogi uspešnejši, saj je bil njihov čas krajši in statistično značilen v primerjavi z začetniki (naključni test: t=3.884, p <0.05; cue test: t=3.155, p <0.05; mešani cue test: t=3.013, p< 0.05). Rezultati študije razkrivajo, da izkušeni taekwondoisti (1) samodejno prilagodijo posturalni nadzor med motorično nalogo in vložijo manj kognitivnega napora, kot je minimalno potrebno, (2) kažejo pozitiven razvoj pri rednih telesnih dejavnostih in vadbi ter drugih sistemih, zlasti v proprioceptivnem sistemu, ki sodeluje pri nadzoru ravnotežja. Glede na rezultate sklepamo, da uspešnost začetnikov v motorično-kognitivnih situacijah z dvojno nalogo močno trpi. V prihodnjih študijah je potrebno izmeriti paradigmo dvojne naloge med različnimi borilnimi športi in primerjati različne strategije posturalne kontrole.

Ključne besede: posturalni nadzor, motorične sposobnosti, kognitivna zmogljivost, dvojna naloga, delovni spomin, pozornost, teorija dvojnega procesa

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INTRODUCTION

A 'dual task' is an experimental neurophysiological process that requires a person to perform two tasks at the same time (Kim and Brunt, 2007; Shumway-Cook and Woollacott, 2007). Dual-task paradigms have been used to differentiate and reveal the role of attention on motor control in both healthy and disabled populations. Attention capacity is considered to be received from a resource pool (Just and Carpenter, 1992). Because a person can only concentrate on a certain amount of information at a time, his/her ability to process information is limited. If attentional capacity is exceeded while performing two tasks, a dual-task intervention effect, which determines that performance on one or both tasks degrades as both tasks compete for the same resource pool appears (Just and Carpenter, 1992). However, several tasks can be performed simultaneously as long as the resource capacity limits of the system are not exceeded. Dual-task paradigms have been used to assess the extent to which downtime information processing requirements are shared with other secondary tasks (Lajoie et al., 1993; Lajoie et al., 1996). Central processing capacity has been claimed to be fixed. Performing two tasks simultaneously, most of the processing capacity is allocated to the primary task. Given that the primary task is relatively easy or proficient, more attention capacity can be allocated to the secondary task, resulting in better performance on it (Schmidt and Wrisberg, 2008). For this reason, the performance in the secondary task can be considered as an indirect reflection of the competence of the primary task (Abernethy, 1998; Huang and Mercer, 2001). It has been proposed that the evaluation of motor performance by a single task test could be misleading (Mulder et al., 2002). A person with poor postural control may compensate for his/her deficits by paying more attention to the task. This may, however, be revealed in a dual-task test as suggested by several authors (Muir-Hunter and Wittwer, 2016; Montero-Odasso et al., 2018; Bech et al., 2021). Previous studies in different areas investigated the acute effects of dual-task practicing on injury prevention (e.g., posture and balance) and motor enhancement (e.g., gaiting, walking, and running) in young healthy individuals (Beurskens et al., 2016), children (Beurskens et al., 2015; Beurskens et al 2016), elderly people (Plummer et al., 2015), patients with Parkinson and Alzheimer diseases (Belghali et al., 2017), and patients with brain injuries (Solomito et al., 2018). In those studies, dual-tasks were used to identify motor and cognitive capabilities of participants by combining motor and cognitive demands to overload the working memory (Rhodes et al., 2019). Moreover, dual-task assessment paradigm is required in many sporting events. Athletes are subjected to both cognitive and motor challenges simultaneously in many sporting contexts. Several cognitive abilities such as attention (Abernethy, 2001), anticipation

(Loffing & Canal-Bruland, 2017), working memory (Buszard et al., 2017), and decision making are necessary in such situations (Baker et al., 2003). The optimal performance in a martial sport such as Taekwondo relies on the ability to perform a technique with sufficient force in the shortest possible time (Lystad et al., 2013; Bridge, et al., 2014; Ji, 2016). Athletes must distribute their attention to many relevant cues during a match. For example, taekwondo athletes must be able to analyze and predict their opponent's next move when performing an offensive or defensive task. Asia and Warkar (2013) and Saulīte et. al. (2012) focused on auditory reaction time and visual reaction time in taekwondo athletes in their study, and Fisekcioğlu (2011) focused on auditory reaction time in right-handed taekwondo athletes. Pieter and Heijmans (2007) focused on timing and speed while evaluating motor skills in Taekwondo athletes. On the other hand, Fong and Ng (2014) examined various types of reaction and speed and their changes caused by taekwondo training. Ervilha et al. (2014) compared the response to a signal or an opponent's movement in men and women practicing taekwondo. The findings of these studies revealed differences in reaction time between men and women and professional and left-handed athletes responded better. In some of the studies, although the reaction time was measured routinely while creating the physiological profile of the athletes, it was also observed that the difference between the results of the elite and non-elite in was not significant. It was emphasized that this result was especially valid when the required movement was the main action of the relevant sport, which was practiced many times. In addition, non-elite athletes are very likely to have spent a significant amount of time practicing the main task in their sport. Since the movements become automatic, it makes it difficult to distinguish the reaction time between elite and non-elite athletes (Chen et al., 2015). Better performance in the secondary task may refer to a greater attentional capacity that can be devoted to evaluating the movements of the opponent (Chen et al., 2015). For example, Laurin and Finez (2020) observed that the higher the level of difficulty of secondary tasks, the higher the cost in performance. Therefore, ability of athletes to deal with dual tasks may be different from the non-athlete ones, demanding a deeper investigation within the sports domain. Due to the limitation of single-task response time in distinguishing elite and non-elite athletes, the dual-task methodology can be adapted to measure the attention required for the primary task in athletes. Despite its usefulness, studies on the implementation of dual-task methodology (task characteristics, the dual-task cost, the participants, and the study design) in skill assessment of elite athletes and effects of dual-tasks on cognitive and motor performances are limited. The training with dual-tasks could be favor the improvement of the working memory capacity and, consequently, the attentional control that is related to perception. These results can help coaches to plan dual-tasks during training to optimize different skill level of athletes' motor and cognitive performances. Therefore, the present research aimed to analyze the changes in motor performance times of national (experts) and non-national players (novices) during motor tasks including different cognitive cues. In addition, the calculation of dual-task costs allows for a systematic comparison of performance decrements across expertise groups and tasks, possible revealing strategy differences between experts and novices. We hypothesize that the improvement in performance time will be more when the simpler cognitive loads (cue) are compared to the given mixed color cues in both groups. In addition, the relative improvement in performance in the trials provided with cue and the mixed cue will be more in the elite group than in the novice group.

METHODS

Design

This study was designed in accordance with the principles of experimental design.

Subjects

The 15 national male taekwondo players (age=17.8±1.65 years; training years=6-13 years; training frequency=5-6 days\week, 2-3 hours\day) and 15 non-national male taekwondo players (age=16.8±1.68 years; training years=3-9 years; training frequency=1.86±0.22 hours\day and 4.33±0.61 days/week) voluntarily participated in the study. National players actively participated in national and international competitions; non-national taekwondo players consisted of players who actively participated in national competitions. None of the players had a remarkable clinical history in the lower and upper extremities in the last 6 months. The protocol of the study was approved by Eskisehir Technical University Ethics Committee [10984]. Written informed consent was taken from the participants to participate in this study considering the approval procedure of the ethics committee. Demographic characteristics of the subjects are presented in Table 1.

Table 1. Demographic Characteristics of Taekwondo Players.

Variables	National Taekwondo Players (Experts)	Non-National Taekwondo (Novice)
	Mean ± sd	Mean ± sd
Age (years)	17.8 ± 1.65	16.8 ± 1.68
Height (cm)	179.73 ± 4.74	175.73 ± 5.44
Weight (kg)	63.8 ± 8.42	63.4 ± 9.33
BMI (kg/m^2)	19.66 ± 1.77	20.43 ± 2.15
Training Age (years)	9.2 ± 3.34	5.2 ± 2.07

Procedure

The FitLight Trainer system was used to determine participants' reaction times in the research. FitLight Trainer system is a wireless reaction system with eight LED lights controlled by a tablet. The sensors can be deactivated by touching the lights as well as by simply hovering over the light. Also, the system allows the lights to be configured and record the reaction time of the controller. During the test, participants were asked to touch and deactivate the light as fast as possible.

Tasks

Protocol

As in the study conducted by Laessoe et al. (2016) and Simsek et al. (2021) by placing eight lights 1,5 meters apart in three different colors at three different locations, participants were made to push their stability limits while trying to reach and turn off the lights (Figure 1).

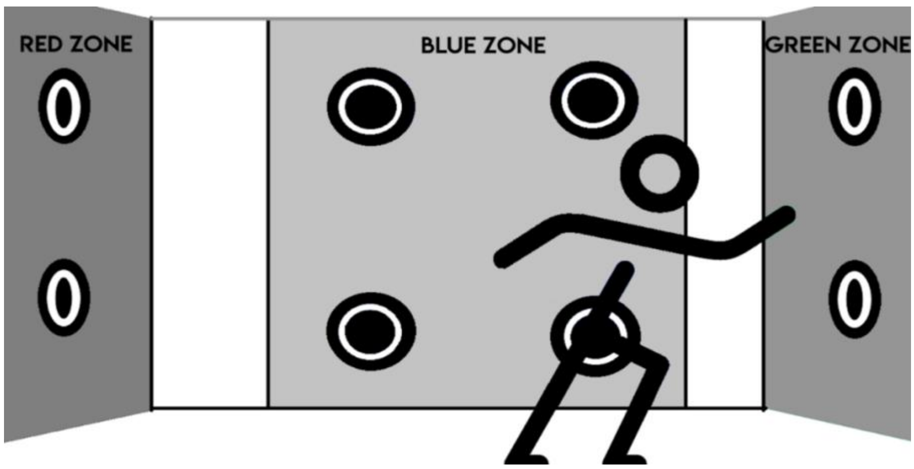
In the research, the primary motor task (all trials) included proactive stepping strategies when moving around between the lights. The secondary cognitive task (in trials 2 and 3) involved analysis and utilization of the leading cues of the colors of the lights for better anticipatory strategies. Participants were encouraged to use cognitive strategies with different possibilities by providing them cues about each task (Laessoe et al., 2016):

(1) ***Random light sequence***: The lights would be lit randomly (red, green, and blue). No cue was given about where the next light would appear. In a cognitive sense, this test was expected to measure the reaction time of the participants.

(2) ***Light color indicates the position of next light – Cue***: The color of the light indicated the position of the next light. The purpose of this was to determine whether the participant was aware of dual tasks. If the light was red, the following light would be lit in the red zone. If the light was green, the following light would be lit in the green zone. If the light was blue, the following light would be in the blue zone.

(3) ***Like trial 2, but with red and green color cues switched – RevCue***: Trial 3 added an extra cognitive load for utilizing the cues. The color of the light determined the position of the next light; however, the red and green cues were reversed. In other words, if the light was red, the following light would be in the green zone, and vice versa. The blue light, on the other hand, indicated the next light to be in the blue zone. This task showed on the promotion of cognitive skills in utilizing the given cues. Performance time in the trials with and without cues was compared with baseline and the relative improvements were the main outcome measures. The programmed order of the lights is shown in Figure 1.

Figure 1. The lights were placed in three zones. Zone 1 and zone 3 were marked as red and green, in the given order. The middle zone was blue. The light sequence was different in each test but all lights were represented equally. In tests 2 and 3, the color of the light indicated the position of the following light.



Random

Light No	8	2	3	4	1	7	2	4	8	7	8	5	2	1	7	3	1	6	4	6	5	7	2	8	1
Color	G	R	G	R	B	B	R	G	G	B	R	B	R	B	G	R	G	B	R	G	K	B	G	R	B

Cue

Light No	4	1	7	2	3	2	8	5	7	1	4	8	2	6	1	7	3	2	8	4	1	7	5	8	6
Color	R	G	R	B	R	G	B	G	R	B	G	R	B	R	G	B	R	G	B	R	G	B	G	B	B

RevCue

Light No	4	1	7	2	3	2	8	5	7	1	4	8	2	6	1	7	3	2	8	4	1	7	5	8	6
Color	G	R	G	B	G	R	B	R	G	B	R	G	B	G	R	B	G	R	B	G	R	B	R	B	B

Installment. G: green zone; B: blue zone; R: red zone

The tests started with a light at a random point. All three tests were conducted in the order mentioned in the previous section. Participants were informed about the procedure prior to each test. Moreover, they were instructed to maintain (keeping a safe balance) their posture while they were deactivating the lights as fast as possible. The entire procedure was performed in two sessions with a 10-minute break. The test-retest method was used in the study for having participants get used to the test and reliability of the research. Only the data acquired from the second session were used for the validity of the research.

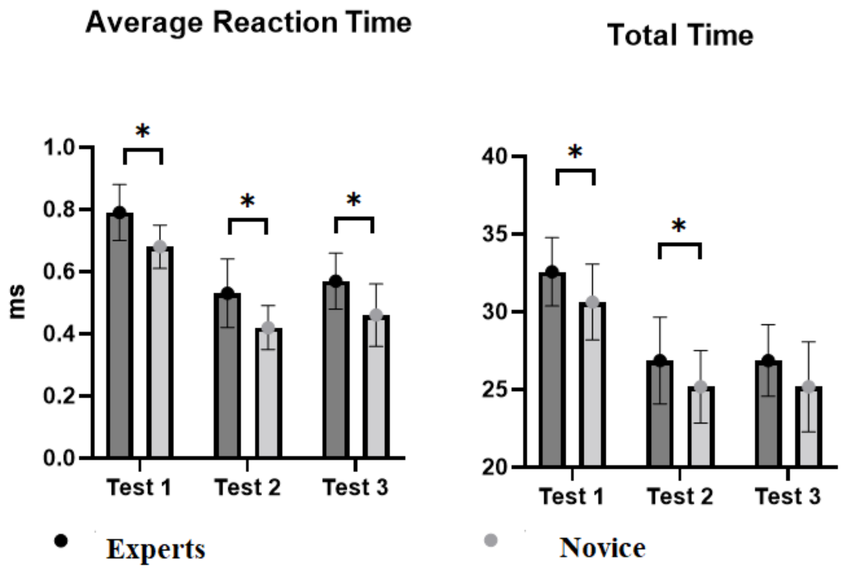
Statistical analysis

For each test, the performance time was recorded automatically by the FitLight software and displayed on the system controlling device. The figures were entered in Excel. The data were analyzed by using SPSS 23.0 (SPSS 23.0, Chicago, IL, USA). (Average times for sessions and groups were presented, and relative percentage changes were calculated for each session.) For each group and session, an average of performance time was presented, and the relative percent value of test 1 (random), test 2, and test 3 (with the cue and random cue) were calculated. Kolmogorov-Smirnov test was used to determine if the data were distributed normally. Reliability was calculated by absolute differences between the sessions and the intraclass correlation coefficient (ICCs). The ICCs were calculated by using an absolute agreement with the two-way mixed model (ICC 3,1). These values were interpreted regarding Kappa values by Landis and Koch: <0.00 is poor, 0.00-0.20 is slight, 0.21-0.40 is fair, 0.41-0.60 is moderate, 0.61-0.80 is substantial, and 0.81-1.00 is almost perfect (Landis & Koch, 1977). To refrain from any biased opinions regarding the learning capacity of participants, and for the validity of the research, only the data collected from the second session were used. Factorial repeated ANOVA was used to measure the performances in all three tests. Scores and deficits between the tests were shown as average and confidence intervals in the charts (CI 95%). In the tests with given cues, performance improvements were evaluated according to the changes in the individual base scores. While examining the differences between groups in Protocol II, the independent samples t-Test was used as the variables revealed normal distribution. Spearman's Correlation Coefficient was used to examine the relationships between variables that did not show normal distribution. Within the scope of the research, the significance value was accepted as $p<0.05$.

RESULTS

Figure 2 shows the difference between the values of the average reaction time and the total time of the experts and novice groups in the three tests. Table 2 and Figure 3 show the total and average performance time and the performance improvements in the cued trials of the experts and novice groups in the three tests.

Figure 2. The average reaction time and the total time of the experts and novice groups in the three tests.



There was a statistically significant difference between Test 1 average reaction times of experts and novice groups (t:3,884; p<0.05). There was a statistically significant difference between ***Test 1*** total time values and groups (t:2.309; p<0.05). There was a statistically significant difference between ***Test 2*** average reaction times and groups (t:3,155; p<0.05). There was a statistically significant difference between the Test 2 total time values and the groups (t:2.09; p<0.05). There was a statistically significant difference between ***Test 3*** average reaction times and groups (t:3.013; p<0.05). No statistically significant difference was found between the Test 3 total time values and the groups (t:1,771; p>0.05).

Table 2. Total and average performance time of the experts and novice groups in three trials and performance improvements in the cued trials.

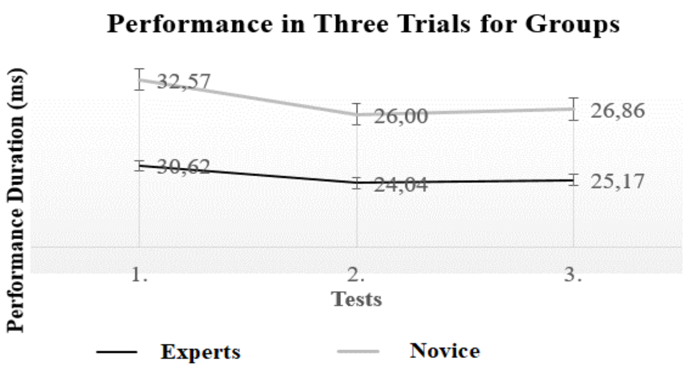
	Baseline motor task (s)	Cue(s)	RevCue (s)	Random vs. Cue (%)	Random vs. RevCue (%)
		Experts Group			
Total Time	30.62(2.43)	24.04(2.33)	25.17 (2.89)	-21.48%*	-17.79%*
Mean Time	0.68±0.07	0.42(0.07)	0.46(0.1)	-38.23%*	-32.35%*
		Novice Group			
Total Time	32.57(2.20)	26.00(2.78)	26.86(2.31)	-20.17%*	-17.53%*
Mean Time	0.79(0.09)	0.53(0.11)	0.57(0.09)	-32.91%*	-27.84%*

***p<0.05**

Time score in seconds; mean and SD, and reduction in time score, mean percentage (SD). Negative values represent performance improvements. ICC: Intra-class correlation coefficient (CI 95%).

Both groups displayed the same pattern in their performance time over the three trials in both the first and the second session (Table 2). In general, the group of novice performed the trials significantly slower than the expert group, p<0.05. Both groups improved their performance time when provided with a leading cue for the motor task. In comparison with the baseline trial, there was an improvement when a leading cue was provided. In addition, the relative improvement in performance in the trials with cues and mixed cues was higher in the expert group (38.23% and 32.35%), respectively than the novice group (32.91% and 27.84%) (p<0.05).

Figure 3. Performance duration.



The novice group was generally slower than the experts in all trials, but the performance (shorter time) of both groups got better in the cued trials (p<0.05).

DISCUSSION

Athletes are subjected to both cognitive and motor challenges simultaneously in many sporting contexts. Taekwondo athletes have to be able to read and predict the opponents' next move while performing an attack or defensive task. The better performance in the secondary task may indicate a greater attention capacity that can be allocated to assess the opponent's movements (Chen et al., 2015). This study aimed to find out the changes in performance times of national and non-national athletes during the motor task, which included cognitive cues.

As hypothesized, the results showed that the national taekwondo group of athletes outperformed the non-national group of athletes in trials with and without a cognitive cue for task performance. Considering the probability of the non-national group to predict the position of the light and to use the expected postural control strategies when complex cues were given, higher performance times were observed to shift attention from posture to cognition compared to the national group. The non-national group demonstrated particularly high cognitive costs in the more difficult dual-task condition. The fact that the non-national group of athletes could not use clues as significantly as the athletes in national group of according to the current research findings, could be explained in two ways. First, the motor task may have required more attention, but the sustained attention capacity among the non-national group of athletes may have been insufficient. Another important reason for national athletes' having slower reaction times than non-national athletes might be the motor learning process. Motor learning includes three stages: cognitive, association, and autonomy (Fitts and Posner, 1967; Shumway-Cook and Woollacott, 2001). The first stage requires conscious attention to each part of the movement, while the third stage leaves attention resources for other tasks. Furthermore, the automatic control is based on the minimization of the role of consciously directed movement (Milton et al., 2004). The fact that the national athletes in the current study had an average of 9 years of sports experience, that taekwondo sport supported the development of postural control of individuals and does not impose high demands on sources of interest also reveals that the performance of the national athlete group was generally higher than the non-national athlete groups in all trials. Chen et al. (2015) aimed to find out the reliability and validity of the dual-task test aiming to measure the reaction time and skill proficiency in roundhouse kicks in elite and sub-elite taekwondo athletes. As a result, they suggested that elite athletes were more skilled and therefore required less attention to execute the complex movement. They assumed that elite athletes might be better at analyzing and predicting the opponent's reaction while executing the movement with greater attentional capacity that can be salvaged from the primary task. Those findings suggest that motor task performance becomes more automated (and therefore less attention-demanding) with increased practice and experience (Huang & Mercer, 2001). Also, Bherer, Erickson, & Liu-Ambrose (2011), investigated how training improved cognitive performance. The research identified the neurophysiological pathways through which training improved cognitive function (Bherer et al., 2013). So, several neurophysiological adaptations could explain our results. Previous reports suggested that improved cognitive performance in individuals with higher fitness levels was due to a greater grey and white matter volume (Colcombe et al., 2003) and a greater hippocampal volume (Erickson et al., 2011; Tseng et al. 2013). In addition, a large number of previous studies showed that the changes occurred as a result of the motor learning process both in the short term (minutes to hours) (Karni et al., 1995) and in the longer term (hours to days or months and beyond) (Karni et al., 1995; Pascual-Leone et al., 1995; Pearce et al., 2000) had a neocortical role. As it can be predicted, the Primary Motor Cortex (M1) is prominently involved in the development of practice-related motor skills. Studies showed that martial arts increase neuromuscular coordination and movement speed (Lee et al., 1999). Our research results are consistent with previous studies (Fontani et al., 2006; Vieten et al., 2007; Ghorbanzadeh et al., 2011). Vieten et al., (2007) found a significant difference in reaction times between members of national taekwondo teams and other groups, namely recreational taekwondo practitioners and sports students. Fontani et al. (2006) reported similar findings for karate players whose sport requires similar skills to taekwondo. The findings of the study conducted by Ghorbanzadeh et al., (2011) have similarities with the findings of the present study. Ghorbanzadeh et al., (2011) aimed to find out the physical and physiological characteristics of elite and sub-elite Turkish male and female taekwondo players and to determine whether those characteristics distinguished elite players from lower elite players. The reaction time of the Turkish Men's National Taekwondo Team athletes participating in the study was found out to be 0.77 ± 0.64. Asia and Walker examined the auditory and visual reaction times of Taekwondo players in their study. In general, it was stated that the neural transmission and response times of the athletes who practiced this sport at an active and professional level were better, and therefore their reaction times were lower. Another study, which was conducted by İpekoğlu et al. (2018) had similar results with the study of Asia and Walker. In this study was found out that taekwondo training 2 days a week for 12 weeks decreased the lower extremity reaction rates of the athletes, both visual and auditory reaction times. These results suggest that greater attention is paid to task components during new skill execution and learning, although this may not be the case for professional athletes with higher levels of practice. The athletes with better performance in the secondary task may undergo training in more complicated situations in which he/she has to read and predict the opponent's movements. On the other hand, the athletes with lower performance in the secondary task may require more practice in the main skills in the single-task situation or less complicated dual-task environment. This study is important for coaches working with taekwondo players in understanding how sport-related differences in cognitive abilities may affect the motor performance of national taekwondo players or their ability to combine cognitive and motor tasks. There were some limitations in this study. First, the number of samples in the study could be increased. The more samples included the more reliable the data will be. Secondly, comparisons of reaction time values and postural control strategies during dual-task need to be studied among players in different martial sports in further studies. Due to the characteristics of movement during martial sports, the use of dual tasks during training can be beneficial to reproduce sports demands by simultaneously requiring the perception of relevant cues and execution of technical actions. Moreover, habitual postural adaptations during sports (ie. taekwondo) could influence balance and oculomotor control (Majcen Rosker et. al., 2021; Majcen Rosker & Vodicar, 2020). As taekwondo players frequently presents hits to the head instability of the cervical spine could influence cognitive dysfunction and consequently balance and eye-movement control (Majcen Rosker, Vodicar & Kristjansson, 2022).

CONCLUSION

The present research aimed to determine the changes in performance times of national and non-national players during the motor task and branch-specific motor task, which included cognitive clues. Compared to the baseline values, improvements were observed in both groups when the cues and mixed cues were provided in this study. The improvement in performance time was greater when the simpler cognitive loads (cue) were compared to the given mixed color cues. In addition, the relative improvement in performance in the trials provided with cue and the mixed cue was greater in the elite group than in the novice group. Players who performed better in the secondary task might join training in more complex situations where they need to analyze and predict the opponent's movements. On the other hand, players who performed poorly in the secondary task may need more practice in the main skills in a single-task situation or a less complex dual-task environment. Dual-task paradigms are typically used for two different purposes. One is to investigate the attention demands of a motor task, and the other is to examine the effects of concurrent cognitive or motor tasks on motor performance.

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Declaration of Conflicting Interests

The author declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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