DOES SPECIALIZATION IN KARATE AFFECT REACTION TIME IN SPECIFIC KARATE KUMITE SITUATIONS?

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The aim of this study was to investigate the effect of karate specialization on the reaction time in specific karate kumite situations. In order to maximize the ecological validity of experimental set-up, we used our recently proposed and evaluated video-based method (Mudric et al., 2015). Within this method, the reaction time is calculated from the kinematic parameters recorded on both offensive action stimuli and defensive action responses. The results obtained from three groups of subjects (i.e., karate kumite, karate kata and beginners) indicate significant differences in reaction time between the beginners and both specialized karate groups. There were also prominent but not significant differences between the karate kumite and karate kata. These findings suggest that particular sport specialization could improve reaction time of an athlete in specific sport situations.

KEY WORDS: simple RT, choice RT, stimulus, response.

INTRODUCTION: Specific situations in many sports require quick and accurate reaction to the opponent actions. This reaction is usually based on the processes of decision making which could be considerably facilitated by a proper perception and anticipation of opponent actions (Ripoll, 1991). Several studies have demonstrated that elite athletes in ball sports (e.g., soccer, hockey, tennis…) have distinct perceptual and anticipatory skills that are suited to the nature of their sport (Williams et al., 1994; Abernethy & Russel, 1987). On the other hand, combat sports could have even more pronounced dependence on perceptual and anticipatory skills since the extremely fast movements are performed by two athletes who face each other at a small distance. This permanent dependence could lead to specific adaptations of perceptual and anticipatory skills to the combat situations.
The measurement of reaction time is a common method that assesses perceptual and anticipatory skills of an individual. Namely, there are three distinctive stages of information processing that intervene within the reaction time (Schmidt & Lee, 2011). The first stage (i.e., the stimulus-identification stage) depends purely on perceptual skills, while anticipatory skills affect predominantly the second stage (i.e., the response-selection stage). The processes that influence the third stage (i.e., the response-programing stage) are out of the scope of this study. Regarding the stimulus predictability, there are two possible paradigms: (1) the stimulus and, consequently, the proper response are known in advance – 'Simple RT' (e.g., the start of 100 m sprint race), and (2) the stimulus is unknown in advance and, therefore, requires both a quick and properly selected response – 'Choice RT' (e.g., the combat situations in various martial arts). It is well known that the Choice RT depends on the number of stimulus–response alternatives where the selection of proper response requires more time when there is a larger number of response alternatives [i.e., Hick's law].
A number of motor actions in combat and team sports are characterized by environmental unpredictability. Karate as a combat sport has two recognized disciplines: karate kumite and karate kata. Karate kumite is based on direct confrontation of two opponents in highly variable and mutually interfering conditions on the basis of distance, movement and different types of applied techniques. In this context, the success of karate kumite competitors is directly associated with perceptual and anticipatory skills (Mori et al., 2002). Contrary, karate

kata as a discipline requires special perceptual skills for both spatial orientation and temporal accuracy. Karate kata consists of defined sequences of defensive and offensive techniques and its performing is without direct disturbing influence of an opponent.
The aim of this study was to investigate the effect of karate specialization on the reaction time in specific karate kumite situations. We hypothesized that both karate specializations would improve reaction time in specific karate kumite situations, but this improvement should be more prominent in the karate kumite comparing to the karate kata group.

METHODS: Regarding the main purpose of this study, we recruited three groups of subjects. The first subject group consisted of male karate kumite (N=10; age 23.3 ± 3.2; data shown as mean ± SD), while the second subject group consisted of male karate kata competitors (N=10; age 22,2 ± 3,4 years) with at least 10 years of experience in competition. The third subject group consisted of age and gender matched beginners (N=10; age 22.6 ± 1.3 years) who were students of the Faculty of Sport and Physical Education. They all practiced basic karate techniques through their academic curriculum.
The applied experimental procedures were experimentally evaluated within our previous study (Mudric et al., 2015). In short, RT was calculated from the kinematic parameters recorded on both offensive action stimuli and defensive action responses. We chose four of the most frequent used offensive action: Kizami zuki (i.e., jab punch), Mae-ashimawashi geri (i.e., front roundhouse kick with front leg), Mawashi geri (i.e., roundhouse kick) and Gyaku zuki (i.e., the reverse punch). The offensive actions were performed by an elite karate kumite competitor. The video camera was placed in a position that simulates both the viewing distance and eye level of a hypothetical opponent in a real combat situation. The video recording was synchronized with the 3-dimensional (3D) infrared recordings of 12 reflective markers positioned on the centers of the wrist, elbow, shoulder, hip, knee, and ankle joints. Subsequently we performed the 3D kinematic movement analysis in order to determine the stimulus onset of four recorded offensive actions. Specifically, when any of the markers reached 5% of its 3D peak velocity was assumed to be the instant of the stimulus onset.
The previously recorded offensive action stimuli of karate model were displayed in real dimensions on a large 2x3 m screen. The subjects were standing 2 m apart, having a reflective marker placed on the processus styloideus of their front hand. The subsequent kinematic analysis was conducted in order to determine the onset of the defensive response (i.e., 5% of the peak velocity of wrist marker). Note that the 3D recording of defensive action responses was coupled with the video projection of the offensive action stimuli by means of a common external trigger. The difference between onsets of an offensive action stimulus and defensive action response was calculated as RT.
RTs were calculated under three different experimental conditions. Within the first one, both the projected offensive action stimulus and the adequate defensive action response were known in advance (i.e., the Simple RT). When Kizami zuki and Mae-ashimawashi geri was expected to be projected, the subjects were instructed to react by performing Te Nagashi uke (i.e., rising palm sweep block). Conversely, when the Mawashi geri and Gyaku zuki was expected, they were instructed to react by performing Gedan barai (i.e., sweeping low block). Within the second experimental condition, two possible offensive actions stimuli were projected in random sequence unknown for subjects and the Choice RT was recorded. Specifically, the subjects were expecting Kizami zuki and Mae-ashimawashi geri or Mawashi geri and Gjaku zuki to be projected and, therefore, instructed to react by proper defensive response (i.e., Te Nagashi uke or Gedan barai, respectively). Similarly, within the third experimental condition, four possible offensive action stimuli were randomly projected (Kizami zuki, Gjaku zuki, Mae-ashimawashi geri or Mawashi geri), while the subjects were also instructed to react properly.

RESULTS: Figure 1 depicts averaged values across the subjects RTs obtained from 3 groups under 3 experimental conditions. Separately for each offensive action stimulus, we applied two-way ANOVA's in order to assess the main effects of group and condition, as well as their interaction.

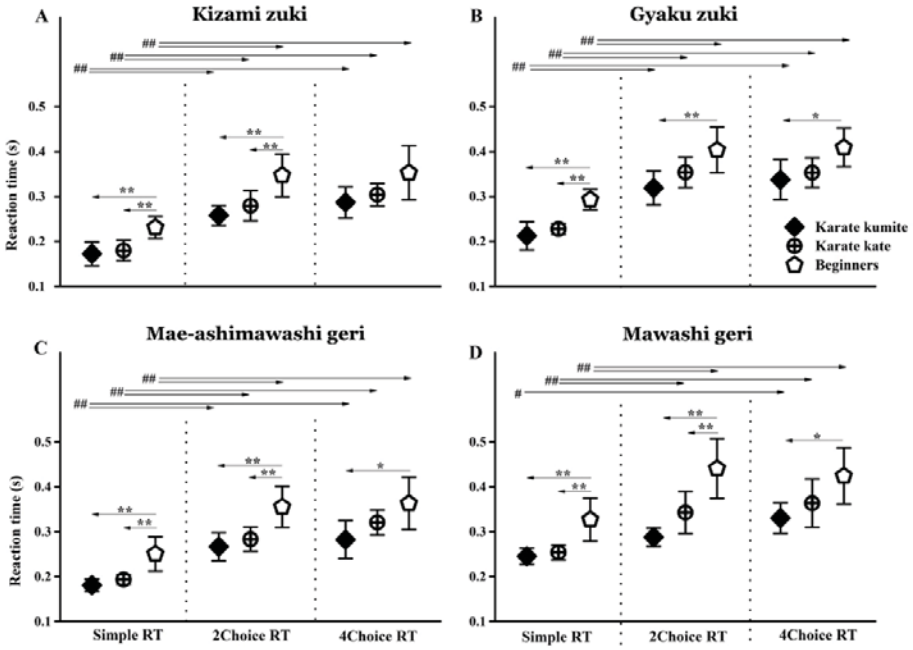

Figure 1. Averaged across subjects data calculated from median value of 3 consecutive trials obtained from different offensive action stimuli (Kizami zuki, Gyaku zuki, Mae-ashimawashi geri and Mawashi geri), groups (Karate kumite, Karate kata and Beginners), and conditions (Simple RT, 2Choice RT and 4Choice RT), shown together with the corresponding 95% confidence intervals error bars.

Regarding all offensive action stimuli (i.e., Kizami zuki, Gyaku zuki, Mae-ashimawashi geri and Mawashi geri - Figure 1; panels A-D), significant main effects of both group and condition were observed, while their interaction was not significant. Specifically, under Simple RT condition both karate groups (i.e., Karate kumite and Karate kata) reacted quicker than Beginners across all applied offensive action stimuli. Similarly, under 2Choice RT condition Karate kumite reacted quicker than Beginners across all applied offensive action stimuli, while Karate kata reacted quicker than Beginners in 3 out of 4 offensive action stimuli (i.e., the reaction was prominently but not significantly quicker in Gyaku zuki). Finally, under 4Choice RT condition Karate kumite reacted quicker than Beginners in 3 out of 4 offensive action stimuli (i.e., the reaction was prominently but not significantly quicker in Kizami zuki), while the reactions of Karate kata compared to the Beginners were also prominently but not significantly quicker across all applied offensive action stimuli.
Note that under all four different offensive action stimuli, subjects reacted quicker in Simple RT condition than in either 2Choice RT or 4Choice RT conditions. In addition, no significant differences were found between 2Choice RT and 4Choice RT. However, in 10 out of 12 situations (3 conditions within each offensive action stimulus) subjects reacted quicker in 2Choice RT in regards to 4Choice RT ($P < 0.01$; Sign test).

DISCUSSION: Within the present study we investigated the effect of karate specialization on the reaction time in specific karate kumite situations. We observed that both karate specializations could improve RT in specific karate situations, but this improvement could be more prominent in karate kumite comparing to karate kata group.
Methodology based on using video technology enables measuring of RT under more ecological conditions. This approach presumably overcomes typical methodological weaknesses that could be found in the literature. Namely, the number of previous studies used a methodological approach where only the stimuli were realistic. Consequently, within these studies only the skill of the stimulus identification, but not the skill of quick selection of the learned sport-specific response was assessed. As a result, the tested performance does not reflect the full 'set' of sport-specific stimulus-response skills.

The obtained results indicate that Simple RT is shorter than Choice RT in all testing conditions. This finding is partly in accordance with Hick's law (Hick, 1952) that presumes Choice RT is increased by a nearly same amount of time when the number of stimulus-response alternatives doubles. Namely, the discrepancy observed in 4Choice RT conditions could be explained by defensive responses and precues that are equal for two different offensive actions. Specifically, Kizami zuki and Mae-ashimawashi geri require the same defensive response (i.e., Te Nagashi uke), while the precues for both offensive actions are movements of the ankle and knee in sagittal plane. On the other hand, the proper defensive response for both Gyaku zuki and Mawashi geri is Gedan barai, while the mutual precues are the movements in the ankle and shoulder joint in frontal plane. Therefore, one could speculate that 2Choice RT and 4Choice RT are based on the similar number of possible stimulus-response alternatives resulting similar RT. This limitation should be taken into account when designing future studies.

The main finding of this study indicates that karate experts of different specialization react faster in specific karate kumite situations than karate beginners. In general, this finding implies strong effect of sport specialization on perceptual and anticipatory skills of an athlete. In order to test whether the selection process based on some genetic predispositions could be possible explanation for this finding, we conducted on same groups of subjects an additional analysis by using the standard RT test (e.g., pressing the button as a response on a stimulus that represents the sudden appearance of a large white circle on a computer screen). The results obtained in standard RT test showed no significant differences among tested groups of subjects. Therefore, there are no genetic predispositions of the selected karate competitors that could explain their faster RT in specific karate kumite situations. The effect of sport specialization could be further investigated through the comparison between karate kumite and karate kata competitors. Although the obtained results do not indicate significantly shorter RT in karate kumite comparing to karate kata, it is important to emphasize that all experimental conditions provide somewhat faster reactions for karate kumite competitors. This potential finding is in line with our main hypothesis that predicts the impact of specialization in karate on RT in specific karate kumite situations. From theoretical perspective, we could speculate that perceptual and anticipatory skills are sensitive to the adaptation on specific sport situation. Regarding the practical aspects of potential findings, it could be speculated that the situational training is indispensable when perceptual and anticipatory skills are practiced in order to improve RT.

CONCLUSION: The obtained findings suggest that recently evaluated novel Video-based method could be routinely used for testing the Simple RT and Choice RT in specific sport situations. The perceptual and anticipatory skills could be suited to the nature of sport as a result of specific adaptation to the various sport situations. Based on the observed results, it could be concluded that regular karate practice improves RT in specific karate kumite situations. Moreover, this improvement in RT could be the karate specialization specific (i.e., karate kumite vs. karate kata).

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