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ELITE FEMALE TAE KWON DO ATHLETES HAVE FASTER REACTION TIME AND LONGER MOVEMENT TIME THAN MALES DURING A STRIKING KICK

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INTRODUCTION

Tae kwon do is the world's most popular martial art and is practiced from non-expert to high competitive levels. In tae kwon do, there are several kicks that are usually used against an opponent. One of these kicks is the "ap bal ap dolio tchagui". Due to its simplicity, this particular kick is widely used in both practice sessions and in competition and is usually performed in reaction to a movement of the opponent.

Reacting to a stimulus requires preparation and it is essential to determine this preparation of an elite athlete in the performance of a task. Reaction time is defined as the time between the presentation of a stimulus and the initiation of a muscular response to the stimulus [1]. Reaction time can be fractionated into pre-motor time and response time (e.g. [2]). Pre-motor time is the period from the stimulus to the onset of muscle activation and it gives information about the preparation for the task, while response time is the period from the onset of the muscle activation (i.e. EMG) to the initiation of movement. Movement time is the period from the initiation of movement to the completion of the task (Figure 1). By fractionating the reaction time into the pre-motor time, response time and movement time components, a greater understanding of how this task is accomplished can be ascertained.

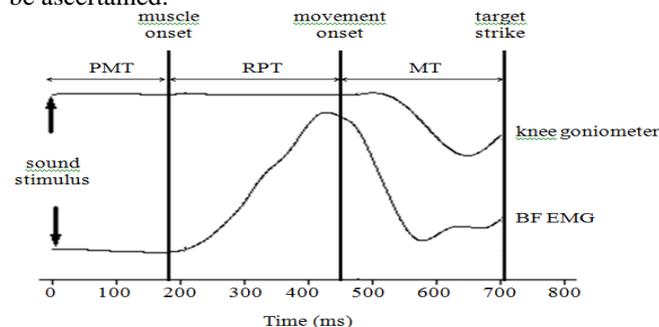


Figure 1. Pre-motor time (PMT), response time (RPT), movement time (MT), movement onset, muscle onset and target strike are illustrated using the biceps femoris (BF) EMG and knee angle from an electrogoniometer for one kick of one athlete.

Studies have yielded contradictory findings about the effect of sex on choice reaction time tasks [3]. Our study investigates the processing, reaction and motor response of male and female athletes in an ecological task.

Therefore, the purpose of this study was to compare the reaction (pre-motor and response) and movement times for the low back and lower extremity muscles of the striking limb between high skilled males and females athletes during an "ap bal ap dolio tchagui" tae kwon do kicking maneuver.

METHODS

Thirteen experienced Brazilian tae kwon do athletes (6 males, 27 ± 2.9 years old, 176.7 ± 6.0 cm height, 66.5 ± 9.6 kg mass and 14.5 ± 3.3 years experience in tae kwon do) and 7 females (20 ± 1.5 years old, 163.3 ± 4.5 cm height, 57.3 ± 9.1 kg mass and 9.4 ± 4.2 years experience in tae kwon do) volunteered for the present study. They were informed about the experiment and gave their written consent in order to be included into the study.

A target with a switch sensor was glued on a heavy bag (mass 75 kg). The target was located 10 cm above the height of each athlete's iliac crest and denoted the end of the kicking trial. Surface electromyography (Noraxon Myosystem 1400, Scottsdale, AZ, USA) was obtained from two trunk and four leg muscles on the kicking limb. The EMG amplifier had the following characteristics: CMRR - 80 dB; high input impedance, bandpass filter - 10-500 Hz; and gain - 100. The EMG signal was pre-amplified 10 times during data collection at the electrode level.

The skin preparation and surface electrode placement on the right and left erector spinae (ES), vastus lateralis (VL), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius lateralis (GA), was accomplished in accordance to the protocols of the International Society of Electrophysiological Kinesiology for surface electromyography for non-invasive assessment of muscles [4].

An electrogoniometer was attached to the kicking thigh and leg respectively with the center of rotation at the lateral femoral epicondyle.

The experimental protocol involved a simple reaction time experiment in which the participant was given an auditory cue to begin the task. When the cue was given, the participant then completed the kicking maneuver using their dominant or preferred leg to strike the heavy bag. Each trial ended when the participant struck the heavy bag. Subjects performed 20 randomly triggered trials.

Movement onset was determined as the first change in angle of the knee electrogoniometer. The key parameters pre-motor time, response time and movement time were calculated as follows: 1) pre-motor time was determined from the initiation of the stimulus to the onset of the EMG of each muscle; 2) response time was determined from muscle onset to movement onset; and 3) movement time was determined from movement onset to target strike.

The subject pool represented all of the national caliber taekwon do athletes in Brazil. Because of this, we did not conduct inferential statistics. Instead we used effect size (ES) to determine meaningful differences between groups for the reaction and movement time parameters [5]. Cohen (1988)[5] proposed that ES values of 0.2 represent small differences; 0.5, moderate differences; and 0.8 large differences.

RESULTS AND DISCUSSION

There were only moderate to small differences ($0.14 < ES < 0.57$) between males and females for three of the muscles (GA, TA, and VL) during the pre-motor time. There were strong effect sizes ($ES > 1.07$) for the right and left ES and the BF with the males having a longer pre-motor time than the females (Figure 2). For reaction time (pre-motor time + response time), there were relevant differences between males and females with females having shorter pre-motor time than males ($ES > 0.86$) for all muscles, except for TA. For response time, the right and left ES presented shorter time for the males than the females ($ES < 0.80$) while the VL, BF, TA and the GA showed in shorter time for females ($ES > 1.22$). There were no differences in motor time between the males (322.8 ± 116.1 ms) and females (362.1 ± 146.7 ms) ($ES = 0.30$). In terms of response time,

there were few differences between males and females for the activation onset of certain muscles (figure 2). There was no difference in movement time between males and females.

Many studies reported differences in reaction time between sexes [6] although few of these studies have used a fractionated reaction time paradigm. In almost every age group, males had lower reaction times than females and the female disadvantage was not reduced by practice [7]. We found that females responded to the auditory stimulus much faster than males. Botwinick & Thompson (1966) [8] found that almost all of the male-female difference was accounted for by the lag between the presentation of the stimulus and the beginning of muscle contraction. Pre-motor time was different between males and females indicating a shorter pre-planning time for the females. Differences in response time, on the other hand, may be explained by the difference in muscle conduction velocity. While there was no relevant difference in movement time between the sexes, males did have approximately 40 ms faster movement than females to make the total stimulus to contact time very comparable. The 40 ms difference could be accounted for by the difference in muscle mass between the males and females.

Conclusions

In taekwon do, athletes have to be very precise and fast in order to surprise their opponent, avoiding defense and counterattack. Monitoring pre-motor muscle activation during training sessions, potentially gives support for specific training and/or aiming movement optimization.

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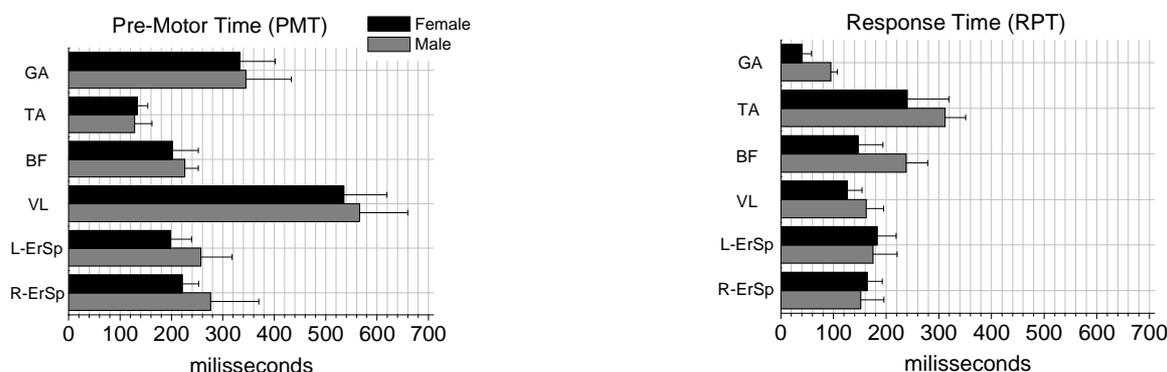


Figure 2. Mean (+SD) pre-motor time and response time for all muscles erector spinae (ErSp) left and right, vastus lateralis (VL), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius lateralis (GA) for males (n = 6) and females (n=7).