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Reaction time in karate athletes

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Abstract

In karate athletes are supposed to develop a high level of reaction time in response to opponent attacks.

The aim of this study was to analyze reaction time in Portuguese karate *shotokan* athletes.

96 *shotokan* athletes from the Portuguese Karate Association participated. The samples were physically characterized and evaluated by *Simple Reaction Time* (SRT), *Choice Reaction Time* (CRT) and *Decision Time* (DT) tests**.**

Data was analyzed by athletes' age (15 to 19, 20 to 35 over 35 yr), by level of expertise (9th to 4th kyu, 3rd to 1st kyu, dan) and by gender (Male and Female).

Male athletes present significant differences from female athletes in height, weight, years of practice and body fat mass.

In relation to SRT all groups tend to a value near to 300 ms without significant differences among them, but the CRT and the DT is significantly higher in the Dan athletes and over 35's than in the other groups. On the other hand the Dan and + 35 yrs athletes tend to make fewer mistakes.

Gender does not influence significantly the reaction time in the *shotokan* karate athletes, but it seems that women tend to have slower reaction times than men.

Athletes with more years of practice and more experience need more time to response to the stimulus than other athletes, but they tend to make fewer mistakes in their choices than other subjects.

Introduction

In karate athletes are supposed to develop a high level of reaction time in response to opponent attacks.

Reaction time (RT) is a physical capacity related to human performance and can be defined as the elapsed time between the presentation of a stimulus and the subsequent behavioral response [Godinho, Mendes, Melo, Barreiros 1999]. In psychology it is considered to be an index of speed of processing [Jensen 2006]. Reaction time also represents the neuromuscular coordination level, in which visual, auditory or tactile stimulations are decoded by the body through different processes (physical, chemical and mechanical), which travel in different ways and arrive at the brain as sensorial stimulations [Der, Deary 2006].

After all this process, the motor reply is transmitted by different neurons that penetrate the spinal cord, carrying information through interneurons which relay the information to the same levels of the desired motor unit.

That is, it indicates how fast the subject can execute the mental operations needed by the task at hand. In turn, speed of processing can be considered an index of efficiency. The behavioral response is typically a button press but can also be an eye movement, a vocal response, or some other observable behavior.

RT is fastest when there is only one possible response (simple reaction time – SRT) and becomes slower as additional response options are added (choice reaction time - CRT). According to Hick's law [1952], choice reaction time increases in proportion to the logarithm of the number of response alternatives. It describes the time it takes for a person to make a decision as a result of the possible choices he or she has.

Empirically, RTs are strongly associated with age. It is well established that, during adulthood, RTs increase and become more variable with age. Reaction time is quickest for young adults and gradually slows down with age. It can be improved with practice, up to a point, and it declines under conditions of fatigue and distraction [Der, Deary 2006].

Reaction time can be divided into two distinct phases, according to Christina and Rose [1985]. In the first phase, called pre-motor or pre-tension, decoding of the stimulation occurs until the first electric activities in the muscle are registered, and carried through to the peripheral nervous system; in the tension or motor phase, muscular cells initiate the process of muscular contraction until the first movements.

Other researchers believe that the pre-motor phase is initiated by the central nervous system. Once determined, SRT tasks are more related to mental factors than to the peripheral nervous system.

Therefore, beyond being an indicator of concentration and attention, the SRT is influenced by factors related to physical conditioning, motor coordination and also genetic and psychological factors.

In sport, reaction time can be seen as the ability to respond quickly with proper posture and control, to a stimulus such as a movement, sound or sight. In many instances, quickness is more important than straight ahead full speed. In many sports, maximum speed is rarely reached or needed, but explosive reaction is often necessary. Although we know that simple reaction time is more influenced by genetics than training, athletes can still improve reaction times by training to make the right choices (choice reaction). Here are some examples:

1) A defensive move in Karate with an interception (block) of an arm or leg attack, because the athlete reads the opponent's eyes/motions or reads body moves, which allows him to position his body based on the receiver's actions and react to the attack. These different stimuli could happen in any order. The most successful karate athletes anticipate, react quickly and explosively with proper posture and control.

2) One of the most important decisions karate athletes makes is "go" or "no go" i.e., whether to perform the attack or not. The most successful ones are able to wait longer and react quicker. This allows karate athletes to read the opponent's move and "go" or "no go".

To Smith [1990] choice reaction time (CRT) is the shortest interval needed to respond to a stimulus that is presented as an alternative to a number of other stimulus. In Karate this time is crucial to performance. However, conventional reaction time training methods, based on specific exercises between two individual [Wichmann 1988, in: Roosen, Compton, Szabo 1999] are limited as soon as the partner's movement responses become predictable [Roosen et al. 1999]. This will artificially decrease reaction time, due to anticipation, and will be very efficient in training, but in competition, where the opponent is less predictable, reaction time will be longer.

In karate sparring, the information to which the karate athlete needs to respond is mainly visual, whether she/he executes a block or delivers a punch or a kick. Further, while speed of response and overall movement time are critical elements in choice reaction time training, the correct execution of the movement components should not be overlooked. In karate training, the most valuable information about one's movement pattern is derived through prescriptive feedback provided by a partner or a teacher [Newell, McGinnis 1985].

According to this, the aim of the study was to analyze visual reaction time in Portuguese karate *shotokan* athletes differentiated by expertise, gender and age.

Methods

Subjects

To accomplish this study the sample was composed of 96 *shotokan* athletes, male and female, aged 15 and above from the Portuguese Karate Association. All subjects were informed about the procedures of the study and data recording and they gave authorization to use and divulge all data.

The athletes' physical characteristics were: age 31,1 ± 14,1 yr, weight 72,7 ± 13,4 Kg, height 171,2 ± 8,1 cm, body mass index 24.7 ± 3,8 and % fat 19.6 ± 6,7. In relation to the practice the group present a mean of weekly hours of training (WHT) of 4.3 ± 1,6 and 14,1 ± 11 years of practice (YP).

Instruments and procedures

Before collecting the data the athletes were instructed about all procedures, then their weight, height, body mass index (BMI) and the % of fat was measured with bio-impedance instruments [Omron BF300, Matsusaka, Japan] and weight and height scales.

Then we used reaction time software called "PRWin" developed in the Sports Sciences School of Rio Maior laboratory to collect the reaction time data. This software works on a laptop and allowed us to evaluate: *Simple Reaction Time* (**SRT**- time between the presentation of a visual stimulus, always in the same location and the motor answer); *Choice Reaction Time* (**CRT**- time between the presentation of a visual stimulus, with four possible different locations, and the motor answer), and *Decision Time* (**DT**- difference between the SRT and CRT). In this procedure the athletes were isolated and

sat at a desk with the laptop. No constrains were imposed on the position of arms.

For the data analysis three different groups were made: by athletes' age (32 athletes between 15 and 19, 27 athletes between 20 and 35 and 37 athletes over 35); by level of expertise (25 athletes from 9th to 4th kyu, 34 athletes between 3rd and 1st kyu and 37 athletes with Dan) and by gender (75 male athletes and 21 female).

Statistical analysis

For the data description descriptive statistics were used so the results were presented according to the mean values and the standard deviation (sd).

Aiming to verify if there were significant differences between groups we used analysis of variance with One-Way Anova and Independent-Samples T Test. The Levene test was used to verify the homogeneity of variance. It was considered a degree of significance of p≤0.05. All data was processed on SPSS 17.0.

Results

As is shown in the table 1 athletes with a higher expertise level tend to be older, heavier, with a superior body mass index and with more years of practice. However the number of hours of weekly training is similar to the remaining groups.

When we analyze the groups by age it is verified that the oldest athletes are significantly heavier, have a larger body mass index, more fat mass and they are the ones who also have more years of practice. In the organization of athletes by gender-table 1 shows a trend that the male athletes are older than the women, and are significantly, taller, heavier , with a bigger body mass index as well as fat mass, and with more years of practice that the women. However, there seems to be a trend that the women practice more hours per week than the men.

In relation to the reaction time of the practicing athletes of *shotokan* karate table 2 identifies that the simple reaction time of the different groups are between the 288 ± 24 ms and the 295 ± 32 ms after the stimulus, without significant differences between the different sets that form the three groups. However, there seems to be a trend that the oldest athletes and females have a faster simple reaction responses.

As for the choice reaction time, the answers happen between the 423 ± 50 ms and the 501 ± 80 ms after the stimulus, verifying that the athletes with a higher expertise level and more than 35 years

Table 1: Physical characterization, years and week time of practice on the different groups.

Expertise	N	Age / sd	Height / sd	Weight / sd	BMI / sd	% Fat / sd	YP / sd	HWT / sd
9º to 4º Kyu	25	26 ± 10	170 ± 8	71 * ± 12	25 * ± 4	21 ± 6	4 * ± 3	4 ± 2
3º to 1º Kyu	34	21 ± 9	171 ± 9	68 ± 14	23 ± 3	17 ± 7	9 * ± 4	5 ± 2
Dan	37	43 ± 11	173 ± 7	78 * ± 12	26 * ± 4	21 ± 6	24,9 * ± 9	4 ± 1
Age								
15–19	32	16 ± 1	170 ± 8	65 * ± 12	23 * ± 3	18 * ± 7	7 * ± 3	5 ± 2
20–35	27	26 ± 7	170 ± 9	70 ± 13	24 ± 3	18 ± 7	9 * ± 6	4 ± 4
+ 35	37	47 ± 7	173 ± 7	79 * ± 12	27 * ± 3	22 * ± 5	24 * ± 12	4 ± 1
Gender								
M	75	33 ± 15	174 * ± 6	76 * ± 12	25 * ± 4	18 * ± 7	16 * ± 11	4 ± 2
F	21	25 ± 9	162 ± 8	60 ± 9	23 ± 4	23 ± 6	8 ± 7	5 ± 2

* With significant differences.

Table 2: Characterization and comparison of the reaction time (ms) and mistakes in the groups.

Expertise	N	SRT / sd	CRT / sd	DT / sd	Mistakes / sd
9º to 4º Kyu	25	290 ± 25	426 ± 45	138 ± 39	4 ± 2
3º to 1º Kyu	34	288 ± 24	429 ± 50	141 ± 50	3 ± 3
DAN	37	295 ± 32	496 * ± 80	195 * ± 67	3 ± 3
Age					
15–19	32	294 ± 26	423 ± 50	129 ± 48	4 ± 3
20–35	27	293 ± 24	443 ± 51	149 ± 46	3 ± 3
+ 35	37	290 ± 31	501 * ± 80	205 * ± 62	3 ± 2
Gender					
M	75	292 ± 30	458 ± 77	163 ± 67	3 ± 2
F	21	288 ± 20	447 ± 40	159 ± 35	4 ± 4

* With significant differences.

old are significantly slower to react to the presented stimulations This indicates that decision-taking time is significantly higher in DAN-level athletes as well as those over 35. However, there also seems to be a trend that the number of mistakes is fewer in older, more technically developed (DAN) male athletes.

In spite of in the analysis by gender that women make more mistakes, a trend is identified that reaction time and decision time are slower for females than for males, which is also evidenced by lower values of standard deviation in female athletes.

Discussion

It is widely accepted that repeated and progressive execution of a skill, improves the quality of the execution and its consolidation. Through repetition, learning is promoted. However this learning involves several factors that are interrelated and will be facilitators or inhibitors of learning.

As part of karate learning, and in association with the objectives of these practices, the need to respond quickly and with accuracy and quality to external stimuli that appear, inherent to interaction with an opponent, would increase the training methodologies used for developing the ability to react to stimuli applied, requesting an immediate response to the stimulus.

The success of a response comes from the ability to react quickly. The duration of weekly practice and one that is developed over a number of years will be a factor conducive to improving the technical performance of different skills in articulation with neurosensory and neuromotor adaptations. Moreover, maturity as well as gender are factors that may induce constraints in motor execution, regardless of practice time.

As identified by the results shown in Table 1, the physical characteristics of karateka differ between the different age groups, in conjunction with the technical level achieved but also with gender. This differentiation does not happen in respect of the time devoted to weekly training where all groups appear to use similar time periods, which could justify that the simple reaction times found don't present significant differences among the different groups. Moreover, factors such as time spent training over the years, expertise or gender did not affect simple reaction time.

According to Roosen et al. [1999] simple reaction time is not so important to karate athletes, nevertheless our results contradict the expectations and results referred to by

other authors [Der, Deary 2006] that age leads to simple reaction time increases but it can be improved with practice. In female subjects in this study simple reaction time tends to be minor, which is in agreement with what was reported by Welford [1980].

The lack of differentiation observed in reaction times may be due to the heterogeneity that exists in karate training classes in Portugal and for the reduced number of weekly hours of practice, which would have a more pronounced impact on higher-level karate athletes . These classes are generally composed of athletes of all ages and all technical skill levels. This method of organizing classes conditioned correct practice, learning, and neuromotor and neurosensory development.

A fast response to stimuli that arise from unexpected locations and times is the requirement constantly demanded of the practitioner of karate, which makes it likely that the athlete with the highest technical level and more years of practice has lower choice reaction time and time decision and makes fewer mistakes than the novice karate athlete.

To the contrary, what was verified in the karate athletes, was that experts and the oldest present a choice reaction time and decision time larger than other karate athletes, but without a different number of mistakes between them, again contradicting what is expected and what is found by Shuji Mori and colleagues [2002]. However, this result fits in part with what is referred to by other authors that refer that aging is a factor that leads to increased choice reaction time and decision making [Ferreira 1990; Alves 1999]. Moreover, in the case of the karate experts older than 35 this increase in choice reaction time must also be influenced by the quality of training. But remembering Roosen et al. [1999] who said that in karate choice reaction time is crucial to performance, it seems that Portuguese athletes with the most expertise must modify the way they train to achieve this goal.

Gender has been one factor that has not been consensual in the analysis of reaction time, being reported by some authors [Landauer et al. 1980; Alves 1999; Neto et al. 2009] that women have higher response time, but other authors [Welford 1980] indicate that these reaction time are lower in women than in men, this reduction being associated with the existence of a sport practice. However, in the karate athletes analyzed, no significant differences were found between gender, but this doesn't lead to the conclusion that karate training leads to homogenization

of reaction time between men and women, because it highlights the tendency that simple reaction times and response as well as decision time are lower in women than in men.

The increase of choice reaction time and time decision in the Dan karate athletes is an indicator that the ageing factor overrides the influence of training in the improving of reaction time, and the similar times of simple reaction between all groups also indicates that the practice of karate does not lead to a differentiation between the groups for this variable.

As a result of this work, it seems that the methodology and strategies for organizing and implementing specific training sessions for reaction time are an essential factor in modifying and improving reaction time in karate athletes.

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Czas reakcji karateków

Słowa kluczowe: karate, reakcja prosta na bodziec, czas podjęcia decyzji

W karate jednym z zadań sportowców jest rozwinięcie wysokiego poziomu czasu reakcji ma ataki przeciwnika. Celem pracy była analiza czasu reakcji wśród portugalskich zawodników karate *shotokan*. W badaniu brało udział 96 sportowców z Portugalskiego Związku Karate. Uczestnicy badania zostali scharakteryzowani fizycznie oraz oceniono ich według Czasu Reakcji Prostej, Czasu Wyboru Reakcji oraz Czasu Decyzji. Analizie podlegali karatecy podzieleni na grupy ze względu na wiek (15-19, 20-35, ponad 35 lat), według poziomu doświadczenia i stopnia (9-4 kyu, 3-1 kyu i stopni dan) oraz według płci (kobiety i mężczyźni).

Mężczyźni karatecy wykazali się znacznymi różnicami w stosunku do kobiet karateków w odniesieniu do wzrostu, wagi, lat praktyki i grubości tkanki tłuszczowej. W odniesieniu do Czasu Reakcji Prostej wszystkie grupy osiągnęły wartość bliską 300 ms bez istotnych różnic między sobą, podczas gdy Czas Wyboru Reakcji i Czas Decyzji były znacznie wyższe wśród karateków starszych stopniem i wiekiem. Z drugiej strony sportowcy ci mieli tendencję do popełniania mniejszej ilości błędów.

Na czas reakcji wśród zawodników karate *shotokan* nie miała istotnego wpływu płeć, chociaż wydawało się, iż kobiety mają krótszy czas reakcji niż mężczyźni. Karatecy z większą praktyką i doświadczeniem potrzebują więcej czasu na odpowiedź na bodziec niż inni zawodnicy, ale popełniają też mniej błędów w odniesieniu do swoich wyborów niż inni uczestnicy badania.