ORIGINAL ARTICLE

Does the reaction time to visual stimuli contribute to performance in judo?

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
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Abstract

Background & Study Aim: Previous studies suggest the choice reaction time to visual stimuli is very important in practice of judo and can be improved by training. The aim of this study is the contribution to the performance in judo of simple and choice reaction time to visual stimuli, to the upper limbs and also to identify the differences between the populations, because we consider that acoustic, vestibular, tactile and kinaesthetic stimuli could also be involved in making quick decisions during the judo fights.

Material & methods: We used a total of 28 male subjects, aged 18-25, taken from two groups respectively. The first group (control) was composed of 20 students in physical education and sport (group 1), the second group was composed of 8 athletes practicing judo with great experience (group 2). The method used allows indirect measurement of reaction time.

Results: The simple reaction time has similar values to all the research groups (238.79±6.8 ms to group 1 and 233.6±5.0 ms to group 2). Also, the choice reaction time to group 2 (404.19±11.0 ms at the dominant hand and 409.0±13.6 ms at the non-dominant hand) is not significantly lower ($p>0.05$) as compared to group 1 (421.34±9.5 ms and 425.9±10.2 ms). We also have not found significant differences between the dominant and non-dominant hands ($p>0.05$).

Conclusions: The results of the study are probably due to the specific training and competition within judo, where the visual receptors probably have not an essential contribution to performance.

Keywords: combat sports • training • speed, computer-based test • receptors

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Introduction

Reaction time values are quite different, depending on some factors (age, fatigue etc.). Normal values of simple reaction time are usually around 200 ms [1], while the lowest values can get down to 140-160 ms [2]. Values concern less the acoustic than the visual stimuli. Regarding choice reaction time, the central nervous system conduct time is considerably higher. From the physiological point of view, there are well-known important roles of the retina [3, 4], visual cerebral pathways [5, 6], motor cortex and cerebellum [7] in the reaction time control to visual stimuli.

In terms of combat sports in general, the low reaction time, including visual stimuli, is very important, because the athletes must take as soon as the appropriate responses to the opponent movements. This factor is particularly important in these combat sports that rest on striking blows out with weapon like in fencing [8, 9] and kendo [10] or with limbs i.e. taekwondo [11]. Response time is important both for

Anticipation reactions – The anticipation of which stimulus (or the response to it) will occur; also called event anticipation [9]

Movement time (MT) – The interval between first muscle activity to the ending voluntary movement task [9]

Reaction time (RT) – The interval of time that elapses from the presentation of an unanticipated stimulus to the beginning of a person's response [9]

SRT – simple reaction time

CRT – choice reaction time

SEM – standard error mean

attack and defence. Introduction of the term "anticipation reactions" [9] is an example of appreciation of the importance of the reaction time in the fight by relying on direct combat of athletes. Although Sadowski et al. [11] found no statistically significant difference between the WTF taekwondo medallists and athletes who did not win medals, however medallists were characterized by both a shorter reaction time (ms) and the time of single movement (ms). Within the selection for the performance and the training, both simple reaction time (SRT) and especially choice reaction time (CRT) are investigated. Regarding SRT, it does not reveal significant differences between athletes and non-athletes [12]. However, the investigation of simple reaction time is useful for the selection and as an indicator of the fatigue [13]. On the other hand, there are data demonstrating that CRT can be improved through specific training [8,14].

Regarding reaction time in combat sports, researchers [15, 16] test the CRT for the lower limb in several other martial arts and combat sports. They found values of the CRT of about 400 ms in individuals with moderate physical activity, around 335 ms in fencers and 340 ms in karate practitioners. In another study [17], performed on the 13 experienced athletes (of Taekwondo, Shaolin Nam Pai and Wu-Shu), the SRT and CRT for the upper limb and the speed of movement (both to the simple and choice reaction time) are measured, the latter by recording time to press a button on the distance of 25 cm. The analysis of the results reveals that there were no differences in reaction time between the dominant and the non-dominant hand. The study confirms the previous results [18], who state that the martial arts' training improves the speed of movement. In Qwan Ki Do [19], regarding the choice reaction time, there was found significant differences ($p<0.05$) for both hands, between advanced athletes of Qwan Ki Do, on the one side, students in physical education and beginners of Qwan Ki Do, on the other side.

Thus, we found some data regarding the reaction time to visual stimuli in judo. The researchers [20] found mean values of 247 ms for SRT and 362 ms for CRT. The SRT was also tested in association with serum lactate before, during and after the fight [21]. The similar values (around 200 ms) demonstrate that the high serum lactate concentration does not affect the motor reaction time in high level judo competitors.

In another study [22], the researchers found significant differences between high and low performance judo athletes in CRT to visual and acoustic stimuli. This suggests the CRT to visual stimuli is very important in practice of judo and can be improved by training.

On the other hand, we consider there are other categories of stimuli, together with visual stimuli, that could be involved in making quick decisions during the judo fights: acoustic, vestibular, tactile and kinaesthetic.

The aim of this study is the contribution to the performance in judo of simple and choice reaction time to visual stimuli, to the upper limbs, and also to identify the differences between the populations, because we consider that acoustic, vestibular, tactile and kinaesthetic stimuli could also be involved in making quick decisions during the judo fights.

Material and methods

Participants

We used two groups (Table 1) and a total of 28 male subjects, aged 18-25. The first group (control) was composed of 20 students in physical education and sport (but no performance athletes), aged between 18 and 24 within the "Alexandru Ioan Cuza" University of Iaşi, Romania (group 1). The second group was composed of 8 athletes practicing judo at Sport Club „Politehnica" from Iași, Romania, with great experience (aged 21-25) that are ranked in the top five places at the national level on their weight category (group 2). Their training lasted for on average of 14 hours/week for more than 10 years. None of them smoked, drank alcohol or was on medication at the time of the investigations. The study protocol was in accordance with the ethical standards of the Helsinki Declaration, accepted by the local Ethics Committee and we had the consent of all the subjects.

Table 1. Subjects of the research.

	Group 1 students	Group 2 judo
Number of subjects	20	8
Body height [cm] (mean±standard deviation)	179.4±5.3	173.5±4.0
Body weight [kg] (mean±standard deviation)	73.6±7.6	70.3±6.4

Investigation of the reaction time

Measurements were performed under the same conditions for all groups, at 10-12 am. This time was

chosen because the subjects should not be tired (the reaction time is obviously altered by the muscle and nervous fatigue). We used four tests: the first test – measuring the simple reaction time; the second test – measuring the choice reaction times only for the dominant hand; the third test – measuring the choice reaction time only for the non-dominant hand; the fourth test – measuring the choice reaction time using both hands for the task.

Method of measuring the reaction time to visual stimuli

The method allows indirect measurement of reaction time [19]. We used a computer and adapted keyboard. The keyboard presents four buttons close to each other, so that they form a square. The software allows recording and storing reaction times, showing the average, maximum and minimum values for a number of determinations.

Test no. 1. Measurement of simple reaction time [ms]

When a large dot, coloured in red, appears on the monitor, the subject must press a default key as soon as possible, using the index, which is in contact with the key (30 measurements for each subject).

Test no. 2. Measurement of choice reaction time [ms] for the dominant hand

The program is set to allow the emergence of the randomly coloured dot in one of the four corners of the screen. When it appears, the subject, using the same set of fingers attached and the dominant hand, will press as soon as possible the appropriate red button on the keyboard (30 measurements for each subject).

Test no. 3. Measurement of choice reaction time [ms] for the non-dominant hand

It is the same as test no. 2, but using the non-dominant hand (30 measurements).

Test no. 4. Measurement of choice reaction time [ms] using the both hands into the task

The program is set to allow the emergence of randomly coloured dot in one of the four corners of the screen, the same as test 2 and 3. When it appears, the subject, using the same set of fingers attached and the dominant or non-dominant hand, will press as soon as possible the appropriate red button on the keyboard, as follows: if the dot appears in the top left or bottom left, use the left hand, pressing the appropriate red button on the keyboard; if the dot appears in the top right or bottom right, use the right hand, pressing the appropriate red button on the keyboard (40 measurements).

Assignation

The second and third tests compare the choice reaction time for the two hands, using only one of them. The 4th test compares the choice reaction time, using both hands in the task. This is a common situation in judo, in which athletes must react with both upper limbs, depending on the opponent's actions. In tests we used for statistical analysis the mean values obtained for each subject at each test (30 measurements for each subject in tests 1-3 and 40 measurements for each subject in test 4).

Statistical analyses

For statistical processing we used the SPSS 17.0 for Windows in the following situations:

Student's unpaired *t*-test (*Independent-Samples T Test*) between groups;

Student's paired *t*-test (*Paired-Samples T Test*) within groups;

The significance level for all analyses was set at $p<0.05$. Data are expressed as mean ± SEM (standard error mean).

Results

All tests judokas performed faster than the students. However, the differences are not statistically significant (Table 2).

Table 2. The values of the reaction time to visual stimuli (ms) in the four tests. Data are in means (±SEM).

Test	Group 1 students (n = 20)	Group 2 judo (n = 8)
Simple reaction time [ms] (Test 1)	238,7 (6.8)	233.6 (5.0)
Choice reaction time [ms] dominant hand (Test 2)	421.3 (9.5)	404.1 (11.0)
Choice reaction time [ms] non-dominant hand (Test 3)	425.9 (10.2)	409.0 (13.6)
Choice reaction time [ms] dominant hand (Test 4)	407.8 (8.1)	391.0 (11.9)
Choice reaction time [ms] non-dominant hand (Test 4)	418.5 (16.2)	395.3 (18.6)

Test 1 – Simple reaction time

Statistical analysis with Student's unpaired *t*-test (*Independent-Samples T Test*) reveals that there have not been found significant differences ($p = 0.653$) between the two groups ($p>0.05$).

Test 2 and 3 – Choice reaction time for dominant and non-dominant hands

Statistical analysis (*Independent-Samples T Test*) reveals that there have not been found significant differences (p>0.05) between groups in both tests. Thus, the *Paired-Samples T Test* shows that there have not been found significant differences (p>0.05) within both groups comparing choice reaction time for dominant (test 2) and non-dominant hand (test 3) – see Table 3.

Table 3. The values of the choice reaction time (ms) and the significance (p) in the test 2 (dominant hand) and test 3 (non-dominant hand). Data are in means (±SEM).

Test	Group 1 students (n = 20)		Group 2 judo (n = 8)	
Choice reaction time [ms] dominant hand (Test 2)	421.3 (9.5)	p=0.354	404.1 (11.0)	p=0.452
Choice reaction time [ms] non-dominant hand (Test 3)	425.9 (10.2)		409.0 (13.6)	

Test 4 – Choice reaction time for both dominant and non-dominant hands in the task

Statistical analysis (Independent-Samples T Test) reveals that there have not been found significant differences (p>0.05) between groups in both tests. Thus, the Paired-Samples T Test shows that there have not been found significant differences (p>0.05) within both groups comparing choice reaction time for dominant (test 2) and non-dominant hand (test 3) – see Table 4.

Table 4. The values of the choice reaction time (ms) and the significance (p) in the test 4 (both dominant and non-dominant hands in the task). Data are in means (±SEM).

Test	Group 1 students (n = 20)		Group 2 judo (n = 8)	
Choice reaction time [ms] dominant hand (Test 4)	407.8 (8.1)	p=0.487	391.0 (11.9)	p=0.648
Choice reaction time [ms] non-dominant hand (Test 4)	418.5 (16.2)		395.3 (18.6)	

Therefore, comparative values of the reaction time to visual stimuli between students in physical education (group 1) and performance judo athletes (group 2) are not different, even if the values in group 2 are slightly lower. Thus, we haven't found significant differences (p>0.05) between the two groups in all tests. Comparing the choice reaction time between the dominant and non-dominant hand, we have not been found significant differences (p>0.05) within the two groups of subjects. The values for the dominant hand are usually slightly lower for all research subjects. The errors made during testing are reduced as average values from all three groups and the differences between them are insignificant (p>0.05).

Discussions

We should point out that, at this time, there are little studies on the reaction time to visual stimuli in judo. Also, the method of measurement used in the present study is slightly different from those used in other studies, so that all comparisons are more or less relevant.

The simple reaction time (SRT)

As a result of the study, the SRT was slightly higher than 200 ms, i.e. close to the average found in various individuals [1, 17, 19]. Concurrently, we have not been found, in general, significant differences between the SRT for the two groups. This supports the assertion that there are not large differences between athletes and unsportsmanlike, in terms of the simple reaction time [12].

From another perspective, the SRT values obtained for the performance judo athletes (233.6±5.0 ms) are longer than those found to athletes from Romanian national team of Qwan Ki Do (207±6.6), where the same investigation method was used [19]. This could be explained by the selection process for Qwan Ki Do national team.

The choice reaction time (CRT)

Regarding the CRT, there are not significant differences for both hands, between the students in physical education and performance judo athletes. Moreover, the CRT values for judoka group in present study are considerable longer than those found in other martial arts [15-17, 19]. These results suggest the specific judo training does not contribute significantly to the CRT shortening to visual stimuli, through the deflation of cerebral conduct and processing time.

We should also mention that differences in CRT for the dominant, respectively non-dominant hand have not been significant in the two groups included in research. Accordingly, there are two aspects that may be taken into consideration: 1. the CRT for the subjects within the study is not influenced by the functional inequality of the two hemispheres of the brain; 2. the judo training does not lead to the significant differences between the CRT to visual stimuli in dominant and non-dominant hand.

Analysing the present research vs. other researches on reaction time in judo, we could state:

the SRT values to visual stimuli are comparable with the results from the literature [20, 21], even if it was used a different testing method;

in opposition with other studies [20, 22], we have not found significant differences in CRT to visual stimuli between performance judo athletes and students, even if the values in judo athletes are little lower.

The results of these studies have another advantage. Confirms the validity of using primarily indicators of: speed, strength and endurance in the selection of judo children and youth [23-25]. Because every combat sport meets the criteria for extreme physical activity [26] and has a utilitarian meaning (every combat sport is an art of self-defense), so the reaction time is an indicator that can be useful in a wide diagnostics of preparing the human for survival. Reaction time can be a useful indicator also in the selection of the firefighters and other rescuers category to solve difficult tasks of rescue [27].

Conclusions

It is obvious that the reaction time to various stimuli is extremely important in combat sports, allowing the athlete to respond to adversary actions with maximum speed. Following the present study, we find that the simple reaction time to visual stimuli has, in general, similar values for the two research groups. Also, the choice reaction time to visual stimuli of the performance judo athletes is not significantly improved. So, the results of our study cannot sustain that CRT to visual stimuli is very important in practice of judo and also it can be improved by judo training. This affirmation is also sustained by the similar results both in dominant and non-dominant hands.

This study found that not visual but probably other stimuli categories are involved in making quick decisions during the fight. This prompts a natural question:

Is it possible that performance judo athletes to have significantly lower values of CRT to vestibular, tactile or kinaesthetic stimuli?

I think this study offers the perspective of investigating the CRT to other than visual stimuli and this could facilitate the optimization of methods and means used in the training of judo for making quick decisions during the fight.

Therefore, in the of judo athletes selection process for high performance, we recommend for coaches testing simple and choice reaction time not only to visual stimuli. We also recommend them to identify the most efficient means of improving training for choice reaction time to various stimuli, given the significant contribution of this neuromuscular factor to victory in the judo competition.

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Competing interests

Authors declare that do not have any financial or personal relationships with other people or organisations that could inappropriately influence paper.

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