

# Is there a difference by sex in simple reaction time and impulsivity in Junior Brazilian Judo Team athletes?

## Authors' Contribution:

- ✓ A Study Design
- 📁 B Data Collection
- 📊 C Statistical Analysis
- 📄 D Manuscript Preparation
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## Abstract

### Background & Study Aim:

The simple reaction time and impulsivity are variables that contribute to the athlete's performance in combat sports. However, little is known about the behaviour of these two variables in relation to elite athletes in judo. Thus, the aim of this study was to know whether there was a difference in simple reaction time and impulsivity in athletes of the Junior Brazilian Judo Team from different sexes.

### Material and Methods:

The mean and standard deviation by two groups of Junior Brazilian Judo Team in 2016 were compared: 17 male athletes (18.5 ± 6.8 years); 17 female athletes (18.9 ± 7.5 years). The reaction time (RT), time of movement (TM) and response time (Tres) were measured by the Reaction Test (RT/S1), present in the Vienna Test System SPORTS® (VTS). To measure the general impulsiveness and its dimensions (second-order factors: attentional, motor, non-planning) the Barratt Impulsiveness Scale (BIS-11) was used (scored in points). The statistical procedures used were mean, standard deviation and the tests of Shapiro Wilk, the independent Student t-test and the effect size ( $p < 0.05$ ).

### Results:

The result were: RT (males 271 ± 41 ms, females 268 ± 51 ms); TM (males 126 ± 31 ms, females 134 ± 41 ms); Tres (males 396 ± 65 ms, females 401 ± 75 ms); BIS-11 (points): impulsivity general (males 59 ± 6, females 62 ± 10); attentional (males 16 ± 3, females 17 ± 4); motor (males 19 ± 3, females 18 ± 4); non planning (males 25 ± 3, females 26 ± 4). Concerning sex comparison, no significant differences were verified for any variable.

### Conclusions:

The simple reaction time and impulsiveness have similar values in comparison to sex between men and women who were summoned to the national team. This indicating that this level of the yield of these two variables are quite homogeneous by sex, considering the high trainability of these athletes and the degree of requirement of sports in which they train and compete.

### Keywords:

Barratt Impulsiveness Scale • elite athlete; response time • time of movement

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Authors have declared that no competing interest exists

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**Psychomotor** – *adjective* relating to bodily movement triggered by mental activity, especially voluntary muscle action [47].

**Psychomotor test** – psychological questionnaires and tests that assess psychomotor reaction time and other psychomotor functions.

**Elite** – *adjective* more talented, privileged or highly trained than others [47].

**Elite athlete** – an athlete who has reached the highest level of performance in a particular sport.

**Combat** – *noun* a physical struggle between opposing individuals or forces [47].

**Behaviour** – the alteration, movement, or response of an object, person, or system acting within a particular context.

**The Barratt Impulsiveness Scale (BIS)** – is a widely used measure of impulsiveness. It includes 30 items that are scored to yield six first-order factors (attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability impulsiveness) and three second-order factors (attentional, motor, and non-planning impulsiveness) [26].

**A Likert scale** – is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research, such that the term (or more accurately the **Likert-type scale**) is often used interchangeably with a **rating scale**, even though the two are not synonymous [48].

## INTRODUCTION

Judo is an Olympic combat sport, which requires from the athletes physical, technical, tactical and psychological capabilities to achieve high-level performance [1-3]. Judo athletes are distributed by age in competitive categories, and the world Judo Championships are disputed for the cadet, junior, senior and master [4, 5].

The junior category of judo represents a decisive moment in which athletes are submitted to the high demand of training and competitions, similar to those found in the senior category [6, 7], having as a peculiarity the process of final enhancement of physical, technical, tactical and psychological demands of judoka. Also, athletes who excel in their clubs and get significant results in major national and international competitions are classified within a ranking of the Brazilian Judo Confederation (CBJ) and qualified to represent the Brazilian team in this age class.

Athletes who represent the Brazilian Judo Team can be classified as elite athletes within the modality. Swann et al. [8] define “elite athletes as being those individuals who participate in training and competitions in high competitive level on national and international levels and represent the teams of their countries”.

It is known that the individual that can process faster and correctly to a piece of information is more effective in achieving success in a motor activity [9]. At the high level of performance of judo, one of the variables that may contribute to the excellence in the performance of the athlete is the reaction time [10]. The reaction time is defined as the time between the moment of presentation of an external stimulus and the onset of the motor response [9]. This variable can be divided into simple, discriminative and choice reaction times [11].

Therefore, the simple reaction time (SRT) becomes an important variable for the elite combat sports athlete. Since the physical, technical and tactics actions undertaken by the athlete and by his/her opponent depends crucially on the factor that both must react within the shortest possible time to be effective during the fight, the SRT is especially relevant in judo [12].

In the general population, studies that evaluated the SRT indicated differences by sex,

with men presenting faster responses than women [13-15]. The authors attributed these findings to possible differences in the effectiveness of the central nervous system [13] and hormonal differences [14] existing between men and women. Silverman [16] suggests that the increase in the practice of sports activities by women tends to improve the SRT. However, little is known whether there are sex differences in the SRT in elite judo athletes, considering that the high trainability of these athletes and the level of requirement in training and competitions can minimise sex differences.

Ong [17] reinforces the need to assess the SRT by means of precise equipment to measure this variable reliably in elite athletes. The study reinforces the importance of using computerized tests capable of detecting minor differences in the performance of elite athletes, in particular, in explosive modalities like judo, in which the speed of execution of the techniques and the motor actions are crucial to the success of the athlete in the sport environment [10, 17].

In combat sports, SRT has been the object of study by researchers in different sports modalities, and there is no scientific consensus about the ability of this variable to be discriminatory in performance (conquest of medals) of the athlete in competition and different competitive levels. In order to correlate sports achievements and SRT, a study conducted with elite taekwondo athletes has identified that those who won medals presented similar SRT to those who did not win medals, showing that the SRT cannot be a predictive marker of sports success in taekwondo [18]. In relation to competitive levels, in karate Mori, Ohtani, Imanaka [19] found no differences between elite athletes and non-athletes for the SRT. In contrast to the findings described above, there are evidences that the SRT can vary according to the level of competitiveness [20] in elite wrestlers and taekwondo athletes [21], but the main gap of SRT in the sports context is related to sex. No evidences have still been found concerning sex differences for elite athletes. Thus, this study aimed to compare whether there are sex differences in SRT in elite judo athletes. It is known that the best athletes are selected to represent national teams, and there is evidence that there are sex differences in the physical capabilities of elite judo athletes [22, 23].

Another variable that deserves attention and which may differ by sex among elite athletes is the impulsivity. It can be defined as a behavioural pattern that predisposes the production of quick answers, without adequate attention to internal and external stimuli from the environment and without the assessment of the negative consequences of these reactions [24]. In the sports context, the impulsivity may influence the implementation of cognitive and motor actions in an untimely manner by the athlete during sports practice [25]. This fact may contribute negatively to judo athletes motor performance and also in carrying out actions of attack, counter-attack and defence, as in judo, the stimulus from the opponent is constantly changing.

The model of explanation of impulsive behaviour proposed by Patton et al. [26] is one of the most accepted in the scientific literature [27]. In this model, the impulsivity is divided into three dimensions relatively independent of each other: motor impulsiveness, attentional impulsiveness and impulsivity by non-planning. Together, these three dimensions give the general level of impulsivity of an individual [26, 28]. There are evidences that the impulsivity may interfere with the motor behaviour in healthy individuals [24, 29, 30] and athletes [25, 31].

It is known that young individuals have a higher frequency of impulsive behaviours when compared to adults [32]. Studies also show that the impulsivity presents sex differences in non-athletes [33, 34]. However, little is known if elite athletes have significant sex differences in their impulsive behaviour.

Studies in non-athletic samples indicate that individuals who are more impulsive are faster in motor responses when compared to their less impulsive peers [29, 34, 35].

In the sports context, Svebak and Kerr [31] were pioneers in studying the relationship of impulsivity with different sports modalities. The authors found higher levels of impulsivity in "explosive" sports athletes (e.g., football, judo) when compared with "endurance" sports athletes (e.g., running).

The few existing studies in sports reported that the impulsivity might be a factor of interference in the athlete's performance [25, 36]. Evidence showed that higher levels of impulsivity in female

handball athletes at the regional level could lead to a faster motor reaction, but with a greater number of errors in the game's technical-tactics actions [25]. In soccer, Cardoso et al. [36] found a negative correlation between impulsivity and the tactical behaviour of young athletes up to the age of 11. These studies show evidence that the impulsivity may influence the sporting performance of athletes.

The comparison by sex on the existence or not of differences in the behaviour of the impulsiveness of elite athletes has not been a focus of research. Based on this premise this study aims to determine whether there is a sex difference among elite judo athletes because it is known that both female and male it is required that judo athletes, in addition to quick decision making, [12, 37].

Thus, the aim of this study was to knowledge whether there was a difference in simple reaction time and impulsivity in athletes of the Junior Brazilian Judo Team from different sexes.

## MATERIAL AND METHODS

### Participants

Thirty-four elite judo athletes, 17 male ( $18.5 \pm 6.8$  years of age) and 17 female athletes ( $18.9 \pm 7.5$  years of age) were evaluated. All athletes representing the Brazilian Junior Judo Team in 2016 were evaluated.

The study was approved by the local ethics committee of Federal University of Minas Gerais (N = 54593116.4.0000.5149), and all participants signed the consent prior to participation in the study.

### Tools and data collection

The athletes' impulsivity was assessed through the Barratt Impulsiveness Scale (BIS-11), validated and standardised in Portuguese for the Brazilian population [26, 38]. This scale has 30 items that should be answered on a Likert Scale of 4 points (1-4) and presents a variation of values between 30-120 points to the impulsiveness. The impulsiveness may be divided into 3 different dimensions and present the following maximum values of 44 points for the motor impulsiveness, characterized by "acting without thinking"; 32 points for the attentional impulsivity, characterized by the "difficulty of concentration"; 44 points

for the impulsivity by non-planning, characterized as “thinking about the present at the expense of the future” [28, 38].

The computerised test Reaction Test (RT/S1), present in the Vienna Test System SPORTS® [39], was used to measure the SRT. The RT/S1 fragments the SRT, measured in milliseconds (ms), in three variables: the reaction time (RT), the time of movement (TM) and the response time (ResT). RT is the time elapsed between the start of the presentation of the visual stimulus and the beginning of activity; MT is given by the interval of time between the beginning, and the end of motor response and Tres is the sum of the RT and MT. Tres is the total time that corresponds to the SRT.

For evaluation of the SRT, the athlete was positioned sitting in front of the computer, with the index finger of the dominant hand resting on the key of rest, in the response panel. Before the evaluation, the athletes went through a familiarisation supplied by the test itself [39]. Subsequently, the athlete was instructed to press the reply button as soon as possible just as a yellow visual stimulus appeared on the screen and this task was repeated for 28 times in an average time of 4 minutes [39]. Similar procedures have been used in the context to evaluate the time of SRT in different forms of combat sports [20, 21].

**Procedures**

First initial contact with those responsible for the Judo Brazilian Team was performed in order to explain the methods and the objectives of the present study. After the consent, two meetings with the athletes were scheduled. The scale BIS-11 and the test RT/S1 were applied in the first two days of the presentation of the athletes in the Team (evaluation week), is that in these two days of data collection there were no training sessions or competitions.

In the first day of the data collection, the athletes received explanations regarding the objectives of this research, signed the term of consent and responded to scale BIS-11. At the second day, all athletes performed the test RT/S1 between 8 and 11 a.m.

All procedures for data collection were performed in a room reserved at the training centre of the CBJ, individually, without external interference, and by the same researcher.

**Statistical analysis**

The data are shown as a mean and standard deviation. Test of the normal distribution (*Shapiro-Wilk*) was conducted on all data before analyses. Differences between sex were analysed using independent Student t test and the effect size using Cohen’s d test [40]. The significance level was set at <0.05.

The effect size classification was performed with the classification of Rhea [40] following values of highly trained athletes: trivial effect  $d < 0.25$ , small effect  $d 0.25 > 0.49$  moderate effect  $d 0.50 > 1.00$  and large effect  $d > 1.00$ .

**RESULTS**

There were no significant sex differences in the SRT of athletes (see Table 1). There was also no sex difference for any of the impulsivity variables (Table 2).

**DISCUSSION**

Regarding the SRT, there are evidences that the behaviour of the variable is different between athletes and ordinary people (non-athletes). Studies show that there are differences by sex

**Table 1.** Simple reaction time, movement and response times in male and female junior judo Athletes.

Indicators SRT (ms)	Mean and SD			Difference	p	Effect size
	general (n = 34)	males (n = 17)	females (n = 17)			
RT reaction time	269 ±45	271 ±41	268 ±51	3	.85	.06
MT movement time	129 ±35	126 ±31	134 ±41	8	.61	.21
Tres response time	398 ±68	396 ±65	401 ±75	5	.84	.06

**Table 2.** Impulsiveness in male and female junior judo athletes based on Barratt Impulsiveness Scale (BIS-11).

Second-order factors BIS-11 (points)	Mean and SD			Difference	p	Effect size
	general (n = 34)	males (n = 17)	females (n = 17)			
total	60 ±45	59 ±6	62 ±10	3	.39	.30
attentional	16 ±35	16 ±3	17 ±4	1	.19	.46
motor	18 ±68	19 ±3	18 ±4	1	.74	.11
non-planning	25 ±3	25 ±3	26 ±4	1	.18	.30

for SRT, with men having quicker replies than women [13-15]. According to the authors, there are differences in SRT by sex, being the males faster than when compared with female. The reason for the disparity by sex for the performance of the SRT is unclear, and the authors attribute these findings to possible differences in the effectiveness of the central nervous system [13], or the authors explained this differences on the basis of the cognitive process of judgment of actions [14]. The authors assume that men and women may present different patterns of speed and accuracy of movements in response to a given stimulus. Therefore, men can process more quickly the information and, consequently, have a response of reaction faster [14].

In contrast to these findings with elite judo athletes, Dykiert et al. [15] showed sex differences for SRT in adults, with men faster than women, however these findings occurred in a sample of untrained/non-athlete persons, which leads us to think that perhaps these sex differences exist in athletes, since they have a ballast of trainability. It is possible that the SRT suffer the influence of daily processes of sports training reducing these differences between men and women. The studies with non-athletes also indicate that there are differences in the levels of hormones, such as estrogen and testosterone, circulating in the body in adulthood, and they affect the brains of men and women differently, and this generates differences in speed of reaction to both simple and complex stimuli [14, 15].

The absence of significant difference for the SRT in comparison by sex of the athletes evaluated can be explained due to the fact that these elite athletes that comprise the Judo Brazilian Team in Junior category have a greater speed of processing in the central nervous system in light of the

requirement and quality of training in which they are subjected daily [23]. It is worth reinforcing that many of times these athletes of males and females train together in the same team, minimizing the differences in SRT.

Another interpretation line of these findings is based on the theory of Ericsson et al. [41] and Lidor et al. [42], who claim that the practice intentionally by athlete of a sport is characterized by highly structured activities, whose explicit goal is to improve his or her performance and contribute so that they perform better physical, technical, tactical and psychological capabilities for the sports performance. In this regard, it can be hypothesized that these elite athletes of both sexes of the Judo Brazilian Team are more likely to reach high levels of sports performance because they are more exposed to qualified coaches, modern and well-equipped training centers [4] systematized and qualified training, high level of competition and competitiveness among the athletes themselves. All these environmental factors, combined with genetic issues, contribute so that the SRT of these athletes is different when compared with other population samples, and that among the elite athletes who serve the Judo Brazilian Team there are no sex differences.

These factors may contribute to the reduction of sex differences for the SRT among elite judo athletes. Up to the present time, no records were found in the literature on this subject, so our results contribute to a new line of discussion within the scientific environment, because it is necessary to check if there are differences by sex in elite athletes in other cognitive abilities, such as, attention, concentration and awareness and also in reactive capabilities as the discriminative and complex reaction time.

Regarding the comparison of impulsiveness by sex, the absence of significant differences in impulsiveness converges in the tendency that these athletes of the Judo Brazilian Team in Junior category present a very similar impulsive control.

In a non-athlete population, studies have shown that the impulsiveness has presented differences by sex in both general analyses [33, 43] and the analysis by dimensions of impulsiveness proposed at the tests [34]. Men are commonly reported as more impulsive than women [33, 34, 43], but the reasons for higher impulsiveness in men are still not explained [34].

Lage et al. [33] found differences in sex only in the dimension of motor impulsivity in young adults, with men more impulsive than women. One of the explanations for the higher motor impulsiveness of men may be based on the concepts of evolution in which men have a larger system of behavioural approach and may be less able to control automatic and prevalent responses [33].

Stanford et al. [27] claimed that the impulsiveness is a factor that interferes with the performance of tasks that require behavioural control. The interference of impulsiveness in the performance of individuals can be increased in specific circumstances as situations which require to recognise the action of the opponent, process a decision and arrange the motor system to initiate a response [27]. An explanation for this fact may be based on the concept of functional impulsivity characterised by the tendency or ability to think, act and speak quickly [29]. According to this theory, it is possible that the impulsiveness interferes in the sports performance of elite athletes, in particular, in explosive modalities as judo [31].

In this sense, in the sports environment, greater impulsivity is related with a lower capacity for concentration and maintain the focus of attention [25, 43]. The few studies carried out were done in collective modalities such as handball, soccer and radical sports [25, 37, 44]. According to Lage et al. [25], The impulsiveness is capable of influencing the decision-making process and the technical and tactical performance of young female Brazilian athletes of handball of regional level. The findings show that the more impulsive the athlete is, the worse his or her decision-making process and consequently his or her performance in technical- tactical actions of the game.

In agreement with the earlier study, Cardoso et al. [36] found that impulsiveness may interfere with the performance of a technical and tactical action in athletes of soccer in category sub-11. This result suggests that high impulsiveness could put the athlete in situations that are not planned and affect his or her sports performance.

These studies provide preliminary evidences that impulsiveness is capable of influencing the performance of the athletes. Also, they demonstrate the relationship of impulsiveness with sports performance and technical and tactical actions for different sports modalities. However, there are no evidences in judo and other martial arts that the impulsiveness interferes in sports performance of an athlete and especially if there are differences by sex in the levels of impulsiveness of elite athletes of these modalities.

One of the few evidences found on this subject [44], comparing the difference by sex for the impulsiveness between two groups, one composed of radical sports athletes and another by non-athletes. The results showed that radical sports athletes of both sexes show high levels of impulsiveness when compared to non-athletes [44]. Moreover, when they performed the comparison by sex for the impulsiveness among radical sports athletes, differences were not found for this variable [44], thus corroborating the findings of the present study.

If we observed the values of the dimensions of impulsiveness found in this study for male and female athletes and compared with the standards proposed by Patton et al. [26], it should be noted that in general the impulsiveness of athletes can be classified as moderate ( $M = 60.35 \pm 7.69$ ). If we analyse by dimensions, both men and women showed moderate for the dimensions attentional ( $M=16.50 \pm 3.61$ ) and non-planning ( $M = 25.38 \pm 3.44$ ), and low for the motor ( $M = 18.44 \pm 3,649$ ).

The explanation for these low and moderate levels of impulsiveness may be associated with trainability and number of fights that these athletes have already gone through what makes the athletes more experienced and less impulsive to act in their combats because they know that any impulsive action without planning can cost them a defeat in the fight.

Another explanation is that these athletes have monitoring and psychological guidance in their clubs as well as in the Judo Brazilian Team, which leads them to have a better perception of their impulsiveness and also a greater emotional control inside and outside of the mats [3, 45]. The low and moderate values of impulsiveness found in both sexes indicate that these athletes have a good ability to cope with the pressure of sports and control the negative aspects of the competitive environment of judo which may generate impulsive behavior, consequently, they can have a better control of their impulsiveness, using the same only in favorable situations, in particular at the combats.

The literature also points that physical exercise is able to influence the neurobiological pathways, such as the catecholaminergic system and, thus, contributes to control the individuals' impulsiveness [46]. Judo elite athletes of both sexes are subjected to the high demand of training with physical exercise during the whole process of sports formation, which can contribute to better control of impulsiveness and also so that there are no differences in levels of impulsiveness among men and women that are inserted in the high-performance sport.

It should be pointed out, some limitations in this study, being the first to have carried out the evaluations only in the Junior category, making it necessary to verify if this behaviour of the SRT and

impulsiveness among men and women is also manifested in others competitive categories in judo. Another limitation of the study was the short time available to evaluate athletes of this team, according to the routine of training and travel, which prevented the completion of a longer battery of tests related to the SRT and impulsiveness. However, the results may contribute establishing normative indicators in relation to SRT and impulsiveness that can guide especially coaches who work with elite athletes who want to achieve the national team of his or her country.

## CONCLUSIONS

The simple reaction time and impulsiveness have similar values in comparison to sex between men and women who were summoned to the national team. This indicating that this level of the yield of these two variables are quite homogeneous by sex, considering the high trainability of these athletes and the degree of requirement of sports in which they train and compete.

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