

# Attention and acute judo-specific effort in athletes preparing for Olympic competition

## Authors' Contribution:

- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
- E Funds Collection

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## Abstract

**Background & Study Aim.** The study investigated the changes in attention concentration corresponding to body activation in judoists of different competitive levels. Changes in attention processes were tested in the context of judo-specific effort.

**Material & Methods.** The Special Judo Fitness Test (SJFT) was administrated to 23 elite judoists during their preparation for the Olympic Games, London 2012. The attention processes were measured with d2 test before the fitness test and repeated immediately after the SJFT.

**Results.** Compared to pretest, the results obtained after the SJFT indicated that the processing speed and the concentration performance increased and the percentage of errors dropped. Participants listed higher on International Judo Federation ranking obtained better results than judoists of the national level. The percentage of error in the d2 test was unsatisfactory in the both international and national groups: high speed of processing was accompanied by a low quality of performance.

**Conclusions.** High processing speed was associated with performance of low quality, which might be improved in the course of psychological and tactical training. Coaches may use tests to monitor psychophysical state of their athletes.

**Key words:** attention · fitness · judo elite athletes · performance

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**Attention** – The selection of information so that the mind can concentrate on one out of several simultaneously presented objects or trains of thought. Attention involves withdrawal from some things in order to deal effectively with others. It enables a person to concentrate on the task in hand. [21]

## INTRODUCTION

Judo fight is an intermittent activity of athlete. Typical sequences of intensive processing range from 19 to 30 seconds, whereas pauses in between range from 7.5 to 14 seconds. The ratio between processing and a pause is usually 2:1 [1, 2]. The effective method applied in a fight consists of five logical steps algorithm [3]: identifying strengths and weaknesses of the opponent; hiding

one's own intentions and, in extreme cases, misleading an opponent; limiting opponent's activity in the attack, choosing the place and the time of the attack; carrying out an attack scoring (*ippon* score); and ending the fight before the time or maintaining the advantage until the end of the fight. In case this conduct fails, the heuristics are being used. Therefore, tactical-technical and psychological preparations are closely related.

Recent research shows that differentiation in the direction of attacks is related to the level of sporting achievements [4]. Nevertheless, the speed of information processing plays an important role in the choice of judoist's attack direction. One of its indicators is the speed of reaction [4, 5] which is associated with attention. On one hand, research conducted among judoists shows that simple reaction time increased due to fatigue caused by fighting [6]. On the other hand, there is empirical evidence suggesting a significant decrease in reaction time with a choice among judoists after performing a specific effort [5].

Theoretical models and research has emphasized the role of the psychological factors in forming the competitive readiness of a judoist [7]. Without a doubt, the athlete has to mobilize multiple psychological self-regulatory mechanisms and skills which assure gaining the advantage in a fight. Attention may be defined as one of the basic mechanisms of self-regulation which determines the efficiency of human performance across a variety of situations and during the course of any actions [8]. The primary function of attention is selectivity that is the selection of the stimuli which are the most important for the task at hand, and a reduction of processing unessential information. Attention can execute these functions in multiple ways and facilitates performing several tasks related to information processing: selection of data sources, search of the perceptual field, extended focus on a selected stimulus or a source of data, and the coordination of simultaneous operations [8]. To our knowledge, there are no studies on attention in judoists.

Changeable conditions arising across sport situations result in difficulties in achieving optimal levels of concentration. Very important is the ability to maintain attention and shifting it in a prolonged time of action [9]. Many athletes relate their greatest achievements to a high level of focus [10]. One of the best known sport psychology models of attention, proposed by Nideffer [11] defines four types of focus, required in various sport situations. The four types of attention differ in terms of the width and the direction of attention. The operational definition of attention and an explanation of arousal and attention relationship can serve the basis for a psychological training [12]. Brickenkamp's d2 test of attention is another valuable option to measure of attention processes [13].

Signals relevant for judo fighting occur both in the activation phase, as well as during the interval. Decisions, however, are often made in the condition of increased fatigue. A successful athlete needs

to focus on the right thing at the right time. It was hypothesized that the mean in attention indicators would change between measurement first and second time points for both competitive levels of judo athletes. The aim of our study was the knowledge about the changes which occur in attention processes in the relation to body activation caused by judo-specific effort.

## MATERIAL AND METHODS

### Participants and Procedures

Participants were elite judoists, 6 women and 17 men who provided their data during the pre-Olympics camp. Data were collected during precompetitive phase of preparation (4 July 2012) for the Olympic Tournament – London, taking place from 28<sup>th</sup> July to 3<sup>rd</sup> August 2012. The athletes and coaches provided informed consent. Research was conducted in line with ethical principles stated in Helsinki Declaration. Neither complains nor fainting incidents were recorded during the data collection.

Among the respondents, 11 individuals had participated in international competitions (the international group: I with participants ranked on the International Judo Federation list) and 12 athletes (the national group: N) took part in national-level competitions only. Among women, four were competing at the international level, two at the national level. Among men 11 were the international elite athletes and 12 were competing at the national level. The distribution of women and men grouped according to level of sports, did not differ significantly (corrected  $\chi^2 = 0.35$ ,  $p = 0.549$ ). So, the proportionality of competitive levels was similar in the both groups. The prevailing level of the sample was 1<sup>st</sup> dan degree ( $n = 17$ ), 5 athletes had 2<sup>nd</sup> and 3<sup>rd</sup> dan and one respondent possessed 1<sup>st</sup> *kyu*. The I group differed from the N group in terms of age ( $24.45 \pm 3.72$  vs.  $21.83 \pm 1.94$  years,  $p = 0.012$ ) and the years of experience ( $16.09 \pm 2.95$  vs.  $12.5 \pm 2.88$  years,  $p = 0.008$ ). Both groups were similar in terms of body mass ( $90.21 \pm 39.25$  vs.  $96.17 \pm 25.66$  kg,  $p = 0.670$ ) and height ( $175.4 \pm 10.24$  vs.  $181.0 \pm 9.21$ ,  $p = 0.190$ ).

### Special Judo Fitness Test (SJFT)

The measurement included a fitness SJFT test conducted according to the instructions proposed by Franchini et al. [14]. The SJFT can be used for the identification of anaerobic and aerobic capacity as well as being able to induce glycolytic and aerobic demand similar in the judo match [15]. A visual presentation of SJFT is available elsewhere [16]. Briefly

the SJFT is divided in three periods (A = 15 sec, B and C = 30 sec) with 10 sec intervals between them. During each period the evaluated athlete (*tori*) throws two partners (*uke* A and B; far from each by 6 m) as many time as possible using the one-armed shoulder throw (*ippon-seoi-nage*) technique. *Tori*, *uke* A and *uke* B should have a similar height and weight. Following the effort in SJFT the measurements of the heart rate were taken twice, immediately after the exercise (intensity), and after one minute of recovery [14]. Heart rate was measured using heart rate transmitter (Polar Electro Oy, Kempele, Finland). The following index is calculated:

$$\text{The SJFT Index} = \frac{\text{Final HR (bpm)} + \text{HR 1 -min after the test (bpm)}}{\text{Number of throws}}$$

The lower values of the SJFT index are indicative of better results. The overall number of *ippon-seoi nage* throws performed by women (n=6) and men (n=17) in SJFT did not differ significantly (27±4.1 vs. 28±2.4,  $p = 0.475$ ), similarly to heart rate (HR) immediately after the judo-specific effort (176±8.2 vs. 183±8.2 bpm,  $p = 0.089$ ), HR after 1 minute recovery (141±5.0 vs. 136±11.9 bpm,  $p = 0.335$ ) and the SJFT index (12.09±2.19 vs. 11.49±1.11,  $p = 0.391$ ).

### The d2 Attention Test

The d2 attention test [13] allows for a neuropsychological estimation of attention and concentration performance in areas of processing speed, rule compliance and quality performance. Three indices were calculated: the processing speed (TN), the percentage of error (E%), and the concentrate performance (CP) [13]. Overall good psychometric properties of this measure were confirmed in previous research [13]. In the present study the d2 test was applied immediately before and directly after the SJFT.

### Data Analysis

The data obtained by means of the SJFT for groups I and N were analyzed in the relation to the following variables: Total throws, HR directly after, and HR after 1 minute recovery. The influence of specific effort factors in SJFT on the change in the d2 test (perception speed indicator, accuracy and concentration performance) was analyzed. Normality of variables was checked and then repeated measures analysis of variance was applied to compare of changes over time. To evaluate the effect of the experimental factor (the judo-specific performance test) on the level of the d2 test indicators. Two factors were taken into consideration: sport's level – the Group (I, N), and the time factor – Condition (pre- and post-effort). For multiple comparisons of means the post-hoc 95 percent

Tukey's honestly significant difference (HSD) procedure was used. The results of the research were coded and presented using normative values. Norms are available for the SJFT scores [14], as well as for d2 Attention Test [13]. There was no missing data.

## RESULTS

The comparison of special fitness and the d2 test results between the international (I) competitive or national (N) level groups SJFT results are displayed in Table 1. Analysis of variance indicated no significant differences between groups I and N were found for SJFT test (all  $p > 0.05$ ). The descriptive statistics for d2 test obtained at the pre- and post-judo-specific effort are presented in Table 1.

**Table 1.** Descriptive statistics for the Special Judo Fitness Test and The d2 attention test.

Variable	The total group (n = 23)	The international level (n = 11)	The national level (n = 12)
Statistics	M (SD)	M (SD)	M (SD)
The results of Special Judo Fitness Test (SJFT)			
Total throws	27.65 (2.87)	28.0 (3.66)	27.33 (2.02)
Heart rate after the SJFT	181.0 (8.61)	179.5 (9.47)	182.5 (7.87)
Heart rate-recovery at 1' after the SJFT	137.5 (10.64)	135.9 (11.07)	139.0 (10.50)
The SJFT index	11.65 (1.44)	11.46 (1.84)	11.82 (0.99)
The results of the d2 attention test before the SJFT			
Processing speed	510.3 (64.76)	520.1(66.24)	501.3 (64.93)
Accuracy of perception	22.60 (8.27)	21.45 (8.26)	23.66 (8.50)
Concentration performance	189.0 (29.48)	192.5 (34.03)	185.9 (25.74)
The results of the d2 attention test directly after the SJFT			
Processing speed	561.4 (43.32)	569.5 (36.06)	554.0 (49.45)
Accuracy of perception	12.95 (6.58)	11.30 (5.43)	14.46 (7.38)
Concentration performance	214.7 (30.80)	221.3 (27.46)	208.7 (33.59)

Note: processing speed refers to the total numbers of items processed; the accuracy of perception refers to the error percentage; the ability to concentrate refers to the concentration performance.

Repeated measures analysis of variance showed that the sport's level factor significantly affected the processing speed (TN) index, with TN for the I Group obtaining significantly higher values than TN for the N Group,  $F_{(1,22)} = 4.43, p = 0.048, \eta^2 = 0.021$ , and its accuracy with the percentage of error (E%) for the I Group obtaining significantly lower values than E% for the N Group,  $F_{(1,22)} = 5.53, p = 0.029, \eta^2 = 0.023$ . The effect of fatigue factor resulting from the implementation of judo-specific effort (the pre- and post-test condition) was larger than the effect of group factor (the I vs. N groups), with lower levels of TN at pre-test, compare to TN at post-test,  $F_{(1,22)} = 39.15, p < 0.001, \eta^2 = 0.183$ , and higher values of E% at pre-test, compared to E% at post  $F_{(1,22)} = 71.83, p < 0.001, \eta^2 = 0.304$ . The Group x Time interaction was not significant as test shows  $F_{(2,21)} = 0.04, p = 0.842$  and  $F_{(2,21)} = 0.18, p = 0.679$ , respectively.

Further, a significant effect of the sport's level factor (the I vs. N Group) on the concentration performance (CP) was found,  $F_{(1,22)} = 4.93, p = 0.037, \eta^2 = 0.022$ . In the I group the value of CP ratio was higher than in the N group, both before (3.6%) and after (6.0%) the SJFT. The Time factor (pre versus post SJFT affected the level of CP,  $F_{(1,22)} = 35.75, p < 0.001, \eta^2 = 0.160$ ). The difference between the CP means at the two measurement points was 13.7%. No significant Group x Time interaction was found,  $F_{(2,21)} = 0.49, p = 0.489$ . The I group exhibited a slightly higher percentage of the increase of CP value indicator than the N group (15.0% vs. 12.3%).

## DISCUSSION

The interactive model emphasized the role of the psychological factors in forming the competitive readiness of judo athletes, proposed by Blumenstein et al. [7] accounts for the psychological preparation in relation to the physical, technical, and tactical preparations. Recent studies have demonstrated that coaches perceive technical schooling as a key factor contributing to judo-sports result (23.4%), but psychological factors contribute as much as 20.1% of variance [17].

Our study explains the relationships between the indices of psychological and motor fitness preparation of judoists measured in the precompetitive phase, directly before the Olympic Games. The present research investigated the scope and the direction of attentional changes in relation to judoists' body activation evoked by judo-specific effort. Importantly, the percentage of error assessed before the SJFT was very high and compared to the normative results [13] the participants obtained scores comparable to 10% of the worst results

in the general population. Following the effort in SJFT the measurements of the heart rate were taken twice, immediately after the exercise (intensity), and after one minute of recovery [14]. The body activation through SJFT effort is similar to the effort occurring in the fight. When compared to the normative data [14] the SJFT results indicated that the performance scores of total throws and Index values were excellent in the I group, whereas they were good in the N group. Regarding the cardiovascular response to exercise similar levels of HR directly after (good) and HR 1 minute after (excellent) were found in both I and N groups. Further, the judoists from the I Group demonstrated a greater processing speed, they committed fewer errors, and they were more accurate, and their concentration of performance was better than among athletes from the N group. The I group participants were more experienced athletes as well as they gained more points in the pre-Olympic ranking of the International Judo Federation.

Our findings provide novel data concerning the attention processes among people pursuing judo and achieve national or international competitive levels. Their fight is characterized by rapid, unexpected changes of the situation, which requires a lot of focus and attention span. In order to meet the demands of the fight situation it is necessary to focus on the factors relevant for fight and to isolate oneself from distractors, such as external stimuli, stimuli from one's own body (e.g., feelings of pain, fatigue), and unconstructive thoughts. During a very short time span the judoists are concurrently in vertical posture, they maneuver to obtain a grip on their opponent's sleeve, collar, lapel in the process of building and offense or defense thus the observation of the attention field must be very careful. Grasping the opponent's clothing enables a judoist to transfer the power necessary to implement tactical and technical elements. However, a decrease in attention can result lack of or a delayed action in attack and defense.

Our results suggesting differences between groups of the national and international competitive levels and a significant effect of the activation highlight the importance of the processing speed of data obtained from visual perceptions in sports such as judo. In other experiment we observed a decrease in reaction time with a choice to visual stimulus after effort in SJFT [5]. However, Heinen [18] did not find differences in the d2 test results between athletes pursuing sports of high load of static component, such as judo, in contrast to dynamic component. Although, the variable in our research (effort resulting in fatigue) was different from the one in the other study (acoustic distractor), we observed higher concentration-performance scores for the auditory distraction

condition for both static-sport and dynamic-sport athletes. In the present study we found a moderate effect / time effect ( $\eta^2 > 0.14$ ) of judoists' activation on such indices as processing speed, accuracy of perception and ability to concentrate, while the effects of the competitive level (national vs. international) remained small.

An important issue, worth further discussion, is a big number of errors committed by judoists in the d2 test. A decrease in the percentage of errors after exercise was reasonable, however it cannot change the overall assessment of quality of processing in athletes, which was low and defined by a large number of errors.

The originality and strength of this study is the recruitment of elite athletes. The results of unique athletes were reported to them and their coaches in a few days after testing session. The number of participants constitutes a main limitation of our study. However, in the case of elite athletes it is difficult to increase this number substantially. In order to replicate the conditions in the training cycle and increase the number of participants, we need to wait until the next Olympic Games. A stronger point, on the other hand, is the fact that our research was of ecological validity that is it was carried out in sport training environment during the period of high relevance for any competitive athlete. In addition, the coaches received immediate feedback on an athlete's physical fitness and the state of their attention.

## PRACTICAL IMPLICATIONS

The attention we measured in the d2 test is not typical for participants of combat sports. In combat phase of

judo, when the grip for clothing has not occurred yet, we could additionally study the visual perceptions. During the fight in the clinch, with both hands grip (*kumi-kata*), the crucial point seems to have a static force of upper limbs and proprioceptive sensation associated with the ability to balance [19]. The combined results obtained from the test of attention d2 and judo-specific tests can be applied to monitor progress in training. Additionally, judo-specific exercises performed before the fight in the competition can also be used as a means to optimize athletic readiness. From a tactical point of view, the low accuracy can adversely affect the effectiveness of decisions made in combat. There are various methods to improve this condition, such as learning to focus on a task instead of a goal (task vs. goal orientation) [20].

## CONCLUSIONS

Across disciplines, psychological skills has been shown to predict athletes' performance under duress [21]. High appraisal of processing speed and concentration performance in the researched group of judoists are accompanied by a low quality of performance, which might be improved in the course of psychological and tactical training. Coaches can use tests to monitor psychophysical state of their athletes.

## COMPETING INTEREST

The authors declare that they have no competing interests.

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