REACTION TIME IN TAEKWONDO

Manfred Vieten [#], Markus Scholz [#], Hashem Kilani [‡], Markus Kohloeffel [*]

[#]University of Konstanz, Konstanz, Germany
[‡]University of Jordan, Amman, Jordan
[*]German Taekwondo Union, Friedrichshafen, Germany

The purpose of the study was to find out if taekwondo players competing on an international level have faster reactions than recreational taekwondo players or sports students. We measured three different time intervals. The time measurements started with the flashing of a light diode and ended respectively with the first visible movement of the hip, the shoulder or the foot. Differences were found depending on the skill level, age and gender with the taekwondo players competing on an international level showing significant faster reactions.

KEY WORDS: biomechanics, taekwondo, reaction time, response time

INTRODUCTION

The Korean martial art Taekwondo is an official Olympic sport since the 2000 Sydney Olympics. Taekwondo is a full contact combat art where the majority of successful techniques are powerful kicks, which are delivered towards the opponent's frontal upper trunk or head. Scoring occurs when those blows are delivered accurately and forcefully. During the last years the type of successful techniques condensed toward direct strait kicks, which can be applied within a shorter time interval compared with more complicated kicks. Therefore, it seems success greatly depends on the execution time of a technique. Beside speed, reaction time and the response to the opponent's actions appear to be one of the key elements for victory. Naturally, coaches and practitioners need to know if a short reaction time is indispensable for high performing athletes. There are two types of reaction time. The "complex" reaction time arises in combat situations. Here an athlete "reads" the situation and anticipates the further progression to take advantage of the situation. The "simple" reaction time is the physiological response toward a neutral sense stimulus. Here (Zaciorskij, 1972) a receptor excitation (e.g. of the eye) initiates a signal which is transmitted via the central nervous system to the motor cortex. Its response triggers a signal that stimulates the muscles and initiates the mechanical activity. With this study we investigated, if high performing taekwondo players on the international level have significantly shorter "simple" reaction times than taekwondo players on regional level or sport students.

METHOD

99 subjects participated in this study and were divided into 7 groups (Table 1) according to age, gender and skill level. All national team members are athletes of the German taekwondo squad competing on international tournaments. The other taekwondo players are active on a regional level. The sport students had taken a first semester of taekwondo.

Table 1 Number of participants within the 7 groups

Group	Abbreviation	No of subjects
Females below 18 years	F<18	9
Females below 18 years, national team members	FS<18	13
Females 18 years and older, national team members	FS≥18	20
Males below 18 years	M<18	14
Males 18 years and older	M≥18	15
Males 18 years and older, national team members	MS≥18	19
Male sport students 18 years and older	Sp	11

All participants were tested after a warm up during one of their training sessions. Within an area of 5 by 5 meters we assigned a training mitt as the target (Figure 1). Two stacks of red

light emitting diodes were place beside the training mitt but not in the reach of a kick. The athlete was positioned in front of the vaulting buck in attack position. Reflective markers were placed on the shoulder, hip, and at the kicking foot (ankle). The subjects were asked to start kicking at the onset of the red diode lights. Ten trials of each subject were filmed. and the actual number of valid trials varied between 8 and 12. We used one digital camera to tape the whole movement and the light diodes.

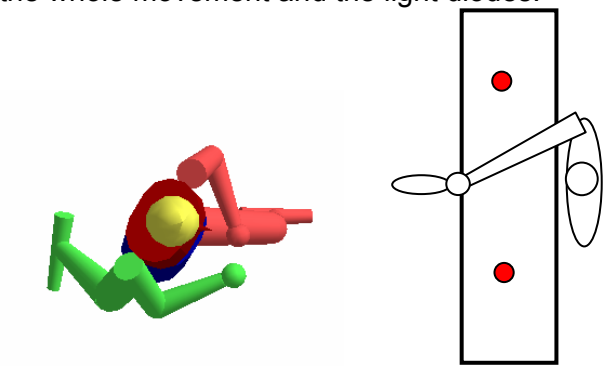

Figure 1 Sketch of the experimental setup from a bird's eye view

The taping was stored in MPEG2 format and later converted to AVI. The 50 half frames per second were analyzed using the APAS trimming module. The evaluation was done by one of us (MS) to avoid effects caused by personal judging differences. We calculated the mean reaction time of each participant. This was the input for the calculation of the group means, standard deviation, and standard error.

RESULTS

Our group selection shows homogeneity within six of the seven groups (see Figure 2 for results on the standard deviation).

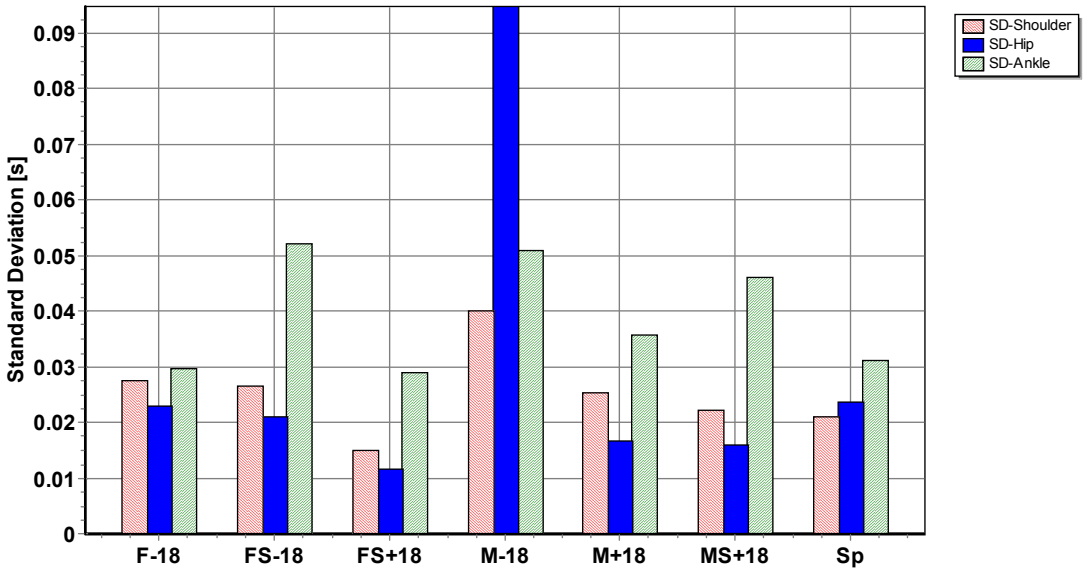

Figure 2 Standard deviation of reaction times for the different groups

The deviations of the groups are comparable with each other with the exception of the males of 18 years or older. This group showed also the widest age rage as well as the highest variability in trainings intensity. Table 2 shows the mean, the standard deviation, and the standard error of each group's reaction time for the shoulder, the hip and the ankle movement.

Table 2 Mean, standard deviation, and standard error of the reaction times

	Shoulder			Hip			Ankle		
Subject	Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
F < 18	0.23	0.03	0.009	0.22	0.02	0.008	0.36	0.03	0.010
FS < 18	0.21	0.03	0.007	0.22	0.02	0.006	0.37	0.05	0.014
FS ≥ 18	0.20	0.02	0.003	0.21	0.01	0.003	0.35	0.03	0.006
M < 18	0.23	0.04	0.011	0.26	0.09	0.025	0.37	0.05	0.014
M ≥ 18	0.23	0.03	0.007	0.22	0.02	0.005	0.36	0.04	0.010
MS ≥18	0.20	0.02	0.005	0.20	0.02	0.004	0.31	0.05	0.011
Sp	0.23	0.02	0.006	0.24	0.02	0.007	0.38	0.03	0.009

There is a substantial difference between the reaction time of the ankle movement and the time for shoulder and hip movement within each group. Between the reaction time for the hip and the shoulder we find no statistically significant difference. However, there exist differences in reaction time between different groups (Figure 3). We found significant differences of the reaction time (see Figure 3 and Tables 3 – 5) between the different groups. For the hip reaction time the adult male national team members are fastest, second are the adult female national squad followed by the female national team members below 18 years of age. The slowest reaction time we found in the male taekwondo players below 18 years, second the male sport students, followed by the recreational male taekwondo players above 18 years of age and females below 18 years.

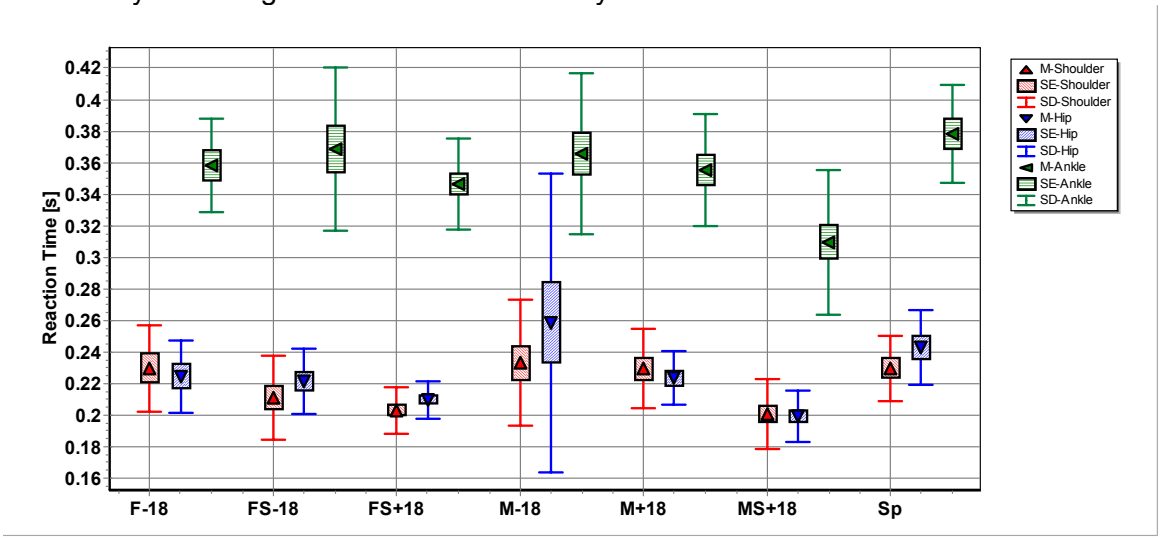

Figure 3 Mean, standard error and standard deviation of shoulder, hip, and ankle reaction times

For the shoulder respectively the foot reaction time negligible changes in the above order occur. In any case the adult male national team members are the fastest followed by the adult female national team members. The significance levels of the differences between the groups as given in the Tables 3 – 5 are to be understood in the following way: Cursive writing indicates the group denoted in the upper line is faster. Otherwise the group indicated in the first column has shorter reaction time.

Table 3 Significance level of group differences for shoulder reaction times

Subject	***F < 18***	***FS < 18***	***FS ≥ 18***	***M < 18***	***M ≥ 18***	***MS ≥ 18***	***Sp***
F < 18	1	*0.1304*	*0.0204*	0.8230	*0.9800*	*0.0061*	0.9984
FS < 18	0.1304	1	*0.3202*	0.1090	0.0878	*0.2376*	0.0762
FS ≥ 18	0.0204	0.3202	1	0.0161	0.0033	*0.7285*	0.0003
M < 18	*0.8230*	*0.1090*	*0.0161*	1	*0.7757*	*0.0133*	*0.7849*
M ≥ 18	0.9800	*0.0878*	*0.0033*	0.7757	1	*0.0020*	0.9745
MS ≥ 18	0.0061	0.2376	0.7285	0.0133	0.0020	1	0.0015
Sp	*0.9984*	*0.0762*	*0.0003*	0.7849	*0.9745*	*0.0015*	1

Table 4 Significance level of group differences for hip reaction times

Subject	*F < 18*	*FS < 18*	*FS ≥ 18*	*M < 18*	*M ≥ 18*	*MS ≥ 18*	*Sp*
F < 18	1	*0.7590*	*0.0963*	0.2154	0.8852	*0.0020*	0.0978
FS < 18	0.7590	1	*0.0791*	0.1744	0.8207	*0.0016*	0.0291
FS ≥ 18	0.0963	0.0791	1	0.0759	0.0093	*0.0203*	0.0008
M < 18	*0.2154*	*0.1744*	*0.0759*	1	*0.1907*	*0.0354*	*0.5560*
M ≥ 18	*0.8852*	*0.8207*	*0.0093*	0.1907	1	*0.0002*	0.0273
MS ≥ 18	0.0020	0.0016	0.0203	0.0354	0.0002	1	1.51E-6
Sp	*0.0978*	*0.0291*	*0.0008*	0.5560	*0.0273*	*1.51E-6*	1

Table 5 Significance level of group differences for foot reaction times

Subject	*F < 18*	*FS < 18*	*FS ≥ 18*	*M < 18*	*M ≥ 18*	*MS ≥ 18*	*Sp*
F < 18	1	0.5970	*0.3217*	0.6987	*0.8452*	*0.0078*	0.1599
FS < 18	*0.5970*	1	*0.1793*	0.8810	*0.4576*	*0.0021*	0.5948
FS ≥ 18	0.3217	0.1793	1	0.2175	0.4349	*0.0048*	0.0078
M < 18	*0.6987*	*0.8810*	*0.2175*	1	*0.5533*	*0.0024*	0.4749
M ≥ 18	0.8452	0.4576	*0.4349*	0.5533	1	*0.0053*	0.1112
MS ≥ 18	0.0078	0.0021	0.0048	0.0024	0.0053	1	0.0001
Sp	*0.1599*	*0.5948*	*0.0078*	*0.4749*	*0.1112*	*0.0001*	1

The most significant differences we find in the hip reaction time between the groups.

DISCUSSION

We found a significant difference in the reaction time between the members of the national taekwondo teams and the other groups namely those practicing taekwondo for recreational reasons and the sport students. Fontani et al. (2006) reported similar findings for karate players whose sport demands similar skills as taekwondo. Our findings make clear success in taekwondo is correlated with a distinctly shorter-than-average reaction time. The higher significance between the participants' hip reaction time and those of the other body segments seems to indicate its specific importance. There are two strong arguments for this. First, taekwondo players recognize an opponent's reaction from his or her movement of the upper body (shoulders and chest). A hip movement is harder to detect. By holding back the upper body movement as long as possible gives an additional timing advantage. Second, an attack in taekwondo is most probable a kick not a punch. So, the hip move must be initiated first. The advantage of moving mainly the hip and not the complete trunk results in a substantially reduced movement of the center of gravity. This saves energy, and because just a part of the body mass has to be accelerated these masses can move faster.

CONCLUSION

Fast reactions are essential for success in taekwondo competitions. During an attack it is advisable to move as little mass as possible to accelerate those segments involved in the movement as quick and as effective as possible. Therefore, the movement should be initiated by the hip. We showed the importance of a short reaction time but how much of it is predisposition and how much can be archived by training? To answer this question we propose a long-time study on beginning taekwondo students to see how they develop during their career. If preposition is an important factor in fast reactions, measuring it at an early stage of an athlete's career could even be used for evaluating their potential.

References

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