DOI 10.2478/afepuc-2022-0007
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2022, 62(1): 72-82

INTRAINDIVIDUAL EVALUATION OF REACTION TIME AT THE MEN'S WORLD ATHLETICS CHAMPIONSHIPS 1999 - 2019

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Summary: The aim of the article was the intraindividual evaluation of reaction time at the Men's World Athletics Championships from 1999 to 2019. We generated the rating of sprinters from the age point of view with comparison of two periods with different false start rules. In the result section, we analysed the sprinters that took part at WCH at least 3 times and appeared in the final. We assessed the reaction speed from the aging point of view, or more different false start judging conditions. The results shows that the stricter start judging rules in sprint disciplines did not have a significant influence on the reaction time. We also confirmed a research that the sprinters over 30 years old sprinters can achieve very low reaction time at the start. Reaction abilities can be improved by regular and systematic training, so it is necessary to pay attention to them in the training process and focus on their monitoring and subsequent improvement.

Key words: athletics, reaction time, world championship, sprinters

Introduction

By many experts the athletics is by considered as a queen of all sports. It has been very popular, not only between professional athletes but also among the general public. We focused in the article on the most popular athletic disciplines, the short distance sprints. The matter is an analysis of reaction times, which is a significant part of it (Mitašík & al. 2020/a, Mitašík & al. 2020/b,). There is a simple reaction to an acoustic stimulus when speaking about short distance sprint start. In these modern ages performance top level sprinters are differentiated only by hundredths of seconds and often are decisive of winners. Reaction speed is measurable by technical equipment into number, which is known as reaction time. Gunfire is the starting stimulus in athletics which means the sprinters react to an acoustic stimulus. Every competitor

that commits a false start (besides combined disciplines), will be disqualified, under the authority of the rule since 1. January 2010. Before year 2010 (SAZ 2010).

The level of reaction time is influenced by number of factors, e.g. age (Fozard et al. 1994), gender (Jain, Bansal, Kumar and Singh 2015), warm-up (Magner et al. 2012), fatigue Brisswalter, Arcelin, Audiffren and Deligniéres (1997), training level (Jawoski, Lech, Ambrozy and Zak 2020), power of the start impulse (Germain, Smith, Maslovat and Carlsen 2020), running distance (Glesk 1986), psychological preparation (Kampmiller and Vanderka 2012), sprinters character (sport.cz).

Reaction time is shorter until 20th year of life, then gradually in slow pace prolongs to the 60 year of life. People over the age of 70 have the the longest reaction time, Jevas and Yan (2001) Luchies et al. (2002) Rose et al. (2002) Der and Deary (2006). The reaction time is influenced by psychological phenomenon as well, whereas older people tend to be more careful and think more (Botwinic 1966). MacDonald at al. (2002) observed adults and seniors, finding out that the variety of reaction time is possible to connect with generally slower reaction times to a specific stimulus.

Because human body is not able to keep a constant level of performance throughout the day, this fact influences reaction time too. Štulrajter et al. (1989) focused their research on oscillation of reaction time during the day in accordance with biorhythm of the human body. The reaction time values measured over 24 hours proved to be significantly oscillating. It shows that the shortest reaction time is in the morning before nine o'clock and in the evening after 18 o'clock.

In their research, Tønnessen and Haugen (2013) analyzed the reaction time of elite sprinters (n = 1319) who took part in the World Championships during years 2003-2009 showed that women over 30 years of age achieved the fastest reaction time compared to women under 30 years (0.153 ± 0.020s).

Methods

We carried out the research on a group of selected elite sprinters in the 100 m run, which took part in several finals at the World Championships in Athletics in the years 1999 – 2019. In the first period (1999 – 2009) we watched the runners in the heats, the quarterfinals, the semifinals and in the final runs. In the second period (2011 – 2019) quarter-final runs were excluded from the program. We obtained the figures of the starting time of sprinters from the mentioned periods from the official website of the IAAF (WA). We presented the results of

selected athletes in figure and tables. In the final part, we analyzed the competitors who participated in the World Championships at least three times and reached the finals. We assessed their reaction rate in terms of increasing age, respectively, different conditions of assesing a false start. We evaluated the reaction speed according to Gaval' (2002), who set aside five levels: excellent (100 – 130 ms), very good (131 – 160 ms), average (161 – 185 ms), below average (186 – 210 ms) and unsatisfactory (211 and more ms).

Results

Selected competitors reached a reaction speed at an excellent, regardless of their age, respectively, the period in which they ran in the finals (Table 1). In some cases (Justina Gatlin, Tyson Gay) they had the fastest reaction at their older age. This finding is confirmed by Tønnessen and Haugen (2013) that the reaction speed can be maintained and developed at an older age. In the table 1 below we see large intra-individual rates of reaction times of monitored sprinters not only in individual monitored years, but also in their entire compared period. Importantly the very low reaction times in the finals gave advantage to the athletes and higher possibility to win the medals (Justin Gatlin 0.138 and 1st place; Tyson Gay 0.143 and 1st place; Justin Gatlin 0.138 and 1st place).

Table 1

Reaction speed of selected athletes, multiple finalists in the 100 m run at the World Athletics Championships

Year	Name	Reaction time				Time in final [s]	Placenent (finals)	Age (years)
		Heats [s]	Quaterfinals [s]	Semifinals [s]	Finals [s]			
2001	**Kim COLLINS**	**0.162**	**0.174**	**0.141**	**0.162**	**10.07**	**5.**	**25**
2003	**Kim COLLINS**	**0.167**	**0.160**	**0.227**	**0.148**	**10.07**	**1.**	**27**
2005	**Kim COLLINS**	**0.148**	**0.142**	**0.146**	**0.146**	**10.05**	**3.**	**29**
2011	**Kim COLLINS**	**0.158**		**0.161**	**0.155**	**10.09**	**3.**	**35**
2005	Justin GATLIN	0.140	0.164	0.141	0.157	9.88	1.	23
2013	Justin GATLIN	0.168		0.157	0.163	9.85	2.	31
2015	Justin GATLIN	0.149		0.153	0.165	9.80	2.	33
2017	Justin GATLIN	0.149		0.152	0.138	9.92	1.	35
2019	Justin GATLIN	0.176		0.198	0.148	9.89	2.	37
2007	**Tyson GAY**	**0.172**	**0.203**	**0.170**	**0.143**	**9.85**	**1.**	**25**
2009	**Tyson GAY**	**0.194**	**0.155**	**0.143**	**0.144**	**9.71**	**1.**	**27**
2015	**Tyson GAY**	**0.137**		**0.117**	**0.128**	**10.00**	**6.**	**33**
2009	**Usain BOLT**	0.144	0.155	0.135	0.146	9.58	1.	23
2011	**Usain BOLT**	0.153		0.164	0.000	0.000	8.	25
2013	**Usain BOLT**	0.155		0.173	0.163	9.77	1.	27
2015	**Usain BOLT**	0.152		0.148	0.159	9.79	1.	29
2017	**Usain BOLT**	0.166		0.166	0.183	9.95	3.	31

The reaction speed of selected finalists compared to the average rates of all finalists (Table 2) was often better. E.g. in 2011, Collins had a reaction rate of 0.155 s, the average time of the finalists was 0.166 s; in 2017 Gatlin had a reaction speed of 0.138 s, the average time of the finalists was 0.155 s.

The reaction speed of selected finalists was also often comparable to the average rates (in 2013 Gatlin reached 0.163 s, the average of the finalists was the same; in 2009 Gay and Bolt had a reaction speed of 0.144/0,146 s, the average time was 0.139 s; in 2003 Collins had a speed reaction 0.148 s, the average was 0.141 s, or worse (in 2001 Collins had a reaction rate of 0.162, the average of the finalists was at the level of 0.149 s; in 2015, Gatlin reacted at a speed of 0.165 s, but the average was 0.147 s).

Table 2

Average age and reaction speed of finalists in100 m sprint in 1st and 2nd observed period

Period	WCH	Average age (years)	Average reaction time (final) [s]
1.	1999	25.00	0.141
	2001	24.88	0.149
	2003	26.13	0.141
	2005	25.38	0.142
	2007	25.13	0.153
	2009	26.63	0.139
Average		25.53	0.144
Max.		26.63	0.153
Min.		24.88	0.139
Vr		1.75	0.014
2.	2011	24.75	0.166
	2013	25.88	0.163
	2015	27.75	0.147
	2017	26.63	0.155
	2019	26.63	0.138
Average		26.33	0.154
Max.		27.75	0.166
Min.		24.75	0.138
Vr		3	0.028

The results confirm (Table 2) that the stricter assessment of starts in sprint disciplines did not have effect on the reaction speed. In the second period, the runners had almost the same average reaction time (+0.012 s) and big difference were also in the slowest (+0,013 s) and small difference in the fastest reaction (-0.001 s).

However, the mentioned differences in the balance of the top sprinters often mean the difference of one, resp. two places in the overall standings. E.g. MS 2001: 3. Boldon 9.98 s (reaction rate 0.148), 4. Chambers 9.99 s (0.160); MS 2003: 2. Brown 10.08 s (0.152), 3. Campbell 10.08 s (0.112); MS 2005: 2. Frater 10.05 s (0.141), 3. Collins 10.05 s (0.146); MS 2011: 2. Dix 10.08 s (0.175), 3. Collins 10.09 s (0.155).

In the individual assessment of changes in reaction time, we analyzed the competitors who participated in the World Championships three or more times, always participating to the finals.

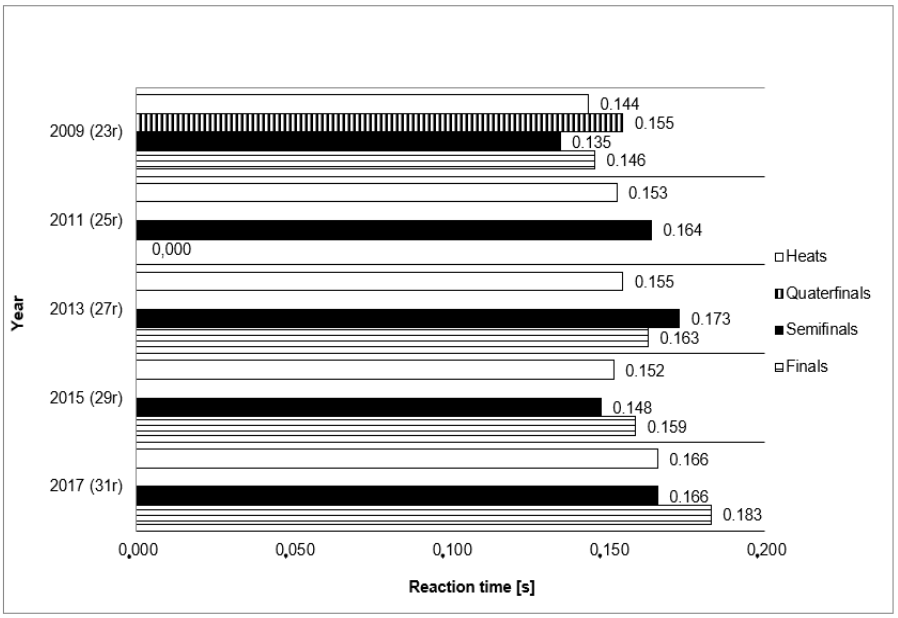


Figure 1

Intra-individual evaluation of the Usain Bolt reaction time at the World Championships in the 100 m run

The competitor achieved a reaction time of less than 0.2 s on all MS. His reactions ranged mostly from average to below average (according to Gaval 2002). After changing the rule, the runner reached the same reaction speed.

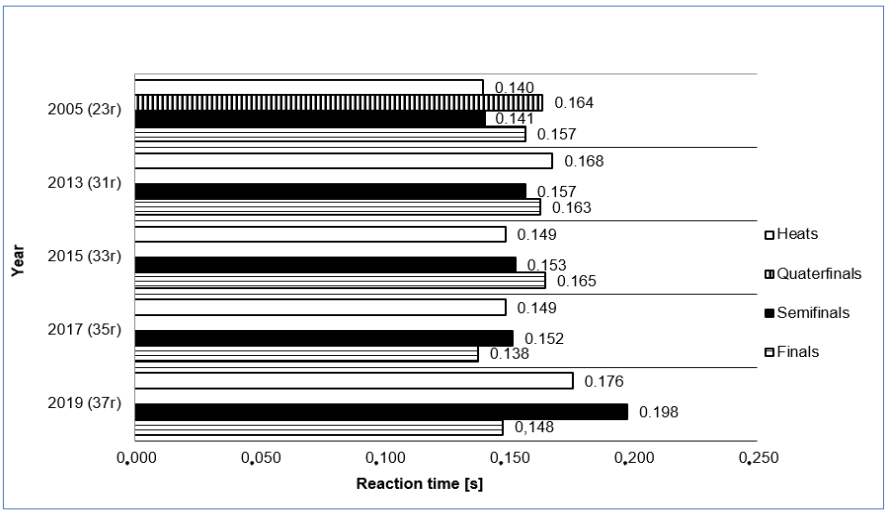


Figure 2

Intra-individual evaluation of the reaction time Justin Gatlin at the World Championships in the 100 m run

The reaction times of the competitors were stable at good level throughout the 12-year period. It approached very good level of reaction speed. Most of the times were very good and only two times were in the average category. The athlete competed in both periods. There is practically no difference in the speed of the reaction between the first and the second period.

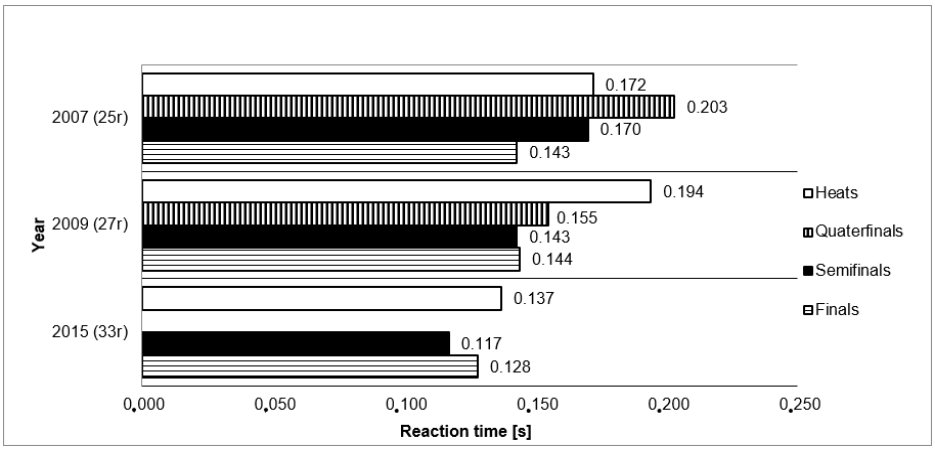


Figure 3

Intra-individual evaluation of the reaction time of Tyson Gay at the World Championships in the 100 m run

When analyzing the reaction time of this competitor, you can see the instability of the speed on the first two MS in first period, on which the reaction speed was close to excellent, resp. below average level. There is difference in the speed of the reaction between the first and the second period. His speed of reaction time in second period was excellent. In semifinal run (0.117 s) and in final run (0,128 s).

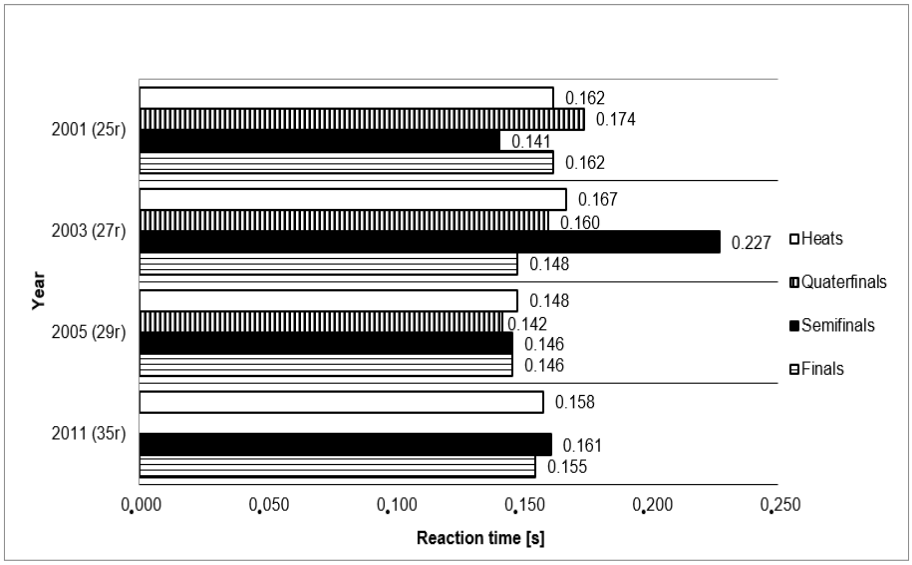


Figure 4

Intra-individual evaluation of the reaction time of Kim Collins at the World Championships in the 100 m run

The competitor achieved a reaction rate of less than 0.2 s on all MS, except for the semifinal in 2003. His reaction times ranged mostly from very good to average (according to Gaval 2002). After tightening the rule, the runner reached the same reaction time.

Table 3

The average age and reaction time of sprinters at the World Championships in the final of the 100 m run in individual years

	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019
Average age (years)	25.00	24.88	26.13	25.38	25.13	26.63	24.75	25.88	27.75	26.63	26.63
Average reaction time [s]	0.141	0.149	0.141	0.142	0.153	0.139	0.166	0.163	0.147	0.155	0.138

Table 3 shows the age of the competitors did not affect the reaction speed in the final runs. At an average age of about 25 years, we recorded an average reaction time of 0.141and 0.153 s, respectively, at about 27 years of age 0.147 and 0.138 s. The speed of the reaction, as we mentioned, is influenced by many factors, and even in older age it is possible to achieve an excellent level of reaction speed. The correlation between these two parameters is shown in Figure 7.

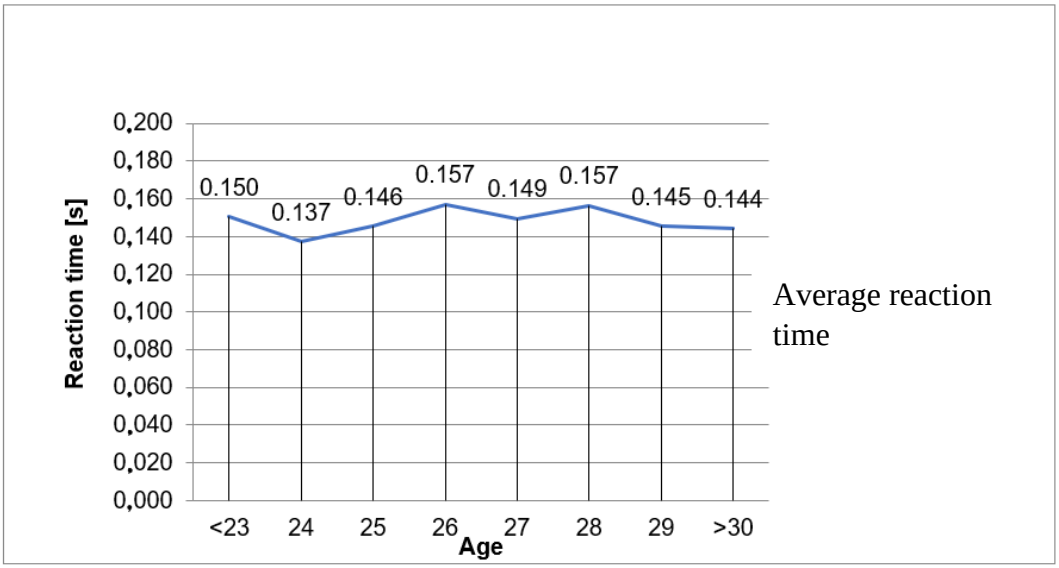


Figure 5

Development of the average reaction time of men´s in the 100 m run at the World Championships in the final runs in correlation with age

Conclusion

1. By analyzing the starting reaction time of the top runners at 100 m at the World Championships in Athletics, we found that two different rules for judging a failed start did not have a good effect on prolonging the reaction speed even after tightening the rule.
2. Despite the conclusions of some authors about the slowing down of the reaction rate with increasing age, some competitors refuted them and achieved the best reaction times over the age of 30. They confirmed that training can not only maintain but also improve this indicator.
3. Although we analyzed the top competitors, only a few of them achieved an excellent level of reaction speed (100 – 130 ms) according to the Gavaľa scale (2002).
4. In addition to the above, the reaction speed is influenced by other important factors - the time zone in which the competitor moved to the race; the weather; quality of opponents.

In study Pavlovic (2021) based on the obtained results, a positive but low correlation was recorded between the mean values of the 100 m sprint results and the reaction time in men ($r = 0.230$ $p < 0.044$), which was also confirmed by regression analysis. In other correlations and values of regression coefficients, no significant numerical values of the influence of reaction time on the result success were recorded in both categories of finalists.

Study of Brosnan et al. (2016) analysed all available World and European Championship reaction time data from 1999 to 2014 to examine effects of rule changes on

competition reaction time at major championships. The exponentially modified Gaussian distribution was used to model reaction time and make comparisons relative to athletes' sex, ruling periods and competition rounds. Revised reaction time thresholds of 115 ms and 119 ms were identified for men and women, respectively, indicating that the current 100 ms rule could result in some false starts not being detected in competitive athletics. The study proposes that when using existing International Association of Athletics Federations approved systems, the false start detection threshold should be increased and that men and women athletes should have different thresholds because of substantial evidence of a sex-based difference in RT in elite-standard athletes.

The results of Ntolaptsis (2021) showed that reaction time was significantly different ($p < 05$) before and after the change of the rules at 2009. A weak, but significant, positive correlation ($r = .228$, $p = .016$) between reaction time and time of 60 m hurdles was observed. Results revealed that reaction time is a factor that affects time of 60 m hurdles. In conclusion, the essential focus on the reaction time at the starting blocks must be given during the training process.

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