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Original Article

Differences in reaction time and agility of 11-14-year-old schoolboys

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Abstract:
Many studies investigating reaction abilities and agility performance were documented. Only a few of them have been dealt with children without sports participation. Therefore, the purpose of this study was to investigate reaction time (simple and choice) and agility time (reaction plus movement time) in 11 to 14 years old schoolboys. These boys were divided into 4 age groups with a one-year difference and performed reaction time tests and agility test. The results showed significant differences in simple reaction time between the age groups 11 and 13 years old ($p = 0.038$; $d = 0.9$), 12 and 14 years old ($p = 0.008$; $d = 10.96$) and 11 and 14 years old schoolboys ($p < 0.001$; $d = 1.37$). Significant differences in choice reaction time were observed between the same groups as in simple reaction time. More specifically, between groups with two-year difference (11 and 13 years: $p = 0.019$; $d = 1.02$; 12 and 14 years: $p = 0.027$; $d = 0.82$) and three-year difference (11 and 14 years: $p < 0.001$; $d = 1.51$). In agility test, significant differences were found between the age groups 11 and 13 years old ($p < 0.001$; $d = 1.61$), 12 and 14 years old ($p = 0.026$; $d = 0.95$), 11 and 14 years old ($p < 0.001$; $d = 2.15$) and also between groups 11 and 12 years old schoolboys ($p = 0.003$; $d = 1.01$). These findings indicate that it is desirable to merge age groups with one-year difference in diagnostics of reaction abilities. However, the differences between groups are more distinct in agility test including also a motor component. It seems that the age between 11 and 12 years is an important period in the development of movement speed or also decision-making in more difficult tasks.
Key words: children; primary school; reaction test; agility test

Introduction

Physical activity of the students these days is significantly different than it was in the past. It is alarming that physical activities as hobbies are dominant only in 10 % of the children even though they have positive relationship to sport (Melek & Antala, 2011).

Reaction is a complex act where speed of a nerve impulse is demonstrated along with intensive physical work (perception and decision-making). That is the reason why it was characterized also as a mental ability (Dovalil, 2002). Reaction abilities to the certain point depends on genotypes preconditions. It is possible to increase them by 10 to 25 % (Choutka, 1981). They are monitored above all in groups of sportsmen of the different performance levels and they are essential part of increasing of the sport mastery. It is not only ability to start quickly but also realise short term physical activity of a maximal intensity on external stimulus. It can be visual, auditory or touch stimulus. The fastest reaction follows the touch stimulus, the auditory stimulus and finally the visual stimulus. A good result of reaction to the visual stimulus is considered 200 – 300 ms (Jain et al., 2015; Měkota & Novosad, 2005; Ng & Chan, 2012; Shelton & Kumar, 2010). The indicators of reaction abilities are simple and choice reaction time. According to Havlíčková et al. (1999) the simple reaction time is a result of stereotypical reaction on a certain impulse which is significantly shorter than the choice reaction time. Choice reaction time includes decision-making and represented a response to multiple stimuli or to only one stimulus which is adequate among several options. But there also exists an ability consists of sensory and decision-making which is actually the same as choice reaction time but it is enriched by a motor component. The result is thus agility time (Zemková, 2011). This agility skills were studied mostly by Zemková & Hamar (2001).

Problems of reaction abilities or agility performance is well investigated in adults (Al Awamleh et al., 2013; Der & Deary, 2006; Horníková et al., 2018; Luchies et al., 2002; Škopek & Laun, 2018; Woods et al., 2015) and in children who participate in sport (Fiorilli et al., 2017; Horička et al., 2018; Mohammad & Tareq, 2016; Obetko et al., 2019). Researches in field of these abilities in children who don´t participate in sport were published in a lesser extent (Bucsuházy & Semela, 2017; Fozard et al., 1994; Kiselev, 2009; Moradi & Esmaelizadeh, 2015). One of the possible reasons can be the fact, that children under 10 years of age have

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unexpecting (excessive) reactions which are gradually becoming steady at the age of 14-15 (Stejskal, 1998). Authors Zemková & Hamar (2001) provided information about orientational age norms of children population in agility time in age categories 7 to 15 years. In mutual category 11 to 12 years old they stated a value 604.9 ± 97.7 ms, in 13 to 14 years old it is 467.5 ± 77.6 ms, and in 14 to 15 years old 453.3 ± 38.6 ms. They founded a significant decreasing of agility time between the age groups 11 and 12 years and 13 and 14 years. However, there were no significant differences between the age groups 13 and 14 years and 14 and 15 years.

To best of our knowledge, similar longitudinal studies were not found about orientational age norms in simple and choice reaction time of children in available literature. Therefore, the aim of this study was to evaluate and differentiate a level of reaction abilities and agility performance in 11 to 14 years old schoolboys.

Material & Methods

Participants

The research was realized on schoolboys of primary schools in Bratislava (ISCED). Specifically, there were 11 to 14 years old schoolboys with no sports activity. First of all, we collected 188 questionnaires. From the questionnaires, we found out that more than a half (100 boys) doesn´t do any organised sports activity. We divided them into 4 age groups: 11 years old (n = 20; 10.98 ± 0.27 years; 147.04 ± 6.47 cm; 41.44 ± 6.79 kg), 12 years old (n = 27; 12.04 ± 0.30 years; 156.25 ± 7.32 cm; 49.29 ± 12.59 kg), 13 years old (n = 26; 13.03 ± 0.27 years; 166.17 ± 7.47 cm; 56.86 ± 13.6 kg) and 14 years old (n = 27; 14.02 ± 0.29 years; 170.11 ± 7.91; 60.23 ± 18.40 kg). Testing was realized in the first half-year (from September to January) in the beginning of the Physical Education lessons in cooperation with teachers. Only students that were confirmed by questionnaires to be non-sporting were tested. All participants realized a 5-minutes warm-up. Then they were tested in simple reaction time test and choice reaction time test. Another day, during the next lesson they were performed an agility test. During the testing there were created standard conditions to avoid the disturbing elements. The parents were informed about the protocol and signed the consent form prior to their child's participation in the study.

Procedure

1.) Measurement of simple and choice reaction time – the subject may respond to either one (simple reaction time) or two stimuli (choice reaction time) appearing on PC screen using FiTRO Reaction check (FiTRONIC, SK). The stimulus was a blue circle on white background. In both tests, the result was an average simple or choice reaction time of 20 stimuli in better of two repetitions.

2.) Measurement of agility time – this test addresses both physical (motor) component and cognitive components as anticipation and pattern recognition. It was used a diagnostic system FiTRO Agility check (FiTRONIC, SK). The subjects were instructed to use either the left or right lower limb to make contact with one of four mats located in four corners outside of a 50 cm square. They were encouraged to perform this test as quickly as possible and to touch the mats in accordance with the location of the stimulus in one of the corners of the PC screen. Similar as in reaction time tests, the result was an average agility time of 20 stimuli in better of two repetitions.

Statistical analysis

The collected data was processed statistically using SPSS statistical program for Windows (Version 20.0; SPSS, Inc., Chicago, IL, USA). The Shapiro-Wilk and Levene´s test for homogeneity of variances were performed on all variables and revealed that data was normally distributed and detected no significant differences in sample variances. The one-way analysis of variance (ANOVA) and Scheffe´s post hoc test was conducted to determine the significant differences in simple, choice reaction time and agility time between groups of different ages. Cohen´s *d* was used to evaluate an effect size between these groups. The t-test for independent samples was used to determine significant differences in height, body mass and BMI between these groups. The criterion level for significance was set at $p \leq 0.05$.

Results

There were found the significant differences ($p < 0.001$) in height among all age groups except for 13 and 14 years old. The significant differences in body mass were observed between 11 and 12 years old, 12 and 13 years old, 12 and 14 years old ($p < 0.05$), 11 and 13 years old ($p < 0.001$). However, body mass did not significantly differ between 13 and 14 years old schoolboys. The BMI values did not differ significantly between any age groups.

One-way ANOVA revealed significant differences in simple reaction time among age groups ($F_{(3,96)} = 8.325$; $p < .001$). Scheffé´s post hoc test showed the significant difference in simple reaction time between 11 and 13-years old, 11 and 14-years old and 12 and 14 years old schoolboys (Table 1). High effect size was observed between these age groups. The differences between others age groups wasn´t significant, but with medium (13 and 14-years old) or small (11 and 12-years old; 12 and 13-years old) effect sizes.

Table 1 Simple reaction time (mean ± SD) and inter-difference matrix between simple reaction times in examined groups of different ages

*p < .05; **p < .01

The similar results were observed also in choice reaction time. There were found significant differences among

Age (years)	Simple reaction time [ms]	11	12	13	14
11	480.80 ± 55.85	-			
12	390.41 ± 54.75	0.606	-		
13	368.47 ± 30.59	0.038*	0.73	-	
14	346.25 ± 35.53	< 0.001**	0.008**	0.379	-

age groups ($F_{(3,96)} = 8.947$; $p < .001$). More specifically, the choice reaction time differ significantly between the same age groups as simple reaction time (Table 2). However, medium effect size was found not only between 13 and 14 years old, but also between 11 and 12-years old schoolboys.

Table 2 Choice reaction time (mean ± SD) and inter-difference matrix between choice reaction times in examined groups of different ages

*p < .05; **p < .01

To the third, agility time differ significantly among age groups of schoolboys ($F_{(3,96)} = 17.288$; $p < .001$). The difference was already found between the two youngest groups. Agility time in 11-years old schoolboys was

Age (years)	Choice reaction time [ms]	11	12	13	14
11	486.37 ± 56.99	-			
12	451.25 ± 60.99	0.196	-		
13	434.22 ± 44.42	0.019*	0.73	-	
14	405.37 ± 49.99	< 0.001**	0.027*	0.299	-

significantly higher compared to all older age groups. It was supported by the high effect sizes. Furthermore, agility time in 12-years old schoolboys was significantly higher than in 14-years old schoolboys (Table 3). Only medium effect size was observed between 12 and 13-years old schoolboys and no effect size between the two oldest groups.

Table 3 Agility time (mean ± SD) and inter-difference matrix between agility times in examined groups of different ages

Age (years)	Agility time [ms]	11	12	13	14
11	993.68 ± 114.08	-			
12	880.96 ± 109.33	0.003**	-		
13	819.77 ± 102.24	< 0.001**	0.182	-	
14	796.34 ± 62.37	< 0.001**	0.026*	0.866	-

*p < .05; **p < .01

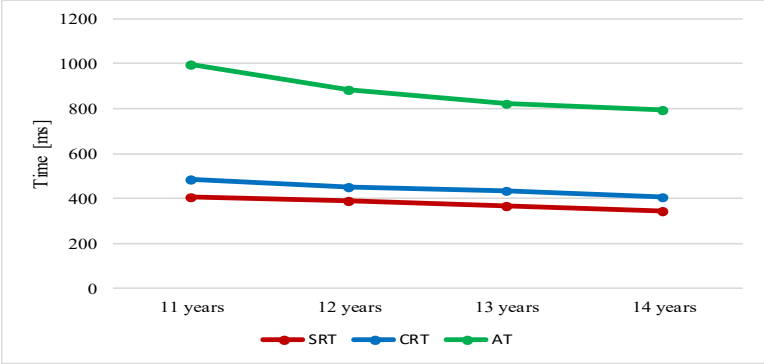

Fig. 1 Simple (SRT), choice reaction time (CRT) and agility time (AT) in 11-14 years old schoolboys

Discussion

There are some differences in reaction time as well as in agility time among schoolboys in the age of 11 to 14. In simple reaction time as well as in choice reaction time there were recorded significant differences only between the groups with the age difference of two or three years. It has to be mentioned that both reaction times decrease every year. The only one difference between simple and choice reaction time was the medium effect size in choice reaction time between two youngest groups as compared to small effect size in simple reaction time. It seems that the quality of decision-making slightly increases already at the age of 12. On the other side, it is recommended to divide an age period from 10 to 12 and 12 to 14 years because of physiological patterns (Votík & Zalabák, 2011). This may be ascribed the nonsignificant differences between 11 and 12 years old or 13 and 14 years old schoolboys. Many studies investigated these abilities, but only in boys up to 10 years of age

(Feč, 2010a; Feč, 2010b) or adults over 18 (Der & Deary, 2006; Luchies et al., 2002). To best of our knowledge, it wasn´t found the similar study dealing with development of reaction abilities in this age period. It is known that the age from 7 to 12 or 13 is considered as a sensitive period for developing of these abilities (Belej, 2001). Therefore, it can be stated that older groups (13 to 14 years of age) already went through this period and that is why the level of their reaction abilities can be higher, mainly in comparison with 11 years old schoolboys. The impact of anthropometric indicators is not expected because they have relatively low influence on these abilities (Kampmiller, 1996).

A slightly different results were recorded in agility performance. Significant differences were observed as early as between two youngest groups of schoolboys, which was already indicated by medium effect size in choice reaction time as mentioned before. In comparison of these two groups of schoolboys it was found that their difference in agility time was 11.3 %. Nevertheless, it cannot be attributed to the improvement of their motor component, because agility test had higher demands also on decision-making as compared to two-choice reaction time test. However, this significant difference between 11 and 12 years of age does not correspond with the study of Zemková & Hamar (2015) who did not find the significant difference between these groups. Nevertheless, they stated that agility time decreases until the early middle-age. This decreasing of agility time is divided into 3 phases. In the first one (7 to 10 years of age) there is 27.1 % decrease in agility time. In the second group (10 to 14 years old) the decrease is 26.5 % and in the third one (14 to 18 years of age) there is 16.5 % decrease. The other results are in correspondence with this study because significant differences were found only between the groups with the age difference at least 2 years. On the other side, another study showed that the agility time was significantly different between 13 and 14 but not between 12 and 13 years old football players (Horička et al., 2018). Taking these findings into account, it seems that divided of children into groups 11-12 and 13-14 years is more useful. It is supported by Zemková & Hamar (2001), who found significant differences in agility time between such divided groups of children. In general, it can be stated that similar as the simple and choice reaction time also agility time decreases every year in this age period. One of the possible reasons is that speed of the movement increases until the age of 14 or 15 then occurs a stagnation (Votík & Zalabák, 2011). However, it should be mentioned that it does not have to be attributed to increasing of the speed of movement but also to improving of decision-making. Therefore, there is a need for another study to determinate which component of agility performance improving more.

Conclusions

This study showed that simple and choice reaction time is decreasing with age in 11 to 14 years old schoolboys. The significant differences were observed only in the groups where the age difference was at least 2 years. However, agility time differed significantly also between groups of 11 and 12 years old. It seems that this age period is critical in terms of speed of the movement or improvement of decision-making in more difficult tasks. In the other groups, the significant differences in agility time were documented only between groups with at least 2-years difference. Based on these findings, it is recommended to divide children during the testing of reaction abilities into groups 11 to 12 and 13 to 14 years. It is due to the fact, that it cannot be expected significant changes in those abilities in such a short period of life. On the other side, testing of agility performance seems to be more sensitive and can better distinguish the differences in children with one-year difference.

Conflicts of interest – The authors declare that there is no conflict of interest.

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