

Construction and Validation of Newly Developed Triangle Test of Reactive Agility in School Children

Vladimir Pavlinović, Željko Cota, Ante Mandić, Jakov Škomrlj, Nikola Foretić,

Faculty of Kinesiology, University of Split, Split, Croatia

ABSTRACT

PURPOSE: Agility is described as a rapid whole-body movement with change of velocity or direction in response to the different stimuli. Scientific research identified two independent types of agility performances: pre-planned agility (CODS) and non-planned agility (RAG). CODS represent generic movement patterns. They can mimic the demands of a sport but all of the movements are pre-planned. In CODS there is no response to a stimulus like in RAG where movements are in response to cues such as the movements of the ball or actions of the opposition players. Literature review show lack of studies that assessed CODS and RAG in children, most probably due insufficiency in quality testing protocols. Hence, the purpose of this study was construction and validation of newly developed agility test that measures RAG performances in children. **METHODS:** For this purpose, the Blaze Pod system (BP) was used. Three lighting pods were mounted on three 50 cm cones in triangle formation with 4,5 meters distance between cones (TRGA). Results were collected via BP app. Four movement patterns were used to test RAG. Start and finish of the tests were conducted with the tap on BP pods. The sample comprised of 80 elementary school children (boys; $n = 39$, age = 14.88 ± 0.36 yrs, height = $174,3 \pm 7,46$ cm, mass $67,86 \pm 16,78$ kg, and girls; $n = 41$, age = 14.85 ± 0.31 yrs, height = 167.49 ± 5.72 cm, mass = 59.34 ± 10.54 kg). Statistical analysis included calculation of normality of distribution, reliability coefficients, correlations and analysis of variance. **RESULTS:** Tests showed acceptable reliability with $CA = 0.58$, $ICC = 0.32$ for boys and $CA = 0.78$, $ICC = 0.55$ for girls. Inter-item correlations were higher in girls' sample ($r = 0.49-0.64$) than in boys ($r = 0.27-0.41$). Also, test showed good sensitivity, normal data distribution and good homogeneity with no differences between items (boys; $F = 0.07$, $p = 0.93$; girls; $F = 0.13$, $p = 0.88$). Better reliability of TRAG test for girls is most probably caused by gender morphological differences. Namely, we observed greater standard deviations (SD) of height (BH) and mass (BM) in boys (boys; $BH = 7.37$, $BM = 16.97$; girls; $BH = 5.68$, $BM = 9.7$) and scientific research confirmed negative influence of BM and BH on reactive agility performance. **CONCLUSION:** Altogether, newly constructed TRGA test seems to be reliable instrument for measuring reactive agility in pubescent boys and girls.

Keywords: non-planned agility, metric characteristics, pubescents, gender

INTRODUCTION

Agility can be described as ability to effectively change movement direction, accelerate and decelerate, without losing balance. According to Sheppard & Young (2006) agility is whole-body movement with change of velocity or direction in response to a stimulus (Sheppard & Young, 2006). It has been suggested that agility is a key condition for optimal performance in sports (Jeffreys, 2006). According to literature, two types of agility has been defined; change of direction speed or pre-planned agility (CODS) and reactive, non-planned agility (RAG). CODS have been described as preplanned movements with no decision making, while on the contrary, RAG appear in response to a stimulus, commonly from opponent's action. Both of these agility types occur in majority of sport activities. In more complex activities, such as team sport games, RAG is more important for successful performance (Young & Willey, 2010).

During everyday play, children find themselves in situations which require change of speed and direction in response to some external stimuli. In their sport games or unstructured games, they have to regulate speed and movement direction and to anticipate the actions of others to avoid bumping into each other. In order to do so they have to develop motor skills but also perceptual skills essential for agility (Serpell, Ford, & Young, 2010). In a similar way, tests to assess agility should be constructed in a way to provide similar stimulus as during a game or sport.

The majority of previous literature show lack of studies that assessed RAG and has more closely examined CODS in children and adolescents who participate in/train different sports. In the study of Eler & Eler (2018) authors concluded that set of agility exercises conducted for 10 weeks has positive effect on COD speed performance (Eler & Eler, 2018). Furthermore, in the study of Acar & Eler (2019) authors have investigated effects of 8-week balance exercises on the speed and agility in 10-12-year-old children in physical education lessons to have a positive effect on speed and CODS (Acar & Eler, 2019). Study made by Sekulic et al. (2014.) investigated the influence of balance, jumping power, reactive-strength, speed, and morphological variables on five different CODS performances in early pubescent boys (Sekulic, Spasic, & Esco, 2014). Authors have concluded that reactive strength was found to be the most important predictor of agility.

However, the lack of research of RAG in school children could be due to insufficiency in quality testing protocols. Furthermore, testing RAG for the mentioned population can be complicated, difficult and technologically demanding. The last one could be the reason why RAG testing started to appear in last few years. Also, most of the testing was done in sports clubs as a result of improving sport performance. As change of direction ability is considered primordial quality in many activities and important physical component related to youth health status (Sporis, Jukic, Milanovic, & Vucetic, 2010; Vicente-Rodríguez et al., 2011; Young, McDowell, & Scarlett, 2001). The purpose of this study was construction and validation of newly developed agility test that measures RAG performances in school children.

METHODS

The study included 7th and 8th grade children (n = 80; boys; n = 39, age = 14.88 ± 0.36 yrs, height = 174,3 ± 7,46 cm, mass 67,86 ± 16,78 kg, and girls; n = 41, age = 14.85 ± 0.31 yrs,

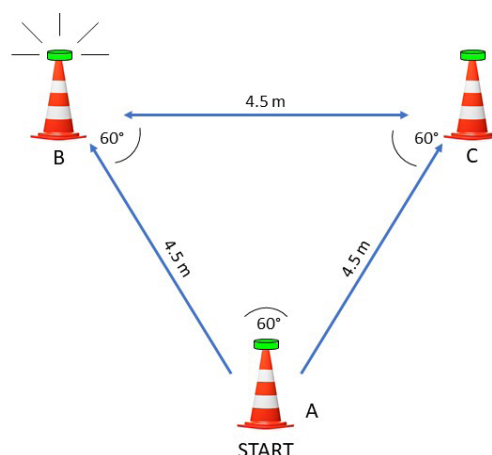
height = 167.49 ± 5.72 cm, mass = 59.34 ± 10.54 kg), all of them attending the same elementary school in Split, Croatia. Testing was performed during physical education classes. All participants were in a good health and none of them reported any current injuries specific to the ankle, knee or hip joints that might be expected to affect performance during the test. All parents of students gave their written informed consent before inclusion in the study. Informed consent was also obtained from the school principal.

Subjects performed newly constructed “Triangle” RAG test (T RAG) at the beginning of their physical education (PE) class. The test was performed in the school gymnasium on the wooden floor and all PE classes were held in the morning shift. Before testing, the participants had completed a 5 min warm-up which consisted of jogging, skipping, lateral running and light jumping. All students were familiarized with T RAG test procedure before data collection. Also, before T RAG test student made two running patterns of CODS test to additionally familiarize with Blaze Pod (BP) system which was used for the purpose of the study. Three lighting pods were mounted on three 50cm cones in triangle formation with 4,5-meter distance between cones which is convenient distance for lighting pods to be in their visual perception field without looking down. The height of the cones forces the participants to be in athletic position which is suitable for fast change of direction. The participants were instructed to begin the test standing next to the starting cone, with their preferred foot forward. The foot of the front leg was placed laterally in relation to the cone. To start the T RAG, students would tap the first lighting pod (A), run to the next lighted cone, touch the designated pod, which triggers the last one. The testing was arranged in groups of 4-5 participants, which allowed for appropriate rest period between the tests. The rest interval was not was not less than 20 s between trials. For the TRAG test, participants did not know the scenario and were tested by the same four templates; (first trial: A–C–B, second trial: A–B–A, third trial: A–C–A, fourth trial: A–B–C). Each participant conducted three random trials. Results were collected via BP application.

Statistical analysis included calculation of descriptive statistics, means and standard deviations for each “Triangle” attempts. The Kolmogorov – Smirnov (KS) test was used to check the normality of data distribution. Reliability of the newly developed test T RAG was calculated with correlation analysis, inter-item correlation and Crobmach’s alpha coefficients.

For all the analyses, Statistica 14.0 (TIBCO Software Inc., Palo Alto, CA, USA) was used.

Figure 1. T RAG test



RESULTS

Results of descriptive statistics are shown in table. From KS test results can be noticed that all variables have normal data distribution. As so, they are suitable for parametric statistical calculations. Results of distributions' skewness and kurtosis refers on good test sensitivity since all its results fits in normal range except third item in male subjects (skew = 1.14; kurt = 3.34).

Table 1. Descriptive statistics

Variables	Mean	Min	Max	SD	Skew	Kurt	KS	p
T RAG 1 M	3.68	2.77	5.09	0.58	0.57	0.00	0.11	p > .20
T RAG 2 M	3.63	2.10	5.47	0.68	0.56	0.94	0.12	p > .20
T RAG 3 M	3.67	2.10	6.15	0.72	1.14	3.34	0.13	p > .20
T RAG 1 F	3.87	2.92	5.32	0.58	0.56	-0.09	0.11	p > .20
T RAG 2 F	3.88	2.77	6.20	0.62	1.01	3.69	0.10	p > .20
T RAG 3 F	3.86	3.22	5.05	0.43	0.63	0.28	0.09	p > .20

Legend: T RAG - "Triangle" RAG test, M – male student, F – female student, 1 – first attempt, 2 – second attempt, 3 – third attempt, **Mean** – arithmetic mean, **Min** – minimum, **Max** - maximum, **SD** – standard deviation, **Skew**–skewness, **Kurt** - kurtosis, **KS** – Kolmogorov-Smirnov test

Table 2. shows correlations between the items of measurement of newly constructed test for reactive agility in school children (T RAG). Significant correlations were found between all items of measurements in both samples. In male sample they ranged from 0.27 to 0.41, and in female sample from 0.49 to 0.64. Obviously, higher correlations are between items in female sample.

Table 2. Correlations between the items of newly constructed test

Variables	T RAG 1 M	T RAG 2 M	T RAG 3 M	Variables	T RAG 1 F	T RAG 2 F	T RAG 3 F
T RAG 1 M	1.00			T RAG 1 F	1.00		
T RAG 2 M	0.41 *	1.00		T RAG 2 F	0.64 *	1.00	
T RAG 3 M	0.27 *	0.29 *	1.00	T RAG 3 F	0.49 *	0.53 *	1.00

Legend: T RAG - "Triangle" RAG test, M – male student, F – female student, 1 – first attempt, 2 – second attempt, 3 – third attempt, * – significant correlation

Reliability coefficients (inter-item correlation and Crobmach's alpha) and results of analysis of variance between items of measurements are shown in table 3. Inter-item correlation coefficients (0.32-0.55) and Crobmach's alpha coefficients (0.58–0.78) show average to good reliability of newly constructed test for male and female respectively. When connected with results of correlations shown in table 2, and respecting sample size and specificity we may state that new test T RAG has good reliability and that has the ability of the scorer to produce the same result each time for the same T RAG test performance. Similarly, results of analysis of variance between items of measurements indicate that there are no significant differences between them in both samples. This means that results in different items don't depend on systemic errors. Generally, that test has good homogeneity and can be used as valid diagnostical tool for assessing reactive agility.

Table 3. Inter-item correlation, Crombach's alpha and analysis of variance

VARIJABLE	II r	Crombach's alpha (α)	F	p
T RAG M	0.32	0.58	0.07	0.93
T RAG F	0.55	0.78	0.13	0.88

Legend: T RAG M – Male “Triangle” RAG test, T RAG F – Female “Triangle” RAG test, II r – inter item reliability coefficient

DISCUSSION

Results of the study indicate three important findings: (i) newly designed reactive agility tests has good sensitivity, (ii) newly designed reactive agility tests has average reliability, and (iii) newly designed reactive agility tests has good homogeneity.

Sensitivity

A sensitive protocol is one that is able to detect small, but important, changes in performance (Paul & Nassis, 2015). In our study, we observed consistent changes in performance between subjects in different items of measurement and therefore concluded that test has good sensitivity. Anyhow, bigger data dispersion was noticed in T RAG 3 M sample and in T RAG 2 F. Cause for this could be searched in previous test that was used as familiarization protocol in which students had determined movement mode and which has been conducted as non-reactive test (T CODS). Most probably, because of its' similarity, this test confused some of the students and they were focused on “wrong” cone, late noticed mistake and consequently performed weaker in this item of measurement. Also, T RAG 2 F sample was conducted in the left side. We can assume that for majority of female students this was “weak side” and they reacted/performed slower than in other items of measurement. “Weak side” slower performance in agility tests was reported before in football, futsal, basketball and handball players, and we assume that this phenomena was present in our study also (Krolo et al., 2020; Pokrajčić, Marić, Foretić, & Uljević, 2021; Sekulic et al., 2019; Sekulic et al., 2017).

Reliability

The reliability of a test is an elementary prerequisite of the test's applicability because it directly indicates the error of measurement (Uljevic, Esco, & Sekulic, 2014). Significant correlation between the three T RAG movement patterns (II r) indicate good reliability of the T RAG test. Also, good value of Cronbach-alpha coefficients (α) for T RAG F and average value for T RAG M shows satisfactory reliability and reduced error of measurement. Reliability of newly constructed T RAG test is similar to reactive agility test in other studies (Krolo et al., 2020; Pojskic et al., 2018). But, like in before mentioned studies, T RAG test has lower reliability than it was reported in studies dealing with CODS tests (Dugdale, Sanders, & Hunter, 2020; Krolo et al., 2020; Serpell et al., 2010). Reactive agility tests are more complex and dependable on different physical features of the athletes (Sheppard & Young, 2006). Most of the time they demand sophisticated measurement tools, are consisted of short and fast movements that appear after cognitive and motor reaction/activity of the athlete. Unlike during CODS testing, every small mistake in test performance by

athlete (e.g. inadequate sport shoes, slippery surface, etc.) or assessment by measurer (fuzzy test instruction, lousy control of measurement equipment, etc.) can significantly influence final result in performance. When having in mind that subjects in our study were elementary school students with very low exposure to agility stimuli lower reliability than in CODS testing protocols is not unexpected.

Homogeneity

Homogeneity is feature of test which shows how results in all items of measurement are dependable on the same subject of measurement. T RAG test show good homogeneity since there wasn't noticed significant difference between items of measurements. Obviously, no systemic error, such as "learning effect" or subjects' fatigue, appeared during test performance. Hence, we conclude that T RAG test has good homogeneity and is valuable protocol for diagnosing reactive agility.

CONCLUSION

The purpose of this study was construction and validation of newly developed agility test that measures RAG performances in children. Tests showed acceptable reliability and therefore may be used as appropriate test in evaluation of RAG in pubescent boys and girls. Also, test showed good sensitivity, normal data distribution and good homogeneity with no differences between items. Better reliability of constructed T RAG test for girls is most probably caused by gender morphological differences. Namely, we observed greater standard deviations of height and mass in boys and scientific research confirmed negative influence of BM and BH on reactive agility performance. In future research, it might be important to separate children which are involved in agility saturated sports and familiar with running technique than kids who are not, which could be considered as possible limitation of this study.

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Corresponding Author:

Vladimir Pavlinović

vladimirpavlinovic@gmail.com

00385 98 181 48 48