'The' pathway towards the elite level in Dutch basketball

te Wierike, Sanne Cornelia Maria

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Chapter 4

Reproducibility and validity of the STARtest; a test to monitor the change-of-direction speed and ball control of youth basketball players

SCM te Wierike, EJY Tromp, LA Meerhoff,
MJ Coelho-e-Silva, MT Elferink-Gemser & C Visscher

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Abstract

The current study investigated the reproducibility and validity of the STARtest. This test measures change-of-direction speed (performing the test without ball) and ball control (performing the test with ball). Youth basketball players (male and female; N=52; 16.25 ± 1.48 years) performed the STARtest without ball and with ball twice (both conditions once during test and once during retest), with two-four weeks between test and retest. No significant differences between test and retest were found ($p > 0.05$). The STARtest was found highly reliable (intraclass correlation coefficient [ICC] (95% confidence interval) change-of-direction speed = 0.78 (0.64-0.87) and ball control = 0.80 (0.68-0.88)). There was sufficient agreement between test and retest for change-of-direction speed and ball control (standard error of measurement [SEM] 0.33 s and 0.41 s, smallest detectable difference [SDD] 0.92 s and 1.13 s, and coefficient of variation [CV] 1.77% and 2.05%, respectively). Multivariate Analysis of Variance (MANOVA) showed that 18-19-year-old players were faster in change-of-direction speed in comparison to 14-15-year-old players ($p = 0.046$). Both 16-17-year-old ($p = 0.04$) and 18-19-year-old ($p = 0.03$) players had better ball control compared to 14-15-year-old players. The slalom sprint and dribble test was used as the criterion standard for measuring construct validity. Pearson's correlation between the slalom sprint test and STARtest measuring change-of-direction speed was 0.74 (very large), and between the slalom dribble test and STARtest measuring ball control 0.60 (large). In conclusion, the STARtest is a reproducible and valid test and it is recommended to coaches and trainers to use the STARtest for monitoring the individual change-of-direction speed and ball control of youth basketball players.

Keywords: reliability, performance monitor, talent identification, talent development, basketball-specific

Introduction

Basketball, like many other team sports, involves short, intense and repeated episodes of activity[1-3]. The game has an intermittent pattern with players changing their actions (e.g., sprinting, dribbling, jumping) every two or three seconds[4]. Sprinting and dribbling are not limited to forward and backward directions, since 30% of the movements occur in a lateral direction. Not surprisingly, change of direction with the whole body, i.e., change-of-direction speed, is an important aspect for basketball players[5]. Due to this complex nature of the game, physiological and technical characteristics are highly important for youth basketball players[6,7].

Researchers have consistently identified change-of-direction speed as one of the most important skills to determine the performance level of basketball players[4,8-10]. In addition, ball control is also a discriminative skill between elite and non-elite basketball players[10]. It is therefore important to gain more insight into these skills and to develop a test that is able to measure both change-of-direction speed as well as ball control.

Given the importance of using sport-specific tests[11], coaches and trainers should use a test that includes the aforementioned basketball-specific actions to measure the change-of-direction speed and ball control of youth basketball players. The STARtest is such a test and is developed by high qualified coaches and trainers of talented youth basketball players. The STARtest has been used in practice for more than a decade to assess and monitor the change-of-direction speed and ball control of youth basketball players in a longitudinal way. Acceleration, change of direction, and speed are combined in this test to make the test as basketball-specific as possible.

For talent identification and development purposes within sports, it is important to monitor the current performance level, as well as the development of youth athletes[12,13]. Athletes who are the best during their junior years will not necessarily remain the best athletes in adulthood, due to effects of training and maturation[e.g., 12,14]. Moreover, it is very hard to predict which athletes will ultimately attain the elite level of performance and which athletes will attain a sub- or non-elite level[15]. Recent research, for example, has shown that coaches and trainers of youth basketball players have some difficulties in predicting the future performance level of their players[16]. For these reasons, it might be helpful for coaches and trainers to use a reproducible and valid test that easily measures important performance characteristics of youth basketball players.

Therefore, the aim of this study was to investigate the reproducibility and validity of the STARtest, which is a test that is already being used in practice by high qualified coaches and trainers of youth basketball players. The reproducibility of a test indicates whether a test is able to give similar results in repeated measurements of the same persons. To examine the reproducibility of the STARtest, reliability and agreement parameters need to be assessed[17]. In addition, the STARtest can be considered valid when the test is able to discriminate between the performances of players of different age categories (discriminant validity), and when the test contains features that are typical for basketball (construct validity).

Methods

Participants

Participants were recruited from one of the national talent development programs for youth basketball players in the Netherlands. The sample was composed of 52 adolescent players (males: n=40, 16.38 ± 1.48 years; females: n=12, 15.83 ± 1.47 years) who had played competitive basketball for 5.95 ± 2.29 years, and were training 13.08 ± 3.83 hours per week. The age of players was defined as follows: a player aged 13.50-14.49 was considered as 14 years old, 14.50-15.49 as 15 years old and so on. For validity purposes, age was divided into three categories: 14-15 years, 16-17 years, and 18-19 years. The mean age of all participants was 16.25 ± 1.48 years (N=52). After being informed about the study procedures, the parents/guardians and the participants gave their written consent to participate. This study was approved by the local ethics committee.

Measurements

STARtest

The STARtest was designed by high qualified basketball coaches and trainers with the aim to develop a test that measures change-of-direction speed (performing the STARtest without ball) and ball control (performing the STARtest with ball) in a basketball-specific setting. The trajectory of the STARtest is shown in figure 4.1. The path was set out on one half of a regular sized basketball court (FIBA rules: length = 28 m; width = 15 m). The trajectory uses the lines of the 3-point area, with a radius of 6.25 m. The STARtest starts out with a flying start through line AB, after which the following types of sprinting (performing the test without ball) or dribbling (performing the test with ball) have to be performed:

- Forwards to point D
- Backwards to point E
- Lateral shuffling to point F
- Forwards to point C
- Forwards to point D
- Backwards to point G
- Lateral shuffling to point H
- Forwards to point C
- Forwards to point D
- Forwards to point AB

Time measurements started and stopped after passing line AB at the beginning and end of the test, and were performed by electronic timing gates (Eraton BV, Weert, The Netherlands). Outcome measure was the time in seconds that players needed to perform the STARtest without ball and with ball.

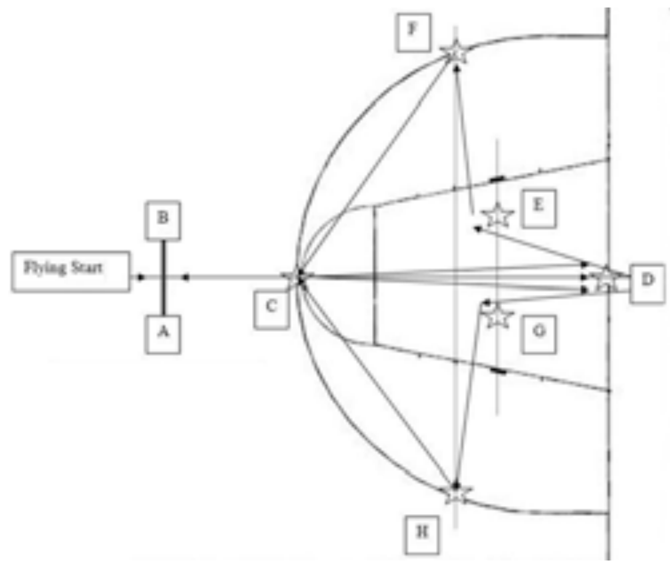

Figure 4.1: Course of the STARtest.

Slalom Sprint and Dribble Test

The slalom sprint and dribble test was used as the criterion standard for measuring construct validity, since this test also measures a form of change-of-direction speed (performing the test without ball) as well as ball control (performing the test with ball). The slalom sprint and dribble test is a field test in which players have to sprint or dribble forwards around twelve cones in a zigzag pattern, as shown in figure 4.2[18]. Time measurement started at point A, and ended when players finished at point B. Time was tracked by an observer using a stopwatch. Outcome measures consisted of the time players needed to perform the slalom test without ball (s) and with ball (s). Besides the indication of a good reliability (without ball: Intraclass Correlation Coefficient [ICC] = 0.91; with ball: ICC = 0.79) and validity (i.e., discriminative between level of performance) for hockey players and soccer players[18-21], the test can also discriminate between the dribble performances of different playing positions of young basketball players (guards < forwards < centers)[22].

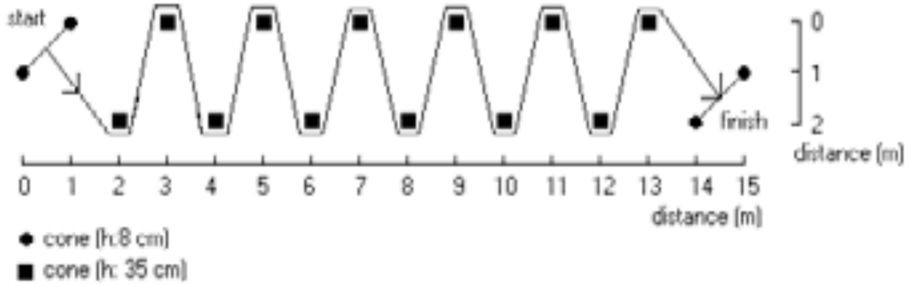

Figure 4.2: Course of the Slalom Sprint and Dribble Test[18].

Procedures

The protocol of this study consisted of two test days (i.e., test and retest) during the competitive season. Both test and retest were performed on the same day of the week, with two till four weeks between test and retest. Within these weeks, normal training sessions were performed. During the first test day, all participants performed the STARtest and the slalom test once without ball and once with ball (to measure change-of-direction speed and ball control, respectively). Sufficient rest between the measurements (at least five minutes) was ensured. Regarding the STARtest, players walked the trajectory of this test once beforehand, to ensure the directions of the test were evident. Players were instructed to complete the trajectory as fast as possible. During the test and retest of the STARtest, one of the observers provided verbal instructions about the directions and type of movements in order to prevent erroneous movements. The slalom sprint and dribble test applied the same protocol as the STARtest, that is, performing the test once without ball, and once while dribbling with the ball, with sufficient rest in between. However, the basketball players did not walk the trajectory of the slalom sprint and dribble test in advance, since the course of this test was more obvious (figure 4.2). During the second test day (retest), only the STARtest was executed with the same protocol as during the first test day. All players were familiar with the STARtest as well as the slalom sprint and dribble test.

Statistical Analysis

Data was analyzed using IBM SPSS Statistics software (version 20.0; Inc., Chicago, Illinois, United States of America). Reproducibility was investigated by examining reliability and agreement parameters[17]. For the reliability of the STARtest, the ICC was calculated with adoption of a two-way mixed model (single measure)[23]. An ICC < 0.40 was considered as poor, 0.40-0.70 as fair, 0.70-0.90 as good, and > 0.90 as excellent[24]. The agreement between the test and retest of the STARtest was investigated by calculating the standard error of measurement (SEM), the smallest detectable difference (SDD), and the coefficient of variation (CV) as shown in equations 1, 2, and 3, respectively[17,23,25]. Furthermore, 95% limits of agreement (LOA) were calculated and Bland-Altman plots were illustrated[26].

Equation 1: $SEM = SD * \sqrt{(1 - ICC)}$

Equation 2: $SDD = 1.96 * \sqrt{2} * SEM$

Equation 3: $CV = (SEM / Mean) * 100\%$

Two types of validity were investigated. First, a multivariate analysis of variance (MANOVA) was performed to examine discriminant validity among male basketball players (n=40) of different age categories (i.e., 14-15 years vs 16-17 years vs 18-19 years). We only analyzed the scores of the male participants, since we expected gender to influence the results. The scores of change-of-direction speed and ball control of the first test day were entered as dependent variables and age category was entered as fixed factor. Effect sizes were calculated to interpret the differences between age categories. An effect size < 0.20 was considered as small, around 0.50 as moderate, and around or > 0.80 as large[27]. Second, construct validity was investigated by examining the Pearson's correlation between the STARtest (performances of the first test day) and the slalom sprint and dribble test for all players (N=52). A Pearson's correlation of <0.10 was considered as trivial, 0.10-0.30 as small, 0.30-0.50 as moderate, 0.50-0.70 as large, 0.70-0.90 as very large and > 0.90 as nearly perfect[28]. Level of significance for all analyses was 0.05.

Results

Table 4.1 summarizes the scores of the STARtest obtained during the test and retest, as well as the reproducibility parameters (i.e., reliability and agreement parameters). Results showed that there were no significant differences between test and retest, neither for the change-of-direction speed ($t(51) = 0.90$, $p = 0.37$), nor for the ball control of players ($t(51) = 0.76$, $p = 0.45$). Bland-Altman plots are shown in Figure 4.3 and 4.4 for the STARtest without ball (change-of-direction speed) and STARtest with ball (ball control), respectively. The STARtest without ball has three outliers (two positive and one negative), whereas the STARtest with ball shows three positive and one negative outlier.

Table 4.1: Descriptive statistics (mean ± SD) and reproducibility parameters of the STARtest (N=52).

		Change-of-direction speed	Ball control
Test (s)		18.68 ± 0.96	20.02 ± 1.37
Retest (s)		18.60 ± 1.11	19.92 ± 1.50
Mean both tests (s)		18.64 ± 0.98	19.97 ± 1.37
Mean difference (s)		0.01 ± 0.70	-0.01 ± 0.91
ICC		0.78	0.83
	95% CI	0.64-0.87	0.68-0.88
SEM (s)		0.43	0.41
SDD (s)		0.92	1.13
CV (%)		1.77	2.05
LOA	Lower	-1.36	-1.80
	Upper	1.38	1.77

Note: ICC = intraclass correlation coefficient; CI = confidence interval; SEM = standard error of measurement; SDD = smallest detectable difference; CV = coefficient of variation; LOA = limits of agreement.

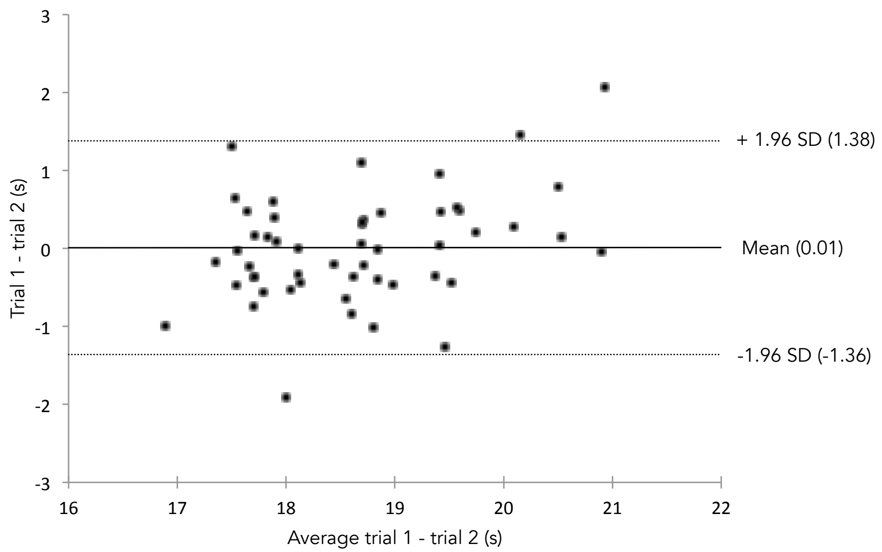

Figure 4.3: Bland-Altman plot – STARtest without ball (change-of-direction speed).

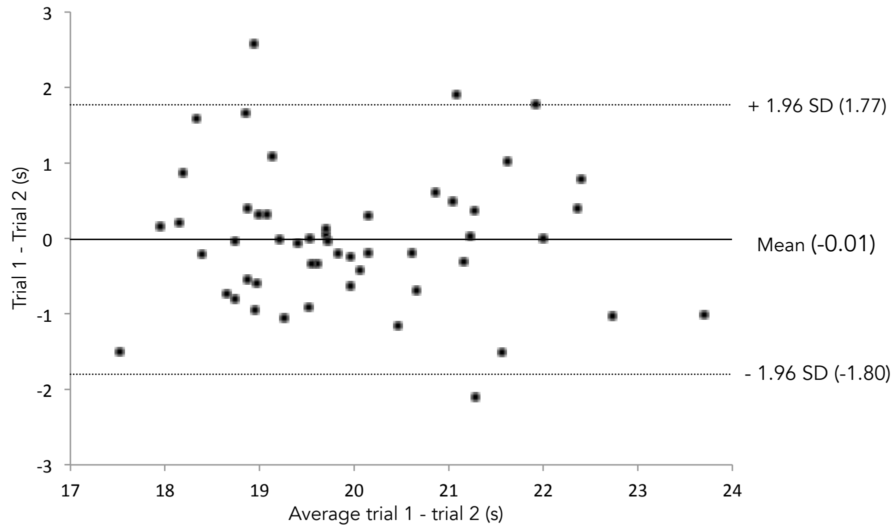

Figure 4.4: Bland-Altman plot – STARtest with ball (ball control).

For validity purposes, descriptive statistics of male basketball players by age categories are shown in table 4.2. MANOVA showed a main effect for age categories regarding change-of-direction speed (F(2,37) = 4.09, p = 0.03). Post-hoc results demonstrated that 18-19-year-old players were significantly faster on the STARtest without ball (change-of-direction speed) compared to 14-15-year-old players (p = 0.046). The differences between the ages 14-15 and 16-17, and between 16-17 and 18-19 were not significant, although the effect sizes were large and moderate, respectively. In both cases, the older group players were faster compared to the younger group. Regarding the STARtest with ball (ball control) (F(2,37) = 4.98, p = 0.01), both 16-17 (p = 0.04) and 18-19-year-old players (p = 0.03) were significantly faster compared to 14-15-year-old players. Moreover, a moderate effect size was found for 16-17 and 18-19-year-old players, again with the older players being faster.

Mean score of the slalom test without ball was 14.10 ± 0.84 s and of the slalom test with ball was 14.91 ± 1.09 s. The significant correlations between the Slalom test without ball and STARtest without ball (r = 0.74), and between the Slalom test with ball and STARtest with ball (r = 0.60) were considered as very large and large, respectively.

Table 4.2: Descriptive statistics and effect sizes of the STARtest without ball (change-of-direction speed) and STARtest with ball (ball control) of male players according to their age categories (n=40).

	Mean ± SD			Effect size (Cohen's d)		
	14-15 year (n=[illegible])	16-17 year (n=[illegible])	18-19 year (n=[illegible])	14-15 vs 16-17 year	14-15 vs 18-19 year	16-17 vs 18-19 year
Change-of-direction speed (s)	19.06 ± 1.05	18.33 ± 0.80	18.00 ± 0.74*	0.78*	1.15*	0.42*
Ball control (s)	20.48 ± 1.25	19.45 ± 1.06*	19.03 ± 0.94*	0.89*	1.41*	0.42*

Note. *Significantly faster compared to 14-15 year age category; [illegible] moderate effect size (d ≥ 0.50), large effect (d ≥ 0.80).

Discussion

The current study examined the reproducibility and validity of the STARtest. This test is a basketball-specific test with the aim to assess and monitor the performances of youth basketball players. The results of this study showed that the STARtest is a reproducible and valid test to measure and monitor change-of-direction speed and ball control of youth basketball players.

Based on the ICC for both the STARtest without ball (change-of-direction speed) and STARtest with ball (ball control) this test was deemed sufficiently reliable. The interpretation of the agreement parameters SEM and LOA is dependent on the context[29]. Related to the STARtest, the SEM values were considered to be small and the LOA values to be narrow, which indicate good agreement between test and retest. The CV, which represents the relative error compared to the mean, was similar to the results of other research concerning basketball tests, indicating sufficient agreement between test and retest[30,31].

Validity analysis showed that older players were significantly faster compared to younger players on both the STARtest without ball (change-of-direction speed) as well as the STARtest with ball (ball control). This result confirms our hypothesis and is in line with other research that showed an improvement in speed with increasing age to perform tests that measure change-of-direction speed and ball control[32-34]. In addition, there was a very large correlation between the STARtest without ball and the slalom test without ball ($r = 0.74$), and a large correlation between the STARtest with ball (ball control) and the slalom test with ball ($r = 0.60$). These results support our hypothesis, since we expected a moderate to strong, positive correlation between the tests, as both tests measure partly the same aspects (e.g., a form of change-of-direction speed and ball control). The good validity of the STARtest is also reflected in the fact that the test comprises various categories of basketball-specific movements, with a change between movement categories approximately every 2-3 seconds, which is designed to be representative of a basketball game[1-3].

Since research has shown the difficulties of predicting future performance level[12,14], it might be helpful to monitor the performances of youth basketball players with an objective test, such as the STARtest, to supplement the subjective opinion of coaches and trainers regarding their basketball players. The STARtest could be supportive for monitoring and evaluating the individual development of change-of-direction speed and ball control of youth players, which in turn can motivate players to train these skills. It is important for coaches and trainers to monitor players' individual development to gain insight into the progress during a specified period[13]. Results of this study showed that a change of 0.92 seconds for the STARtest without ball (change-of-direction speed), and 1.13 seconds for the STARtest with ball (ball control) is necessary to mention a significant increase or decrease in performance (i.e., SDD). The results of this study can be used by coaches and trainers as input for training programs for their basketball players.

Conclusion

This study showed that the STARtest, which has already shown its practical value for coaches and trainers, is a scientifically reproducible and valid test to measure and monitor the change-of-direction speed and ball control of talented youth basketball players. Coaches and trainers can easily administer the test themselves, since the STARtest can be performed on a basketball court and no expensive or special equipment is needed. It is therefore recommended to coaches and trainers to use the STARtest in their training programs to monitor and evaluate the individual change-of-direction speed and ball control of their basketball players. Coaches and trainers are advised to monitor their players at least twice a year to obtain data about their development within a season and between seasons. In this way, players are evaluated individually, which is very useful since each player can improve their own weaknesses to increase their performance level.

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