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A Review of Reactive and Non-reactive Agility Tests Concerning Neurologic Aspects

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Abstract

Agility is an essential component of sport performance, especially in ball sports. It is also a significant indicator of sport skills under competitive conditions. Agility is one of the most critical factors in the sport performance of soccer players. Agility and coordination of the nervous-muscular system to produce maximum force, as an important factor of function and physical fitness, which is considered along with perception and decision making in unpredictable situations. Assessment tests for assessing agility are divided into two general areas called non-reactive agility as well as reactive agility test. Although non-reactive agility tests are superior to reactive agility tests in terms of reliability, reactive agility tests are more similar to the movement and skill pattern in soccer and can distinguish players from each other well. In reactive agility tests, the movement path of the experimenter is not predictable and not all changes in path are predetermined and exactly the movement pattern in the soccer game where the movement path of the player is not predictable and the movement path of the ball as well as the prevailing conditions in the game that determine and change of direction player at any moment. The results showed that non-reactive agility had a higher relative validity and reliability than reactive agility. This small difference was acknowledged by researchers related to the reactivity and complexity of reactive agility tests. finally a review of the above studies and findings confirms that the use of reactive agility tests is necessary to evaluate athletes

Keywords: Non-reactive Agility, Change of Direction, Agility

1. Context

Soccer is a popular sport whose structure has changed dramatically in recent decades toward being more dynamic and faster (1, 2). It is a multidimensional sport in which techniques and tactics are influential. In competitive soccer, intermittent intense running and direction change are required at the same time (3, 4). This unique condition of movement pattern depends on agility. The increasing speed of competitive soccer signifies the importance of agility (5, 6). Agility is an important skill to escape or put pressure on when attacking or defending (7, 8). Soccer players change their direction every 2 - 4 seconds, amounting to 1200 - 1400 direction changes during the 90 minutes of the competition, emphasizing the vital role of agility (9).

Agility is defined as the ability of a person to change direction and maintain body balance in a short time. Standard field tests evaluate agility and distinguish professional and elite players from others (10, 11). Nevertheless, recreation requires standardized tests. The current laboratory tests are often expensive and cannot be used easily, while coaches usually have a limited time before the start of the season and do not have the opportunity to do laboratory tests. Therefore, there is a need for a standard test under the soccer movement pattern to evaluate players' agility (12, 13).

2. Types of Agility Tests

2.1. Non-reactive Agility Test

The current field agility tests are either non-reactive or reactive. Most available tests assess the players' agility while the experimenter's path is predetermined, and the subject is fully aware of which direction he must follow during the test. In other words, such tests evaluate the change of direction. So far, various non-reactive agility tests have been designed for different age groups, and coaches use these standard field tests to assess players' preparedness and differentiate them from each other. There are various non-reactive agility tests to determine the performance of soccer players based on speed, reversal, and

turns, such as Illinois, modified Illinois, sprint 5 × 5 meters, 505, zigzag, *t*-test, slalom test, sprint 4 × 5 meters, sprint with 90-degree turns, sprint 9-3-6-3-9 meters with 180-degree turns, and sprint 9-3-6-3-9 forward and backward running in different distances (9, 14, 15).

2.2. Reactive Agility Test

The movement pattern in reactive agility tests is not predetermined, and the player is unaware of the new direction change, so it happens based on game conditions in the hundredths of a second. In other words, the game condition determines the direction the player must move, and everything is done reactively.

Reaction time plays a vital role in such situations. It is referred to as reactive agility (16, 17). Due to the variable and unpredictable nature of soccer competition, eccentric and concentric muscle contractions are the most common muscle functions for agility and reorientation. It is known as the shortening cycle, in which the nervous and muscular systems' ability is influential (18). Plyometric exercises are also essential in this regard. Tendons can produce maximum force in the shortest possible time (19, 20). Reactive agility means the simultaneity of multiple factors, including speed and movement coordination, direction change in a coordinated manner without a predetermined path, and maintaining balance by perceiving and deciding in response to an external stimulus in line with movement patterns of soccer competition (21, 22). According to the definition of reactive agility, an evolved species of agility that requires the coordination of the nervous-muscular system, there are standardized tests compared to non-reactive agility tests. This type of evolved test seems more similar to conditions in a real soccer competition (23, 24). Despite the direction change, they also reactively evaluate agility, like in a soccer competition played with a ball (25, 26). Therefore, the execution protocol of these tests involves running like in a soccer competition with a ball. All tests are highly standardized, distinguishing players for coaches and identifying their performance levels.

Agility is a significant factor that can differentiate between elite players. In designing and executing such tests, it is necessary to be satisfied with the speed, turns, and predetermined changes. In addition, the lateral superiority of players, reaction speed in response to external stimuli, and the musculoskeletal system need to be examined. The sudden change of direction with perception speed and the decision speed with the ball in response to an external stimulus and an unexpected direction such as the conditions of a real soccer game must also be institutionalized (27-29). Therefore, various reactive agility tests have been designed and standardized, including skill agility, special soccer agility test, reactive agility test, special soccer test, and Y test (26, 28).

To be successful, soccer players need to have both agility and skill in working with a ball, so it seems that another critical factor for agility testing is to follow the principle characteristics of tests such as running with a ball (30, 31). One of the critical points that prioritizes reactive over non-reactive agility tests is the uncertainty of the path. The experimenter does not know in which direction he should move, a condition similar to real soccer; the player's path will not be predictable, and it is the game conditions that determine in which direction the player is guided. Thus, this factor will affect the differentiation of players in agility tests (32, 33).

Research results on non-reactive and reactive agility tests based on standard capability, validity, reliability, and characteristics are summarized in Tables 1 and 2. The purpose of these studies is specific to agility, and the common field tests are based only on the nature of agility, while age and gender were not the parameters in these studies.

3. Discussion

Agility is an essential physical fitness factor in soccer, and primary studies distinguished between elite and ordinary players. Therefore, this vital principle of performance cannot be neglected. The more sensitive this essential factor is in the protocol implementation, the more accurate it will be to distinguish elite players from the ordinary (34, 35). Unpredictable change of direction distinguishes reactive agility from non-reactive agility, which requires neuromuscular coordination, reaction time, stimulation of neural neurons, muscle fiber recruitment, and faster nerve firing, just like soccer players' movement patterns. There is no predetermined path, and the player may follow a new direction at any moment; there is no predetermined path, but it constantly changes according to the competition conditions. Soccer players need to work with the ball and benefit from the skill and agility factors to be successful on the field.

Another vital factor for agility testing is to follow the principle of characteristics that tests like playing. Reactive and non-reactive agility tests utilize this critical principle. The test steps are performed with the ball based on the nature of the soccer competition. Reactive agility tests after standardization were found to have acceptable test-retest reliability. Kutlu et al. demonstrated the standardization of the agility and skill response agility test with an average score of 12.02 ± 0.62 in the initial test, 12.04 ± 0.62 in the retest, and the ICC of 0.95% for capability (26). The reliability of the new agility test is determined compared to the standard Illinois test, linear *t*-test, and 20-m speed test by

Table 1. The Results of the Research on Non-reactive Agility

Population				Short Description	Species	Results	Reference
N	Gender	Age (y)	Level (playing)				
51	Male	10 - 14 years	10-month competitive season	5 × 5 squares zigzagging and changing direction	(NRAT)	ICC = 0.94 SD = 0.14	Bidaurrazaga-Letona et al. (30)
18	Male		Elit player	Running in 4 distances of 5 meters in a zigzag pattern	(NRAT)	ICC = 0.90 CV = 5%	Loturco et al. (4)
95	Male	13.61 ± 1.04	From a professional and semi-professional soccer academy	Illinois agility test as a maximum run, spin and run spiral, and again a maximum run of 60 meters.	(NRAT)	ICC = 0.94 SEM = 0.23 SWC = 0.25	Hachana et al. (9)
				The modified Illinois Agility Test has been reduced from 60 meters to 30 meters for a maximum sprint, spin and run, and maximum sprint again.	(NRAT)	ICC = 0.99 SEM = 0.10 SWC = 0.33	
86	Male	13.6 ± 2.0	Elit player	Test 5 × 5: Running a distance of 10 meters and turning 180 degrees and turning a distance of 5 meters	(NRAT)	ICC = 0.84 - 0.89 CV = 0.0 - 5.3	Dugdale et al. (3)
150	Male		Elit player	(TT): Running a distance of 9.14 meters and two round trips of 4.57 meters in a round trip.	(NRAT)	ICC = 0.928 CV% = 3.3	Sporis et al. (14)
				(ST) Running a distance of 6 meters. Every 1meter spiral back and forth.	(NRAT)	ICC = 0.992 CV% = 2.9	
				(S4 × 5): Run 4 distances of 5 meters with 90 and 180 degree rotations.	(NRAT)	ICC = 0.978 CV% = 4.3	
				(S90°): Running longitudinal distances of 2 and 3 meters with different transverse distances and with 90 degree rotation.	(NRAT)	ICC = 0.975 CV% = 2.9	
				(S180°): Running distance 9.3.6.3.9 meters with rotation	(NRAT)	ICC = 0.945 CV% = 5.1	
				(SBF): Running distance of 9.6.3.6.9 meters by running backwards and forwards	(NRAT)	ICC = 0.946 CV% = 5.6	

Abbreviations: ICC, intraclass correlation coefficient; SWC, smallest worthwhile change; CV, coefficient of variation; SEM, smallest error measurement; AUC, area under roc curve; SD, standard deviation; NRAT, non-reactive agility test; TT, *t*-test; ST, slalom test; S4 × 5, sprint 4 × 5; S90°, sprint with 90°-turns; S180°, sprint with 180°-turns; SBF, sprint with backward and forward running

the smallest worthwhile change (SWC), which was in the excellent range with a 0.98% correlation. In a diagnostic study conducted by Pojskic et al. on 20 elite male soccer players, they assessed the reliability of the reactive agility test compared to the Illinois non-reactive agility test (17). The ICC of the reactive agility test was 0.81 - 0.88, and the ICC of the non-reactive agility test was 0.84 - 0.99. The SWC was 0.14 in the Illinois non-reactive agility test and 0.15 in the reactive agility test, indicating acceptable validity and reliability. Since the sample size may have been influential in the extracted data, there is a need for a larger statistical population (17, 36). Pojskic et al. indicated that the slight difference in ICC between the non-reactive and reactive agility tests was due to perception, reaction, and the greater complexity of reactive agility tests, which does not occur objectively in non-reactive agility tests (17).

In another study by Krolo et al. on a Y-reaction agility test in a statistical population of 59 amateur soccer players, the ICC was reported as 0.79%, indicating acceptable reliability (25). However, the test needs to be evaluated in the statistical population of elite players so that it can be used to evaluate players with high confidence (25). Sekulic et al. compared the reliability of the Y dribbling reactive agility test and the non-reactive agility test (28). The results showed that the ICC of the reactive agility test was 0.60 - 0.83, and the ICC of the non-reactive agility test was 0.79 - 0.81. The difference in reliability was related to the complexity and responsiveness of the tests. If the tests put dribbling at the top of their agenda, it would reduce the reliability of the test (28). Loturco et al. conducted a diagnostic study to determine the validity and reliability of the Zigzag non-reactive agility test and determined that the ICC values of 0.90% were for a sample of 20, showing high reliability (4). If the sample size in this research was more, it could

Table 2. The Results of the Research on Reactive Agility

Population				Short Description	Species	Results	Reference
N	Gender	Age (y)	Level (playing)				
34	Female	20.8 ± 1.9	1.1 - 2.7 years at university player	4 balls 2 middle balls with a distance of 1.20 meters and 2 side balls with a distance of 3.94 meters distance 2 balls to the goal 10 meters and 2 side balls 11 meters. Distance from the starting point to the first ball 9.14 meters reactively and hit the goal	(A&S)	ICC = 0.95 SWC = 0.13 Pearson Correlation = 0.98	Kutlu et al. (26)
20	Male	17.0 ± 0.9	Elite player at least 6 years of football experience	4 balls with an angle of 45 degrees and a distance of 2 meters to the place where the light turns on are carried by foot	(SRAT)	ICC = 0.87 SWC = 0.15 CV = 4.94	Pojskic et al. (17)
32	Male	26.22 ± 5.22	Elite player	1-meter distance and 2 distances of two meters to start to move with and without the ball	(RAY)	ICC with ball = 0.60 CV with ball = 10% ICC without ball = 0.83 CV without ball = 0.08%	Sekulic et al. (28)
37	Female	20.9 ± 2.9	Athletes with different levels	Speed of hand reaction on smart wallboard	(RT)	ICC = 0.68-0.97 CV = 11.1 ± 9.4 AUC = 0.89	Pojskic et al. (27)
59	Male	13.40 ± 1.25	Normal and amateur game levels	Test Y and shoot towards the goal. Starting distance 1 meter and 2 distances of 3.5 meters for 2 balls to shoot towards the goal	(FSRA)	ICC = 0.79 CV = 0.05 SEM = 0.24	Krolo et al. (25)

Abbreviations: RA, Reactive agility; RAY, Reactive agility Y test; A&S, Agility and skills; SRAT, Special reactive agility test; RT, Response time; FSRT, Football specific reactive agility

increase confidence, as the sample size may have affected reliability (4, 36).

Another point to consider is lateral superiority. Zouhal et al. found that lateral superiority characteristics were 66% in the right eye, 92% in the left hand, and 82% in the right foot in amateur and professional soccer players (37). It was found that soccer players have a relative lateral advantage to the right side of their body and their right half (eye, hand, and right foot) has a relative lateral advantage over the left. If the agility test is to be held non-reactively, this lateral advantage causes the impact of the record will be achieved. However, this lateral superiority is considered in the agility of the reaction to an external stimulus. The experimenter needs to move from the whole half due to the sudden change of direction in response to an external stimulus to use the left and right limbs to improve agility records. Reactive agility tests after standardization were found to have acceptable test-retest reliability.

Validity and reliability are used to standardize the tests. Reactive agility tests have acceptable coefficients of validity and reliability compared to non-reactive agility tests. Therefore, we use standardized and reliable tests to identify and differentiate players (37). Non-reactive agility tests, due to their excellent ICC, can differentiate players with high reliability. However, in such agility tests, due to their nature (no sudden direction change and less similarity to the soccer's movement and reaction pattern), we need to use the reaction agility tests, which are more similar to the nature of soccer competition. Because ICC is less than non-reactive agility tests, it can be used as a field test to detect players' performance levels. A few difference will not be considered a weakness for the agility test protocol and is related to the reactive nature and complexity of the test (25, 26).

4. Conclusions

Agility and coordination of the nervous-muscular system produce maximum force and are regarded as essential factors of function and physical fitness, which are considered along with perception and decision-making in unpredictable situations. Reactive agility is performed to

achieve validity and reliability. The results showed that non-reactive agility tests have a higher relative validity and reliability than reactive agility tests. Researchers attributed this slight difference to the reactivity and complexity of reactive agility tests. Although non-reactive agility tests are superior to reactive agility tests in terms of reliability, reactive agility tests are more similar to soccer's movement and skill patterns and can distinguish players from each other well. Reactive agility tests are more complex than non-reactive agility tests because there is a fantastic moment during the reactive agility test when the subject must immediately respond to visual stimuli by performing an appropriate movement pattern (changing the direction as quickly as possible, just like the movement pattern in soccer). Finally, a review of the above studies confirms that reactive agility tests are compulsory for evaluating athletes.

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Footnotes

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