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Research article

Multi-Directional Sprint Training Improves Change-Of-Direction Speed and Reactive Agility in Young Highly Trained Soccer Players

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Abstract
The aim of this study was to evaluate the effect of a repeated sprint training with multi-directional change-of-direction (COD) movements (RSmulti) compared to repeated shuttle sprints (RSS) on variables related to COD speed and reactive agility. Nineteen highly-trained male U15 soccer players were assigned into two groups performing either RSmulti or RSS. For both groups, each training session involved 20 repeated 15 s sprints interspersed with 30 s recovery. With RSmulti the COD movements were randomized and performed in response to a visual stimulus, while the RSS involved predefined 180° COD movements. Before and following the six training sessions, performance in the Illinois agility test (IAT), COD speed in response to a visual stimulus, 20 m linear sprint time and vertical jumping height were assessed. Both groups improved their performance in the IAT ($p < 0.01$, ES = 1.13; $p = 0.01$, ES = 0.55). The COD speed in response to a visual stimulus improved with the RSmulti ($p < 0.01$, ES = 1.03), but not the RSS ($p = 0.46$, ES = 0.28). No differences were found for 20 m sprint time (P=0.73, ES = 0.07; $p = 0.14$, ES = 0.28) or vertical jumping height ($p = 0.46$, ES = 0.11; $p = 0.29$, ES = 0.12) for the RSmulti and RSS, respectively. In conclusion, performance in the IAT improved with the RSmulti as well as RSS. With the RSmulti however, the COD movements are performed in response to a visual stimulus, which may result in specific adaptations that improve COD speed and reactive agility in young highly trained soccer players.

Key words: COD movements, repeated shuttle sprints, speed, Speedcourt, team sport.

Introduction

Soccer is characterized by an intermittent exercise profile (Girard et al., 2011; Hader et al., 2014; Wong del et al., 2012). Match play requires maximal acceleration for each of the sprints as well as fatigue resistance when the intermittent exercise progresses (Bishop et al., 2011; Girard et al., 2011). In addition to linear sprinting, soccer involves frequent turns, twists and explosive change-of-direction (COD) movements. For instance, in crucial game situations elite players perform 49±9% of the movements in a linear direction (Bloomfield et al., 2007) and complete 726±203 turns with various angles and in different directions during a single match (Bloomfield et al., 2007). Additionally, most COD movements in team sports are not pre-planned but executed in response to an external stimulus, such as ball movement, several interacting opponents and changing game situations, which has been termed reactive agility (Sheppard and Young, 2006).

Recently, a novel method (the so-called ‘Speedcourt’) was developed to improve and assess COD speed and reactive agility and proved to be useful, valid and reliable for the determination of multi-directional COD movements (Duking et al., 2016). The Speedcourt consists of a platform (5.25 x 5.25 m) with twelve contact plates positioned in a symmetric order. The contact plates are highlighted on a large screen displaying the running paths to the player. As soon as the Speedcourt registers the foot touchdown on the targeted contact plate the next running path is exhibited to the player. Since the running paths are unknown beforehand, the players continuously perform repeated sprints and random multi-directional COD movements (RSmulti) in response to a visual stimulus.

However, the question remains whether this kind of novel training performed on the Speedcourt exhibits superior performance gains in COD speed and reactive agility when compared to more common conditioning drills such as repeated shuttle sprints (RSS) with predefined 180° COD movements. Therefore, the aim of the study was to compare the effect of six training sessions of either RSmulti in response to a visual stimulus on the Speedcourt or RSS on variables related to COD speed and reactive agility in young highly-trained soccer players.

Methods

Subjects

Nineteen highly-trained male soccer players (age: 14 ± 0.6 yrs, height: 1.74 ± 0.08 m, body mass: 59 ± 12 kg) competing in the second highest league for this age-group in Germany, volunteered to participate in the study. After being informed on the testing procedure as well as risks and benefits involved, all athletes and their guardians gave their written consent for the athlete’s participation in the study. The study design was pre-approved by the local University ethical committee and in accordance with the Declaration of Helsinki.

Study design

All participants were well familiarized with the Speedcourt before the start of the tests and attended well hydrated and refrained from consuming food for at least two hours beforehand. All tests and training sessions took place at the same time of the day between 1700 and 2030. For both testing sessions, before (Pre-) and after (Post-) the training period, all participants wore the same shoes

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and clothes. After Pre-, the athletes were assigned into two groups. To assure similar pre-conditions for agility and speed in both groups, the athletes were matched by the fastest time achieved in the Illinois agility test (IAT). During a 3-week training period both groups performed six training sessions. In each session, the players of both groups performed 20 sprints with a length of 15 s which were interspersed with 30 s recovery. While the one group performed the sprints on the Speedcourt as RSmulti in response to a visual stimulus, the other group performed RSS with predefined 180° COD movements as a control condition. The Speedcourt has been previously evaluated to be useful, valid and reliable for the assessment of multi-directional COD movements (Duking et al., 2016). In addition to this training, all players completed two soccer specific training sessions together under the same coach as well as one competitive match per week.

Data collection

After body composition analysis (BF511, Omron Healthcare, Mannheim, Germany), all participants performed the team's standard pre-match warm-up routine including light running and sprints with progressively increasing speed.

Jumping height and 20 m Sprint time

To evaluate the players' isolated explosive strength abilities of the leg muscles and possible changes that might occur during the training period, a counter-movement jump was performed (OptoJump, MicroGate, Bolzano, Italy). All athletes performed three counter-movements jumps which were separated by a 1 min rest period. The best of the three attempts was used for further analysis. In addition, the 20 m sprint time was used to evaluate the linear sprint performance. For this purpose, timing gates were placed at the start and the end of the running track (TC, Brower Timing Systems, Draper, Utah, USA). On a verbal countdown the participants initiated the sprint 1 m behind the first timing gate. All athletes performed three 20 m sprints, separated by a rest period of at least 1 min, and the best attempt was used for further analysis.

COD speed

To evaluate the pre-planned COD movements the athletes performed the IAT as it has been described in detail elsewhere (Hachana et al., 2013; Raya et al., 2013). Times were recorded with timing gates (TC, Brower Timing Systems, Draper, Utah, USA) at the start and the end of course. The faster of two successful attempts was used for further analysis.

COD speed in response to a visual stimulus

The COD speed in response to a visual stimulus and anaerobic performance was assessed on the Speedcourt (Globalspeed GmbH, Hemsbach, Germany) with twelve consecutive sprint intervals and a work-to-rest ratio of 1 : 2 (~15 : 30 s). In each sprint interval, the players had to touch a sequence of 11 contact plates with their foot in the minimum time possible. The running paths included 9 COD movements from 10° to 180° and were designed based on pre-tests to target a sprint time of 15 s. On a visual countdown, the players had to sprint to the first contact plate and the next contact plate was visualized on the screen as soon as the Speedcourt registered the foot touchdown.

The running paths were different for each of the 1st, 2nd, 3rd and 4th of the twelve sprint intervals. This sequence of four intervals was repeated three times to analyze the COD speed for the beginning (Sprint 1-4), midsection (Sprint 5-8) and end (Sprint 9-12) of this test. The exact same protocol was used for both, Pre- and Post-, but none of the running paths applied in Pre- and Post- were used in any of the training sessions. Since the running paths were unknown to the players, this test is considered as measure for reactive agility including COD movements in response to a visual stimulus. Additionally, the contact times on each of the plates were measured and indicated as mean values for each of the intervals.

The re-test reliability of this test for COD speed in response to a visual stimulus and the anaerobic performance was evaluated in a pre-test. Twenty-five soccer players, other than the ones included in the present study (age: 22 ± 2 yrs, height: 1.80 ± 0.07 m, body mass: 72 ± 9 kg), performed the exact same protocol two times and one week apart. The mean sprint times for the overall protocol, the beginning, midsection and end showed a high correlation ($r = 0.94$, $p < 0.01$; $r = 0.89$, $p < 0.01$; $r = 0.93$, $p < 0.01$ and $r = 0.91$, $p < 0.01$, respectively) as well as low coefficient of variation between the first and second trial (2.51; 2.86; 2.75 and 2.66%, respectively).

Training

For each training session, the players performed 20 repeated sprints with a sprint time of 15 s and an active rest period of 30 s (work-to-rest ratio of 1 : 2) in both groups. The sprints were performed in 4 sets of 5 sprints, which were separated by 5 min of active rest. For each of the 15 s sprints, the RSmulti group performed multi-directional COD movements in response to a visual stimulus on the Speedcourt. In contrast, the RSS group performed repeated shuttle runs with predefined 180° COD movements (Figure 1).

RSmulti group

For the RSmulti group, each of the sprint intervals was initiated on a visual countdown. One of the contact plates of the Speedcourt was subsequently displayed on a large screen. As soon as the software registered foot touchdown on the targeted contact plate, the next contact plate was visualized on the screen. For each of the sprint intervals, the players had to touch as many contact plates as possible within a time period of 15 s. Since the order of the contact plates was randomized by the Speedcourt software, the players constantly performed multi-directional COD movements in response to a visual stimulus.

Control group

As a control condition, each of the 15 s sprints involved RSS with predefined COD movements by 180°. For the first training session the sprint distance was set at 20 m that had to be covered 4 times for the 1st and 2nd set as

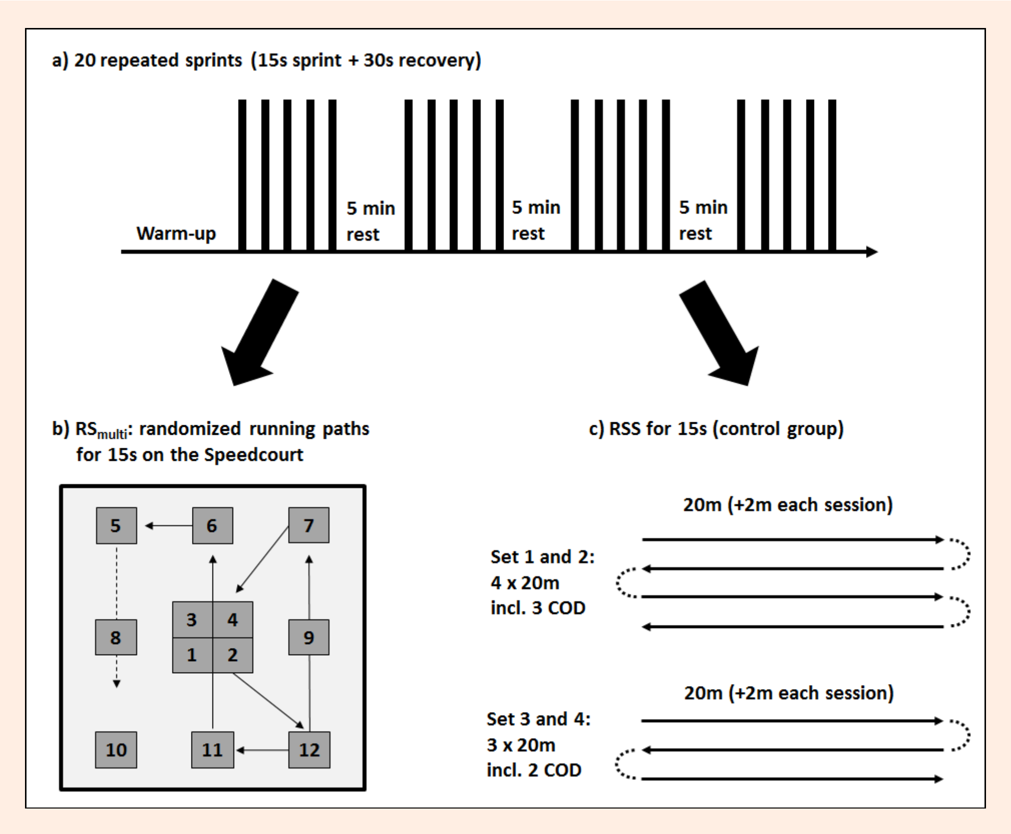

Figure 1. Schematic illustration of a) the basic exercise protocol with 20 repeated sprints performed in 4 sets of 5 sprints and interspersed with 5 min of recovery, b) the Speedcourt with the 12 contact plates and the randomized running paths for the RS_{multi} in response to a visual stimulus, and c) the RSS with 180° COD movements and the progression of the sprint distances during the training period. COD = change-of-direction, RS_{multi} = repeated sprints with multi-directional COD movements, RSS = repeated shuttle sprints

well as 3 times for the 3rd and 4th set. Thereby, each of the RSS involved 2-3 predefined COD movements by 180°. To maintain a sprint time of 15 s throughout the training period, the 20 m sprint distance was extended by 2 m for each session. The number and distribution of the COD movements remained unchanged. For motivational reasons and to assure maximum effort in each of the sprint intervals, all athletes of the control group performed the training sessions together.

Statistical analysis

All data are presented as mean ± standard deviation (SD). After confirmation of normal distribution, an (2 x 2) ANOVA with Fisher's post-hoc test was performed to detect any statistical significant differences between as well as within the training groups. An alpha-level <0.05 was considered to be statistical significant. The analysis was performed with the STATISTICA software package (version 10.0, StatSoft Inc., Tulsa, OK, USA). To indicate the practical relevance of any changes occurring during the training period, Hedges's (1985) effect size (ES) g was calculated by dividing two means by the pooled standard deviation (Fröhlich et al., 2009). An ES of <0.2, <0.6 and <1.2 was regarded as small, medium and large, respectively (Hopkins et al., 2009).

Results

Table 1 summarizes the mean ± SD data of all the performance variables before and after the six sessions of both groups executing either RSmulti or RSS.

While there was no differences between the groups at the two points of measurement, ANOVA revealed an improved performance in the IAT after six training sessions compared to Pre- with both, the RSmulti and RSS (p < 0.01, ES = 1.13; p = 0.01, ES = 0.55, respectively). Further, no differences were evident in vertical jumping height (p = 0.46, ES = 0.11; p = 0.29, ES = 0.12) and 20 m sprint time (p = 0.73, ES = 0.07; p = 0.14, ES=0.28) from Pre- to Post- with the RSmulti and RSS, respectively.

After six training sessions, the RSmulti-group improved the performance in COD movements in response to a visual stimulus compared to Pre- (p < 0.01, ES = 1.03) and compared to the control group (p = 0.01, ES = 1.29). The split times for each third of the test, beginning (p = 0.02, ES = 1.05; p < 0.01, ES = 1.36), midsection (p = 0.01, ES = 1.48; p < 0.01, ES = 1.40) and end (p = 0.04, ES = 1.10; p < 0.01, ES = 1.25), were improved at Post- with the RSmulti compared to the RSS and Pre-, respectively. With RSS, neither mean sprint time (p = 0.46, ES = 0.28) nor split times (best p = 0.25, ES = 0.42) showed any improvements after six training sessions. The mean contact times remained unaffected with both, the RSmulti and RSS (p = 0.65, ES = 0.15; p = 0.44, ES = 0.38, respectively).

Table 1. Performance assessment for both, the RS_{multi} and RSS group, before and after six training sessions. Data are means (±SD).

Variable	RS_{multi} Pre-	RS_{multi} Post-	ES	%-change	RSS Pre-	RSS Post-	ES	%-change
Vertical jumping height, cm	35.7 (7.1)	34.9 (6.3)	.11	- 2.1	32.0 (8.8)	33.1 (9.1)	.12	3.4
Illinois Agility Test, s	17.8 (.3)	17.3 (.5)**	1.13	- 2.8	18.2 (.9)	17.8 (.6)*	.55	- 2.4
20-m Sprint time, s	3.26 (.15)	3.27 (.14)	.07	0.3	3.32 (.20)	3.37 (.16)	.28	1.5
COD speed in response to a visual stimulus: Mean sprint times, s								
Sprint 1-12 (overall)	15.7 (1.5)	14.3 (1.2) **†	1.03	- 9.9	15.8 (1.2)	15.4 (1.2)	.28	- 2.2
Sprint 1-4 (beginning)	16.2 (1.3)	14.4 (1.3)**†	1.36	- 12.2	15.9 (.8)	15.6 (.9)	.42	- 2.2
Sprint 5-8 (midsection)	15.4 (.9)	14.3 (.7)**†	1.40	- 8.1	15.8 (1.1)	15.6 (1.0)	.23	- 1.6
Sprint 9-12 (end)	15.5 (1.2)	14.1 (.8)**†	1.25	- 9.4	15.5 (.8)	15.1 (1.0)	.43	- 2.6
COD speed in response to a visual stimulus:Mean contact times [s]								
Sprint 1-12 (overall)	.263 (.097)	.251 (.041)	.15	- 4.6	.237 (.06)	.216 (.047)	.38	- 9.6
Sprint 1-4 (beginning)	.270 (.089)	.253 (.037)	.24	- 6.4	.226 (.040)	.220 (.045)	.14	- 2.7
Sprint 5-8 (midsection)	.262 (.100)	.251 (.034)	.15	- 4.5	.243 (.057)	.212 (.041)	.62	- 14.7
Sprint 9-12 (endsection)	.256 (.078)	.249 (.030)	.12	- 2.9	.241 (.059)	.216 (.041)	.50	- 11.6

COD, Change-of-direction; ES, Effect size; RS_{multi}, Repeated sprints with multi-directional change-of-direction movements; RSS, Repeated shuttle sprints. * < 0.05, ** < 0.01, *** p < 0.001 compared with Pre-. † significant (p < 0.05) difference to the RSS group at the specific point of measurement

Discussion

In young highly trained soccer players, six training sessions of RSmulti and RSS improved performance in the IAT. The COD speed in response to a visual stimulus however improved with the RSmulti but not the RSS. For both groups, no differences were evident for vertical jumping height and 20 sprint time.

In a previous study, the players performed a repeated sprint training without a visual stimulus (10 wks, 2-3 sets of 5-6 RSS and a rest period of 14-23 s) improving the repeated-sprint ability and fatigue resistance (Buchheit et al., 2010). However, during match play most COD movements are not pre-planned, but performed in response to an external stimulus such as interacting opponents, ball movements and changing game situations (Sheppard and Young, 2006). In the present study we chose a protocol that required the players to perform the multi-directional COD movements in response to an external stimulus to mimic the specific demand of soccer match play and constantly challenge to the players' decision-making abilities.

In this context, a recent study showed that, the improvements in reactive agility mainly relied on an improved perception of and reaction time to a given external stimulus rather than the actual speed of movement. In particular, after 11 training sessions during a 7-week period, decision-making time during the reactive agility task was reduced only with an agility-like training requiring the players to perform the COD movements in response to an external stimulus (Young and Rogers, 2014). Therefore, soccer specific conditioning drills should involve multi-directional COD movements in response to an external stimulus rather than predefined COD movements such as RSS. The Speedcourt could provide a valuable method to design such drills and improve reactive agility by providing random COD movements in various directions.

Interestingly, in the present study, with RSmulti the COD speed and reactive agility improved but not 20 m sprint performance and counter-movement jump height. Although, strength and power are prerequisites for straight 20 m sprints and counter-movement jumps (Hunter et al., 2005), improvements in COD speed and reactive agility mainly seem to rely on other neuromuscular factors (Brughelli et al., 2008; McCormick et al., 2016). For instance, technical skills seem to dramatically impact the efficiency of the COD movements due to the various dimensions of COD movements such as moving forward, backward, sideways as well as accelerating and decelerating quickly (Brughelli et al., 2008). A review in this context points out, that many studies failed to improve COD movements by performing bilateral strength and power training such as heavy squat exercise and Olympic lifts which are involved in common strength and conditioning programs (Brughelli et al., 2008). Unilateral and horizontal jumping as well as performing specific COD movements in multiple directions are suggested to improve the ability to change the direction fast and explosively (Brughelli et al., 2008; McCormick et al., 2016).

From a practical point of view, small-sided games mimic the physiological and physical demands of soccer and help to improve COD speed and reactive agility with a higher training intensity than during actual soccer match play (Hill-Haas et al., 2011). However, compared to a training on the Speedcourt the nature of small-sided games is less structured (Hill-Haas et al., 2011) and it is difficult to adequately control the intensity of training (Hill-Haas et al., 2011). As well, highly skilled players might be able to conserve physical effort due to their technically and tactically advantages.

In the present study, the protocol of the RSmulti training on the Speedcourt aimed to match both aspects: on the one hand to control the training load individually and provide a substantial stimulus to each of the players. On the other hand, on the Speedcourt COD speed and reactive agility are trained in a way closely related to the actual demand of soccer match play by requiring the players to perform multi-directional COD movements and to cover short sprint distances while moving forward, backward or sideways in response to an external stimulus (Bloomfield et al., 2007). Based on the aforementioned considerations and the present data, the Speedcourt may represent a valuable method to individualize drills and improve COD speed and reactive agility.

Limitations of the study

Although soccer players barely perform 15 s sprints during match play (Carling et al., 2012), we chose a sprint duration of 15 s in the present study since pre-tests showed, that an interval duration of 15 s was necessary to induce recognizable fatigue in our well-trained U15 soccer players. Future studies are warranted to clarify whether a training protocol with shorter sprint intervals < 10 s might result in even further benefits for COD speed and reactive agility and might even improve the repeated-sprint ability (Girard et al., 2011).

The training protocol applied here, with 15 s sprints and a rest period of 30 s allows two players to train at the same time while one is performing the sprint intervals in the rest period of the other player. Still, the current type of RSmulti presents a fairly time consuming training method for most teams with a large squad besides its promising effects on variables related to COD speed and reactive agility. Finally and from a practical point of view, high costs restrict the equipment acquisition of the Speedcourt to teams with a solid financial budget.

Conclusion

The present study aimed to evaluate the effect of six sessions of RSmulti compared to RSS on variables related to COD speed and reactive agility when performed by young highly-trained soccer players during a competitive season in addition to the usual soccer training. While soccer match play involves frequent twists, turns and COD movements (Bloomfield et al., 2007) in response to an external stimulus (Sheppard and Young, 2006), the present RSmulti can serve as a conditioning drill that is closely related to the demands of actual soccer match play. Based on the current data we may conclude that both, the RSmulti and RSS, improved performance in the IAT. With the RSmulti on the Speedcourt however, the COD movements are performed in response to a visual stimulus, which may result in specific adaptations that improve COD speed and reactive agility. From a practical point of view, the Speedcourt could serve as a valuable method to design and individualize specific conditioning drills for soccer players.

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References

Bishop, D., Girard, O. and Mendez-Villanueva, A. (2011) Repeated-sprint ability - part II: recommendations for training. *Sports Medicine* **41,** 741-56.

Bloomfield, J., Polman, R. and O'donoghue, P. (2007) Physical Demands of Different Positions in FA Premier League Soccer. *Journal of Sports Science Medicine* **6,** 63-70.

Brughelli, M., Cronin, J., Levin, G. and Chaouachi, A. (2008) Understanding change of direction ability in sport: a review of resistance training studies. *Sports Medicine* **38,** 1045-1063.

Buchheit, M., Mendez-Villanueva, A., Delhomel, G., Brughelli, M. and Ahmaidi, S. (2010) Improving repeated sprint ability in young elite soccer players: repeated shuttle sprints vs. explosive strength training. *Journal of Strength and Conditioning Research* **24,** 2715-2722.

Carling, C., Le Gall, F. and Dupont, G. (2012) Analysis of repeated high-intensity running performance in professional soccer. *Journal of Sports Sciences* **30,** 325-36.

Duking, P., Born, D. P. and Sperlich, B. (2016) The SpeedCourt: Reliability, Usefulness, and Validity of a New Method to Determine Change-of-Direction Speed. *International Journal of Sports Physiology and Performance* **11,** 130-134.

Fröhlich, M., Emrich, E., Pieter, A. and Stark, R. (2009) Outcome Effects and Effects Sizes in Sport Sciences. *Journal of Sports Science and Engineering* **3,** 175-179.

Girard, O., Mendez-Villanueva, A. and Bishop, D. (2011) Repeated-sprint ability - part I: factors contributing to fatigue. *Sports Medicine* **41,** 673-694.

Hachana, Y., Chaabene, H., Nabli, M.A., Attia, A., Moualhi, J., Farhat, N. and Elloumi, M. (2013) Test-retest reliability, criterion-related validity, and minimal detectable change of the Illinois agility test in male team sport athletes. *Journal of Strength and Conditioning Research* **27,** 2752-2759.

Hader, K., Mendez-Villanueva, A., Ahmaidi, S., Williams, B. K. and Buchheit, M. (2014) Changes of direction during high-intensity intermittent runs: neuromuscular and metabolic responses. *BMC Sports Science, Medicine and Rehabilitation* **6,** 2.

Hedges, L.V. and Olkin, I. (1985) *Statistical methods for meta-analysis.* New York, London. Academic Press.

Hill-Haas, S.V., Dawson, B., Impellizzeri, F. M. and Coutts, A. J. (2011) Physiology of small-sided games training in football: a systematic review. *Sports Medicine* **41,** 199-220.

Hopkins, W.G., Marshall, S.W., Batterham, A.M. and Hanin, J. (2009) Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise* **41,** 3-13.

Hunter, J.P., Marshall, R.N. and Mcnair, P.J. (2005) Relationships between ground reaction force impulse and kinematics of sprint-running acceleration. *Journal of Applied Biomechanics* **21,** 31-43.

McCormick, B.T., Hannon, J.C., Newton, M., Shultz, B., Detling, N. and Young, W.B. (2016) The Effects of Frontal-plane and Sagittal-plane Plyometrics on Change-of-Direction Speed and Power in Adolescent Female Basketball Players. *International Journal of Sports Physiology and Performance* **11(1),** 102-107.

Raya, M.A., Gailey, R.S., Gaunaurd, I.A., Jayne, D.M., Campbell, S.M., Gagne, E., Manrique, P.G., Muller, D.G. and Tucker, C. (2013) Comparison of three agility tests with male servicemembers: Edgren Side Step Test, T-Test, and Illinois Agility Test. *Journal of Rehabilitation Research and Development* **50,** 951-960.

Sheppard, J.M. and Young, W.B. (2006) Agility literature review: classifications, training and testing. *Journal of Sports Science* **24,** 919-932.

Wong Del, P., Chan, G.S. and Smith, A.W. (2012) Repeated-sprint and change-of-direction abilities in physically active individuals and soccer players: training and testing implications. *Journal of Strength and Conditioning Research* **26,** 2324-2330.

Young, W. and Rogers, N. (2014) Effects of small-sided game and change-of-direction training on reactive agility and change-of-direction speed. *Journal of Sports Science* **32,** 307-314.

Key points

- During soccer, the players perform repeated sprints involving multi-directional COD movements, while most of these turns and twists are not pre-planned but executed in response to an external stimulus, such as ball movement, several interacting opponents and changing game situations.
- Both groups improved performance in the IAT. With the RS_{multi} on the Speedcourt however, the COD movements are performed in response to a visual stimulus, which may result in specific adaptations that improve COD speed and reactive agility.
- The Speedcourt could serve as a valuable method to design and individualize specific conditioning drills for young highly-trained soccer players.

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