Journal of Human Kinetics volume 85/2022, 87–96 DOI: 10.2478/hukin-2022-0112

Change of Direction Ability

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Reactive Agility in Competitive Young Volleyball Players: A Gender Comparison of Perceptual-Cognitive and Motor Determinants

by

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Limited evidence is available providing specific details about the perceptual-cognitive and motor factors that contribute to reactive agility (RA) and variations between genders in young athletes. The aim of the study was to investigate perceptual-cognitive and motor determinants of RA in competitive youth volleyball players. A total of 135 volleyball players (61 males, 74 females) aged 16–18 years were included in this study. The independent variables were as follows: explosive strength, maximal frequency of movements, simple and complex reaction time, selective attention, sensory sensitivity, and saccadic dynamics. Multiple linear regression analyses showed that explosive strength (ß = -0.494; p < 0.001) and complex reaction time (ß = 0.225; p = 0.054) accounted for 23% of the variance in RA performance in male players. The best exploratory model for RA contributed 34.5% of the variance in RA for female players with significant determinants of explosive strength (ß = -0.387; p < 0.001), sensory sensitivity (ß = -0.326; p = 0.001) and selective attention (ß = 0.229; p = 0.020). Male athletes obtained better results in RA, in all motor tests (effect size of 0.88 to 2.58) and in five variables of perceptual-cognitive skills (effect size of 0.35 to 0.98). Motor and perceptual-cognitive components significantly contributed to performance in RA in competitive youth volleyball players. Gender differentiates between players' RA performance, motor properties and saccadic dynamics to a large extent, while the remaining analyzed perceptual-cognitive components vary between female and male players to a small and moderate extent.

Key words: *team sports, explosive strength, foot tapping, saccadic dynamics, sensory sensitivity.*

Introduction

Volleyball is an open skill sport in which players are required to react in a dynamically changing, externally-paced and unpredictable environment (Araújo et al., 2006). During the game, players constantly adapt their movements relative to complex temporal and spatial stimuli, and in consequence develop particular mechanisms of neural synchronization during visuospatial demands. Reactive maneuvers in such a sport require integration between perceptual-cognitive functions and motor components (Farrow and Abernethy, 2003). The typical relationship between perception and movement can be represented in agility tasks that require an athlete to formulate adaptive movements in response to environmental constraints (Spiteri et al., 2018).

Reactive agility (RA) is identified as one of the most important determinants of performance in team sports, which involves movements based on change of direction speed in response to an external stimulus (Mroczek et al., 2017; Sheppard and Young, 2006; Spiteri et al., 2018). It is generally accepted that agility is positively associated with motor and biomechanic components, such as linear running speed, running technique, balance, strength and power of lower limbs (Condello et al., 2016; Dos'Santos et al., 2018; Freitas et al., 2022; Loturco et al., 2019).

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Authors submitted their contribution to the article to the editorial board.
Accepted for printing in the Journal of Human Kinetics vol. 85/2022 in December 2022.

Specifically, most previous studies have shown that various aspects of speed were positively associated with superior agility performance (Horníková et al., 2021; Loturco et al., 2019). However, there are little data regarding the impact of the ability to maintain faster stride rates on agility performance, which is very specific for team sport athletes (Popowczak et al., 2016). Maximal frequency of movement is identified as an important component of neuromuscular function that was recently indicated as a potential contributing factor to the rate of change of direction (Chaabouni et al., 2022). In the present study we explored this issue by considering variables from the foot tapping test.

Reactive agility refers to non-planned movements determined by the physical (anthropometrics and general motor abilities), technical, and perceptual-cognitive qualities (Spiteri et al., 2018). Although the physical and technical determinants of RA are rather well-known, there is limited evidence concerning the perceptual and cognitive factors that can influence RA performance. Perceptual function mainly refers to an athlete's ability to control their gaze, rapid stimulus localization and identification, whereas cognitive function refers to an athlete's ability to quickly process, store and use information from different sources needed to recognize and recall patterns of movements, predict actions, and make decisions within a split second of time (Roca and Williams, 2016; Spiteri et al., 2018). To maintain the integrity of the sport-specific skills in the playing environment, e.g. agility, team sports have a great demand on coupling the athlete's perceptual-cognitive and motor subsystems (Farrow and Abernethy, 2003). It seems that the recognition of perceptual-cognitive and motor determinants of RA performance could have practical implications for sports training. Some research has analyzed the effects of visuomotor processing on RA performance, such as in Scanlan et al. (2014), who indicated that in basketball players, response time and decision-making time had a larger impact on RA performance than morphological and speed factors. Moreover, it was observed that both simple and two-choice reaction times were highly related to RA when covering distances of 0.8 m, 1.6 m and 3.2 m (Zemková, 2016). Recently, Horníková et al. (2021) found that the reaction time to rapidly generated visual stimuli had a 23.6% contribution in determining RA performance in handball players. Another study showed the significant effect of correct reactions during a peripheral perception test on RA scores in youth team sport players (Popowczak et al., 2020). It seems that perceptual-cognitive processes are a significant subcomponent of RA performance, making continuation of research in this area justified.

Previous studies have also identified gender as a significant determinant in agility tasks in which boys achieved significantly better results (Dos'Santos et al., 2018; Popowczak et., al 2020; Zwierko et al., 2022). Males produced significantly faster agility movements as seen in faster decision times and post stride velocity than females (Spiteri et al., 2014). The question of the extent to which both perceptual-cognitive processes and motor components contribute to RA performance, and how they vary between genders in youth athletes is not completely known. The current study was conducted to address this issue by investigating the effect of motor and perceptual-cognitive components on RA in young volleyball players. In line with previous studies (Dos'Santos et al., 2018; Popowczak et al., 2020; Spiteri et al., 2014; Zwierko et al., 2022), it was hypothesized that youth male players would achieve better results in motor and perceptual-cognitive tests than female players, as seen in faster agility performance. Verification of this hypothesis was accomplished by the investigation of the relationship between RA (dependent variable) and simple and complex visuomotor reaction time, selective attention, oculomotor dynamics, sensory sensitivity threshold, explosive strength of lower limbs, and maximal frequency of movement, all of which can contribute to RA in volleyball players.

Methods

Participants

Sample size calculations were performed using G*Power 3.1 (Faul et al., 2007). Cohen's f^2 coefficient (Cohen, 1988) was used to calculate the effect size in a multiple regression model. Following Cohen's guidelines (1988), $f^2 \geq 0.02$, $f^2 \geq 0.15$, and $f^2 \geq 0.35$ represent small, medium, and large effect sizes, respectively. In the sample size calculations, we used the medium effect size, taking into account the number of participants for each gender-group separately. Assuming an effect size f^2 of 0.15, alpha of 0.05, and power of 0.90, the power analysis projected that a minimum of 59 participants in each group were required. The sample size of 74 (female group) referred to an actual power of 0.951.

A total of 135 youth volleyball players aged 16–18 years were included in this study, 61 males (body height: 187.0 ± 5.5 cm, body mass: 76.7 ± 8.1 kg, age: 17.0 ± 0.8 years, sport experience: 6.7 ± 1.2 years, training sessions per week: 6.9 ± 1.3), and 74 females (body height: 176.6 ± 5.4 cm, body mass: 65.8 ± 8.2 kg, age: 17.0 ± 0.7 years, sport experience: 6.3 ± 1.3 years, training sessions per week: 6.7 ± 1.4). All players were in good physical condition. The inclusion criteria were: a) volleyball training on a regular basis, at least five days a week, with a minimum weekly training duration of seven hours; b) participating in official volleyball federation competitions during the season in which the measurements were taken; c) having played volleyball with a volleyball federation license for at least 3 years. The exclusion criteria included suffering from an injury that prevented completion of the tests. All the players, as well as their parent(s) and legal representative(s), were informed about the testing procedures, and written informed consent was obtained for the use of the data for research purposes. The Research Ethics Committee of the University School of Physical Education in Wroclaw reviewed and authorized the designed research protocol (No 8/2021).

Procedures

Participants completed two testing sessions on two different days. Firstly, participants performed laboratory tests for perceptual-cognitive skills evaluation. To evaluate simple reaction time, complex reaction, sensory sensitivity, selective attention and visual orientation, tests of the Vienna Test System (Schuhfried, Austria) were applied. The Vienna Test System is a reliable and valid psychometric tool (reliable coefficients between 0.84–0.95 of the tests used). Secondly, motor tests (RA, maximal frequency of movement, explosive leg strength) were performed on a volleyball court. A standard warm-up routine was performed prior to the study, including aerobics and dynamic stretching.

Measurements

Reactive agility test

A Fusion Smart Speed System (Fusion Sport, Coopers Plains, QLD, Australia) was used during the ‘five-time shuttle run to gates’ test for the determination of RA following the procedures proposed by Popowczak et al. (2016). The system comprised electronic gates with a photocell and an infrared transmitter and light reflector, a Smart Jump mat integrated with a photocell, an RFID reader for identification of the athlete's tag, and computer software. The RA test measured the timing of movement during repeated “stop’n’go” directional changes in response to a random light signal at the gate. Each participant ran five times from the starting mat to particular gates (lines placed between photocells with reflectors, 1 m long) and then to the next gate's mat. The RA test was repeated twice with a 3-min rest interval in between, and the best result (total time) of the run [s] was used for further analysis. The reactive agility protocol was characterized by a good reliability level (ICC = 0.88; CV = 2.07%; TE = 0.38 s).

Maximal frequency of movement

The foot tapping test (FT) followed the protocol (ICC from 0.83 to 0.98) by Krauss (2011), using the Optojump Next (Microgate Next, Bolzano, Italy) to assess the maximal frequency of movements. The test determines the frequency of foot movements by calculating the time of flight/contact (one cycle) of the foot through infrared beams over a period of 15 s. Foot tapping was quantified as a FT coefficient (FTC = foot tapping frequency/ground contact time x 100). A higher FTC indicated a higher performance capacity.

Explosive leg strength

A squat jump (SJ) (ICC = 0.90; CV = 7.37%; TE = 2.42 cm) and a countermovement jump with an arm swing (CMJA) (ICC = 0.95; CV = 4.88%; TE = 1.79 cm), which followed the protocol by Bosquet et al. (2009), were performed to measure explosive leg strength. During the SJ the hands were placed on the hips throughout the entire jump. No specific instruction was given regarding the depth or speed of the countermovement or the arm swing. At least 30-s recovery was allowed between jumps. The best jumps for both the SJ and the CMJA were retained for further analysis. Jump height [cm] was analyzed. The validity coefficients of SJ and CMJA measurements were r = 0.99 (Bosquet et al., 2009).

Simple reaction time

The simple reaction time (SRT) evaluation consisted of 28 yellow light stimuli generated at different and randomly selected time intervals (2.5–6.0 s). Participants pressed a key in response to the programmed visual stimuli as quickly as possible. Below the ‘reaction key’, the panel had a 'stand-by key'. The participant held a finger on the 'stand-by key'; in reaction to the visual stimulus, the finger was moved from the 'stand-by key' to the 'reaction key'. A total simple reaction time [s] was analyzed.

Complex reaction

To evaluate complex reactions the determination test (DT) was used. Participants were to react to visual stimuli (in white, yellow, red, green and blue colors) and auditory stimuli (high pitch and low pitch sounds) by pressing the appropriate button for the stimulus. Moreover, white lights which appeared on a black background on the screen required pressing one of the two reaction pedals with a foot. The correct responses [n] and mean reaction time [s] were analyzed.

Selective attention and visual orientation

A visual pursuit test (LVT) was used to measure the selective attention and visual orientation performance for simple structures in a complex environment. The participant was presented with a number of random and disorderly lines and asked to visually identify the end of a particular line as quickly as possible. To ensure that the lines were not traced with the finger, two keys on the response panel had to be depressed throughout the task. Scoring involved the number of tasks solved correctly and the mean time of correct answers [s].

Sensory sensitivity

A flicker frequency test (FFT) was used to calculate the sensory sensitivity threshold. The mean score of individual measuring values obtained in the decreasing mode was frequency [Hz], at which a subjectively perceived transition from constant to flickering light took place.

Saccadic dynamics

To trigger a saccadic dynamic (SAD), a free-viewing visual search task without a sport-specific design was used in which participants were required to detect a target (red letter E) among 47 distractors (inverted red letter E - "Ǝ", blue letter E and red letter F) (Zwierko et al., 2019). Visual stimuli were displayed on a 55-inch television monitor (Samsung, UE55NU7172, Korea) at a distance of 1 m. During the visual search task, participants used one button to confirm detection of the target (target present trials) and another button to note the absence of the target (target absent trials). Psychometric properties for the visual search test protocol for target present trials were ICC = 0.80, CV = 7.64%, TE = 0.40 s, and for target absent trials were ICC = 0.83, CV = 6.20%, TE = 0.47 s. Gaze data during the visual search task were recorded binocularly using a mobile eye tracking system at 60 Hz (SMI ETG 2w, Germany). Standard one-point SMI calibration was carried out binocularly. Data were encoded through iViewETG version 2.2 software. Gaze data were analyzed using SMI BeGaze 3.5.101 software. The following gaze variables were analyzed: saccade average acceleration [°/s²], saccade peak deceleration [°/s²], and saccade average velocity [°/s].

Statistical Analysis

Descriptive data are presented as means, standard deviations and 95% confidence intervals (CI). The normal distribution of the data (Shapiro-Wilk test) and the homogeneity of variances (Levene´s test) were confirmed ($p > 0.05$). The *Student's t-test* was *used* for the two independent groups (female vs. male). The magnitude of the effect size for pairwise comparisons was also determined using Cohen's *d* (Cohen, 1988). The effect was characterized as small (0.20), medium (0.50), or large (0.80). A backward multiple linear regression analysis was performed in blocks with the entered determinants based on the significance of Pearson's R with the variables that had shown significant correlations to identify the relationships between RA (dependent variable) and the remaining independent variables (continuous). The magnitude of relationships between the variables were: trivial: 0.00–0.10; small: 0.11–0.30; moderate: 0.31–0.50; large: 0.51–0.70; very large: 0.71–0.90; and almost perfect: 0.91–1.00 (Hopkins, 2016). Statistical significance was indicated at $p < 0.05$. The JASP statistical package (version 16.1) was used for all analyses.

Results

Gender-specific analyses revealed that gender accounted for 30% (adjusted $R^2 = 0.303$, $F_{(1,133)} = 59.250$, $p < 0.001$) of the variability in RA performance. The standardized ß coefficient (ß = -.555, B = -1.499, t = 7.697, $p < 0.001$, 95% CI -1.885 to -1.114) indicated that male volleyball players obtained better results in the RA test (17.573 ± 1.156 vs. 19.072 ± 1.102, effect size 1.33) than female volleyball players. Due to the substantial influence of gender on RA performance in the regression model, further regression analyses were carried out separately for male and female players.

In the group of independent variables, in most cases (in 3 motor variables and in 5 perceptual-cognitive variables), male volleyball players were better than female volleyball players, with differences of large (0.84 to 2.58), medium (0.64 to 0.73), and small (0.31 to 0.35) effects. Descriptive and statistical values for dependent and independent variables in the groups of female and male athletes are shown in Table 1.

The Pearson correlation analysis showed nine significant ($p < 0.05$) correlations between RA and the independent variables (Figure 1). This confirms significant relationships between RA and the following variables: SJ (R = -0.500, $p < 0.001$), CMJA (R= -0.668, $p < 0.001$), FTC (R= -0.438, $p < 0.001$), SRT (R = 0.287, $p < 0.001$), DT_ reaction time (R = 0.329, $p < 0.001$), LVT_response time (R = 0.272, $p < 0.01$), FFT (R= -0.258, $p < 0.01$), SAD_acceleration (R = -0.363, $p < 0.001$) and SAD_velocity (R = -0.385, $p < 0.05$). Finally, considering multicollinearity, seven of the independent variables were used in the further regression analysis.

A backward multiple regression analysis was used to obtain the best exploratory models for RA in each group. For female volleyball players, the best exploratory models for RA contributed 34.5% of the variance in RA, and 23.6% for male volleyball players (Table 2).

The standardized regression coefficient values (ß) for the independent variables in the best exploratory models for RA are shown in Table 4. The CMJA (ß = -0.387; $p < 0.001$), LVT_response time (ß = 0.229; $p = 0.020$), and FFT (ß = -0.326; $p = 0.001$) significantly contributed to the variance of RA scores of female volleyball players. CMJA (ß = -0.494; $p < 0.001$) and DT_reaction time (ß = 0.225; $p = 0.054$) had a significant influence on RA of male volleyball players, which means that faster RA was achieved by athletes with better scores in the CMJA and shorter DT_ reaction times (Table 3).

Discussion

This study provides the first data to quantify and examine gender differences in motor and perceptual-cognitive predictors of RA performance in competitive youth volleyball players. The main finding was that RA performance and most of the physical and perceptual-cognitive properties were significantly different between genders. Our findings confirmed that compared to female players, male players had significantly better achievements (with large effect sizes in range of 0.88–2.58) in the RA test, explosive strength (SJ, CMJA), maximal movement frequency (foot tapping test), and saccade dynamics. The other perceptual-cognitive factors (selective attention, simple reaction time, complex reaction time, sensory sensitivity) presented non-significant or small to moderate differences (effects from 0.23 to 0.73) in relation to gender.

These findings are consistent with most previous research indicating that males displayed faster agility performance compared to females (Dos'Santos et al., 2018; Sekulic et al., 2013; Spiteri et al., 2014). It has been reported that gender differences in high-intensity movements (like agility) begin from an age of 7–12 years (Golle et al., 2015) when boys outperform girls in various physical fitness tests. Gender differences in agility tasks have been attributed mainly to neuromuscular characteristics (Landry et al., 2009), body strength of the lower limbs (Spiteri et al., 2013), strike velocity, ground reaction forces (Condello et al., 2016) and potential differences in perceptual-cognitive processing. Spiteri et al. (2014) found that in team sport athletes, males demonstrated significantly faster agility movements (defensive and offensive), producing greater force, impulse, trunk and knee flexion angles than females, resulting in significant gender differences in decision time and post stride velocity.

Our study shows that RA performance is associated with both motor as well as perceptual-cognitive factors. A large magnitude of correlation coefficients was confirmed between RA performance and explosive strength. Moreover, explosive strength of the lower limb was the main determinant of RA regardless of gender. Our findings are in line with previous studies indicating that lower-limb strength and power as well as motor abilities are associated with agility performance (Horníková et al., 2021; Spiteri et al., 2014; Thomas et al., 2018). A positive correlation with moderate magnitude was also found between RA performance and a maximal frequency of movements (foot tapping test) indicating that a higher pace of movements and shorter contact time determined better results in RA tasks. Foot tapping tests are considered to be independent of strength and a valuable supplement to strength and speed related performance tests in talent identification as well as in neuromuscular function and the rehabilitation process in team sports (Chaabouni et al., 2022). Our results confirm its significant contribution to RA performance in competitive youth volleyball players.

Table 1. *Descriptive and statistical values for RA variable and independent variables in the groups of female and male volleyball players.*

Variable	Female (n = 74)	Male (n = 61)	95% CI for Mean Difference		t	p	Cohen's d
	Mean ± SD	Mean ± SD	Lower	Upper			
Motor tests							
RA [s]	19.072 ± 1.102	17.573 ± 1.156	1.114	1.885	7.697	< .001	1.33
SJ [cm]	26.534 ± 4.859	36.252 ± 7.174	-11.964	-7.472	-8.559	< .001	1.48
CMJA [cm]	28.872 ± 4.509	44.254 ± 7.348	-17.421	-13.344	-14.925	< .001	2.58
FTC	37.850 ± 6.709	44.422 ± 8.256	-6.572	-4.024	-5.103	< .001	0.88
Perceptual-cognitive tests							
SRT [s]	0.420 ± 0.070	0.379 ± 0.056	0.019	0.063	3.701	< .001	0.64
DT_reaction time [s]	0.744 ± 0.057	0.697 ± 0.071	0.025	0.068	4.242	< .001	0.73
DT_number of reactions [n]	244.257 ± 27.953	254.361 ± 29.744	-19.947	-0.261	-2.030	0.044	0.35
LVT_response time [s]	3.396 ± 0.499	3.245 ± 0.495	-0.019	0.322	1.762	0.080	0.31
LVT_number of tasks [n]	17.284 ± 1.141	17.033 ± 0.999	-0.118	0.620	1.345	0.181	0.23
FFT [Hz]	43.403 ± 6.740	44.222 ± 6.836	-3.139	1.502	-0.698	0.487	0.12
SAD_ acceleration [°/s²]	4472.302 ± 55.155	5231.390 ±833.859	-1067.783	-50.393	-4.864	< .001	0.84
SAD_ deceleration [°/s²]	487.925 ± 95.260	491.125 ± 83.608	-34.050	27.651	-0.205	0.838	0.04
SAD_velocity [°/s]	84.085 ± 17.261	99.550 ± 13.954	-20.889	-10.042	-5.641	< .001	0.98

Note: RA - reactive agility, SJ - squat jump, CMJA - countermovement jump with an arm swing, FTC - foot tapping coefficient, SRT - simple reaction time, DT - determination test, LVT - visual pursuit test, FFT - flicker fusion test, SAD - saccadic dynamic

Table 2. *Adjusted coefficients of determination in the best exploratory models for RA.*

Model	R	R^2	Adjusted R^2	Residual statistics	
				F	p
Female volleyball players					
RA [a]	0.610	0.372	0.345	13.815	< .001
Male volleyball players					
RA [b]	0.511	0.261	0.236	10.262	< .001

Note. Dependent variables: RA

[a] *Determinants for RA of female volleyball players: CMJA, LVT_ response time, FFT*

[b] *Determinants for RA of male volleyball players: CMJA, DT_ reaction time*

Table 3. *The B and ß coefficients of the best exploratory models for RA.*

Model	B	ß	95% CI		t	*p*
Female volleyball players						
Constant	22.397	-	19.933	24.861	18.128	< .001
CMJA	-0.094	-0.387	-0.141	-0.047	-4.011	< .001
LVT_ response time	0.506	0.229	0.084	0.928	2.390	0.020
FFT	-0.053	-0.326	-0.084	-0.022	-3.418	0.001
Male volleyball players						
Constant	18.449	-	15.595	21.303	12.939	< .001
CMJA	-0.078	-0.494	-0.114	-0.042	-4.326	< .001
DT_ reaction time	3.673	0.225	-0.060	7.406	1.969	0.054

Note. B – non-standardized coefficients; ß - standardized coefficients,
CMJA - countermovement jump with an arm swing; LVT - visual pursuit test,
FFT - flicker fusion test, DT - determination test

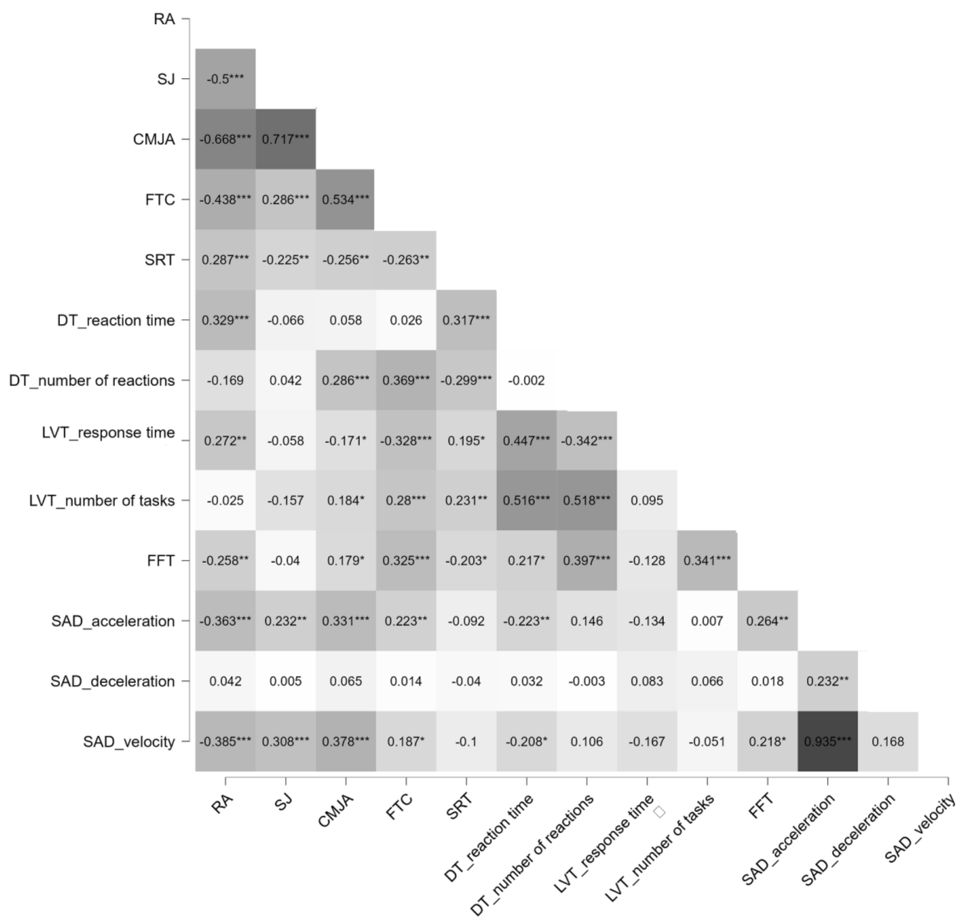

Figure 1. *Heat map showing Pearson correlation coefficients (R) between the analyzed variables.*
Note: RA - reactive agility, SJ - squat jump, CMJA - countermovement jump with an arm swing, FTC - foot tapping coefficient, SRT - simple reaction time, DT - determination test, LVT - visual pursuit test, FFT - flicker fusion test, SAD - saccadic dynamic
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Furthermore, the current study results showed that perceptual-cognitive factors had significant contribution to RA. In particular, positive relationships between RA, complex and simple reaction time, selective attention, and oculomotor dynamics were found, however, the magnitude of correlation coefficients was moderate.

To the best of our knowledge, this is the first study in which oculomotor dynamic variables in relation to RA performance were considered. During highly dynamic and constantly changing scenarios in volleyball, players need to rapidly process a considerable amount of information in order to make appropriate decisions. Gathering information from the ball trajectory, opponent's defense, teammate's game positions, all occurs usually with players moving. Oculomotor patterns seem to be crucial for task-relevant location and for processing information, especially in line with the cognitive demands of the player's positioning in the game while facing context-specific situations (Fortin-Guichard et al., 2020). Many studies have shown that volleyball players demonstrate superior perceptual-cognitive function, and that visuomotor skills seem to be one of the important determinants for expert performance. For instance, compared to non-athletes or athletes from other sports, volleyball players have faster visuomotor processing (Zwierko et al., 2010), more effective eye movement dynamics (Fortin-Guichard et al., 2020) and better accommodative *facility* (Jafarzadehpur et al., 2007). Our findings are in line with some previous observations (Popowczak et al., 2020; Scanlan et al., 2014; Spiteri et al., 2018; Zemková, 2016) and highlight the significance of perceptual-cognitive functioning in the context of specific movements requiring reactivity in volleyball.

The best exploratory models for RA for each gender of players included perceptual-cognitive factors, the complex reaction time model for male players, and selective attention and sensory sensitivity for female players. These findings support training programs for the improvement of perceptual-cognitive abilities in volleyball players. Thus, future research should be focused on the effects of reactive intervention among youth volleyball players.

While our findings provide understanding of the significance of motor and perceptual-cognitive variables in contributing to faster RA, the current study did not intend to measure other factors that usually contribute to RA, i.e., linear speed, pre-planned changes of direction speed, ground reaction forces, and morphological features (Dos'Santos et al., 2018; Horníková et al. 2021; Popowczak et al., 2020; Scanlan et al., 2014; Spiteri et al., 2014). While these contributing factors may further distinguish between RA considering gender, it will be necessary to take into account the interrelationship of all of these variables in an analysis comparing male and female athletes.

In conclusion, gender differences in motor properties and saccadic dynamics to a large extent, and to a small extent in simple and complex reaction time and selective attention, differentiate between RA of female and male players. Motor and perceptual-cognitive components significantly contributed to RA performance in competitive youth volleyball players. Consequently, explosive strength, complex reaction time, sensory sensitivity and selective attention can be considered significant factors of reactive agility in volleyball players. Moreover, the current findings add to the somewhat mixed findings (Horníková et al., 2021) in the literature regarding the extent to which perceptual-cognitive function may be associated with RA. From a practical perspective, as perceptual-cognitive processes are significant determinants of RA, it is necessary to create training programs which would improve perceptual-cognitive skills in athletes.

Acknowledgements

We would like to thank the teams: Gwardia Wroclaw, AZS AWF Wroclaw and SMS Police for their participation in this research.

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