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RELIABILITY OF A REACTIVE AGILITY TEST FOR YOUTH VOLLEYBALL PLAYERS

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Abstract

Introduction. This was a cross-sectional study aiming to test the reliability of a new reactive agility test designed for youth volleyball players to improve both reaction time and hand-eye coordination. ***Material and methods.*** Twenty-four youth volleyball athletes (15 girls and 9 boys) were recruited to participate in this study (age: 11.58 ± 2.20 years old). This study used a FitLight Trainer (FITLIGHT Sport Corp., Ontario, Canada), a wireless system using interconnected light-powered sensors, to measure reaction time and hand-eye coordination. The subjects performed the hand-eye coordination test twice, exactly one week apart, for 30 seconds, with three trials performed for each test. Repeated measures ANOVA was used to test the variation of the six trials performed during the two sessions. ***Results.*** The analysis comparing the sessions revealed significantly longer reaction time in session 1 than in session 2 (mean difference: 47.85 [95% CI: 10.86 to 84.84]; $p < 0.012$; ES = 0.128). Across the different trials, the greatest single ICC measure (ICC = 0.645) and average ICC measure (ICC = 0.784) were achieved in trial 3. Across the sessions, the greatest single ICC measure (ICC = 0.951) and average ICC measure (ICC = 0.863) were achieved in session 2. ***Conclusions***. FitLight Trainer is a valid and reliable tool for developing reaction times of youth volleyball athletes.

Key words: reproducibility, reactive agility, precision, light stimulus

Introduction

Reaction time (RT) and hand-eye coordination have been studied across different sports [1, 2, 3, 4]. This fact is justified by the impact of these variables in sports, cognitive performance, or other daily tasks in that RT is related to an increase in physical fitness and attention capacity [3, 5, 6]. In this sense, regarding sports activities, performance in which RT plays a significant role depends on physical qualities, such as agility [7], acceleration, and maximal speed [8], as well as cognitive components, such as visual scanning techniques, visual scanning speed and anticipation [9].

In addition, studies on the relationship between agility and cognitive skills have found positive associations with visual processing speed, sensory memory, selective focus, and anticipation [9, 10, 11]. The aforementioned skills are required for athletes – especially youth volleyball players, for whom the game dynamics and short RT to different game situations are extremely important [12]. Therefore, volleyball players need to improve their skills in terms of sensory and cognitive skills, as well as physical and motor skills [13].

For this reason, this kind of specific training for components such as speed and agility should be applied from a young age [8].

Since physical conditioning plays a very important role in the development of physical fitness [14], there should be an increase in the use of new methodology using technology across sports, particularly in volleyball.

Therefore, in order to improve athlete performance (specifically by enhancing agility and RT), it is important to reinforce innovative methods instead of classical methods[15]. One innovative method of improving agility is the FitLight Trainer (FITLIGHT Sport Corp., Ontario, Canada), which is a wireless reaction system composed of LED lights controlled by an Android tablet [16]. Moreover, despite the fact that the FitLight Trainer system is not intended for a specific age, it is considered a valid tool in research settings to measure and assess RT, selective attention, physical activity, and physical fitness in children [5, 7, 17, 18, 19, 20, 21], as well as to assess change of direction speed and reactive agility [7, 17] and to measure static balance, dynamic response time balance [16, 20], and mobility time [21].

Despite these studies on physical fitness, physical activity and sports, no studies were found regarding improvements in the RT and hand-eye coordination of youth volleyball players. Furthermore, the device has been applied in many individual and team games in the training unit in many countries, but not as a research study but rather in sports clubs.

Further investigations focusing on the effects of the FitLight Trainer in a specific sport, such as volleyball, is essential to understanding the novelty and new practical approaches that could come from the FitLight system. Therefore, the aim of this study was to test the reliability of a new reactive agility test designed for youth volleyball players in order to improve both reaction time and hand-eye coordination.

Material and methods

Study design

This was a cross-sectional study that took place in a sports hall and was applied twice (repeated measures) to youth volleyball players, exactly one week apart during January 2021 (the

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first third of the competitive season). The timeline of the study can be found in Figure 1.

In order to analyze RT, which is one of the main variables that should be developed in youth volleyball, a wireless system using interconnected light-powered sensors manufactured by FITLIGHT Sport Corp. (Ontario, Canada) was used (details are available in the Instruments section). The test started at 9:00 a.m. In the first session, each participant was required to complete two trials to explore the instrument and understand the experimental approach. For both tests, the temperature inside the sports hall was around 12°C, which is within the FIVB regulations to play volleyball (more than 10°C).

Participants

Through convenience sampling, 24 youth volleyball athletes (15 girls and 9 boys) were recruited to participate in this study (age: 11.58 ± 2.20 years old; height: 1.51 ± 0.11 m; body mass: 46.9 ± 11.20 kg; experience playing volleyball: 2.12 ± 2.13 years). The inclusion criteria were the following: (i) between the ages of 6 and 12, (ii) less than five years of volleyball experience, and (iii) regular participation in volleyball training (> 4h/week). The exclusion criteria were the following: (i) any recent injury that required medical attention and (ii) failure to participate in both moments of assessment. The study design and experimental approach were explained to all athletes and their parents/legal guardians. After giving their approval, the parents and youth athletes signed a free consent form. The study was approved by the institute's research ethics committee (the Scientific Council of Polytechnic of Viana do Castelo) and followed the ethical recommendations for studies in humans as suggested by the Declaration of Helsinki (2013).

Instruments

This study used FitLight Trainer (FITLIGHT Sport Corp., Ontario, Canada) to measure RT and hand-eye coordination. This system consists of four sensors, which were placed on a table 120 cm high and drawing a line. The sensors were placed 20 cm apart (see Fig. 2).

The data were obtained using an Android tablet (version 4.4.2) that exported several variables to a spreadsheet, including (a) the light that was on, (b) step (number of hits during the performance), (c) the split time between lights (the millisecond at which the light switched on), and (d) the RT (time spent between the light switching on and the athlete deactivating the light).

Measurements and Procedures

Hand-eye coordination is a crucial motor function that facilitates the goal-directed use of the arm and hand to produce controlled, accurate and rapid movements. The FitLight system's hand-eye coordination test measures RT and counts hits within a given period of time – in this case, we chose 30 seconds (Fig. 3).

All measurements were performed by the principal investigator and one trained assistant. To perform the hand-eye coordination test, the athlete stood in front of the sensors, and every time a sensor switched on, the athlete (as quickly as he/she could) tried to touch or pass a hand over the sensor (with the left or right hand). The internal software package enables four random LED activation programs. Consequently, performance in all tests included movements that were completely unknown to the subjects.

After each athlete had been given the opportunity to explore the instrument, groups of four athletes were established.

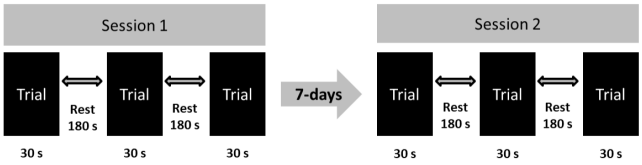


Figure 1. Method and dimensions of the ball control test

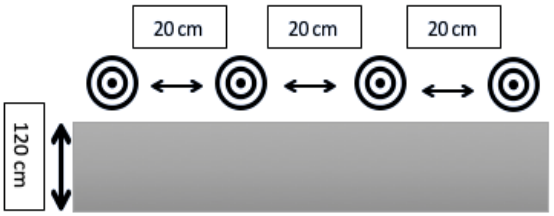


Figure 2. Timeline of the study

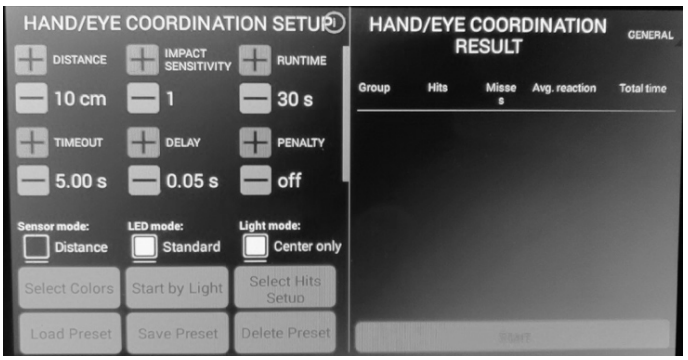


Figure 3. Example of the mode selection in the FitLight system

The subjects performed the test for 30 seconds (the test started when the first light switched on) for three trials. Participants were allowed to take a 3-minute break between trials. The outcome extracted from each trial was the response time (recorded in milliseconds). Reaction times faster than 100 ms or slower than 1000 ms were referred to as anticipation error or omission error and were not included in the analysis [22, 23].

Statistical Analysis

Normality and homogeneity of the sample was firstly tested and confirmed using the Kolmogorov-Smirnov test ($p > 0.05$), as well as Leven's test ($p > 0.05$). Repeated measures ANOVA tested the variation of the six trials performed during the two sessions. The Mauchly's test presented no sphericity (Mauchly's $W = 0.063$; Approx. Chi-Square = 58.173; $p < 0.001$). The Greenhouse-Geisser value was 0.497. Based on that, Greenhouse-Geisser correction was used for correcting the violation of sphericity. The between-session analysis was conducted using mixed ANOVA, with a factor (session) and dependent variables (trials). The Mauchly's test presented sphericity (Mauchly's $W = 0.918$; Approx. Chi-Square = 3.854; $p = 0.146$). The effect size (ES) for repeated measures ANOVA was calculated using the Partial eta squared. Pairwise comparison was conducted using Bonferroni test. The intraclass correlation coefficient (ICC) was tested for measuring the reliability within trials and within sessions. The ICC scores less than 0.5 were considered poor

reliability, between 0.5 and 0.75 moderate reliability, between 0.75 and 0.90 good reliability and above 0.90 indicated excellent reliability [24]. Two-way random model was chosen, as well as the type of absolute agreement. The Cronbach's Alpha, single and average measures ICC were reported. For the case of comparison within-trial, the single ICC was collected (since only one reading was collected). For the case of within-session analysis, the average measures were reported (since more than one trial was taken). All the statistical procedures were executed in the Statistical Package for the Social Sciences (version 25.0; IBM; USA) for a $p < 0.05$.

Results

Descriptive statistics and pairwise comparisons of reaction time (ms) presented in the different trials and sessions can be observed in Table 1. The repeated-measures ANOVA corrected by Greenhouse-Geisser revealed significant differences between the six trials ($p < 0.001$; ES = 0.464).

Between-session analysis revealed significant longer reaction time in session 1 than in session 2 (mean difference: 47.85 [95% CI: 10.86; 84.84]; $p < 0.012$; ES = 0.128). Within-session analysis revealed significant differences between trials ($p < 0.001$; ES = 0.224). Pairwise comparisons found significant longer reaction time in trial 1 than in trials 2 (mean difference: 19.03 [95% CI: 6.46; 31.60]; $p = 0.001$) and 3 (mean difference: 25.25 [95% CI: 11.06; 39.44]; $p < 0.001$). No significant differences were found between trials 2 and 3 (mean difference: 6.22 [95% CI: -4.83; 17.25]; $p = 0.506$).

The within-trial reliability analysis can be observed in Table 2. Trial 1 presented poor reliability, and trials 2 and 3 presented moderate reliability levels.

The within-session reliability analysis can be observed in Table 3. In the sessions 1 and 2 and overall, the reliability was excellent (ICC > 0.90).

Discussion

The ability to measure RT and to practice during training sessions is important for volleyball coaches and sports scientists in terms of monitoring physical components, such as agility and hand-eye coordination. The results of this study showed statistical differences between sessions and trials in the FitLight test. This may have been caused by the participants becoming used to the hand-eye coordination test. However, reliability results have also revealed that the FitLight Trainer is a valid tool to apply in training sessions.

Therefore, it was concluded that FitLight Trainer is a simple, valid, and reliable tool for developing the RT and hand-eye coordination of youth volleyball athletes.

Conclusions

In young, healthy and physically active men, SOD2 polymorphism has an influence on the resting level of oxidative stress marker in the blood without affecting both enzymatic and non-enzymatic antioxidant potential. In turn, both SOD1 and GPx1 polymorphisms do not seem to affect oxidative-antioxidative status of the blood. However, the absence of mutant homozygotic genotypes (i.e. SOD1 CC and GPx1 Leu/Leu) in the study group may indicate that these genotypes are disadvantageous, and thus underrepresented in young, healthy and physically fit men.

Table 1. Descriptive statistics of reaction time (ms) in the different trials and sessions

	S1T1	S1T2	S1T3	S2T1	S2T2	S2T3
Mean (ms)	510.3[b,c,d,e,f]	482.4[a,d,e,f]	469.8[a,e]	446.3[a,b]	436.2[a,b,c]	436.3[a,b,c]
SD (ms)	76.9	72.3	71.2	59.7	61.2	57.3
CV(%)	15.1	15.0	15.2	13.4	14.0	13.1
SEM (ms)	15.7	14.8	14.5	12.2	12.5	11.7

S1T1: session 1 – trial 1; S1T2: session 1 – trial 2; S1T3: session 1 – trial 3; S2T1: session 2 – trial 1; S2T2: session 2 – trial 2; S2T3: session 2 – trial 3; ms: milliseconds; CV: coefficient of variation; SEM: standard error of mean; S1T1[a], S1T2[b], S1T3[c], S2T1[d], S2T2[e] and S2T3[f] significantly different at $p < 0.05$.

Table 2. Reliability analysis for between sessions (split by trials)

	Trial 1	Trial 2	Trial 3
Cronbach's Alpha	0.817	0.806	0.840
Single measures ICC	0.487 [95% CI: -0.079; 0.789]	0.552 [95% CI: 0.052; 0.804]	0.645 [95% CI: 0.222; 0.845]

ICC: intraclass correlation coefficient 95%; CI: Confidence interval for 95%.

Table 3. Reliability analysis for between trials (split by sessions)

	Session 1	Session 2	Overall
Cronbach's Alpha	0.947	0.951	0.951
Average measures ICC	0.922 [95% CI: 0.794; 0.968]	0.902 [95% CI: 0.902; 0.977]	0.916 [95% CI: 0.817; 0.963]

ICC: intraclass correlation coefficient 95%; CI: Confidence interval for 95%.

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