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# ANALYSIS OF CHOICE REACTION TIME IN ADOLESCENT RUGBY PLAYERS: A PILOT STUDY

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**ABSTRACT.** *Background*: The aim of this paper is to investigate the choice reaction time in the upper and lower limbs in adolescent rugby players, both girls and boys. *Materials and Methods*: In this study, the reaction time of 113 adolescent rugby players was investigated, including 55 players in the U13 age category—10 girls and 45 boys—and 58 players in the U15 age category—12 girls and 46 boys. The choice reaction time of the players' upper and lower limbs was evaluated using the T-Reaction software. *Results*: The results suggest that there are statistically significant differences between the mean values obtained in the two age categories, U13 and U15 ($p< 0.05$), and there are no statistically significant differences between the mean values obtained for the dominant and non-dominant upper and lower limbs ($p>0.05$). *Conclusions*: The results suggest that there are certain significant differences in the reaction time of the upper and lower limbs, both in terms of age category and the athletes' gender. Additionally, concerning the dominant and non-dominant limbs, the reaction times are similar, with no statistically significant differences identified between them.

**Keywords:** reaction time; adolescent; rugby

## INTRODUCTION

Reaction time (RT) is a key factor in sports performance, defined as the time from stimulus appearance to response (Kuang, 2017). It depends on the sensorimotor cycle, including stimulus detection, nerve signal transmission, CNS response generation, and movement execution (Adleman et al., 2016; Greenhouse et al., 2017; Sant'Ana et al., 2016).

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Simple reaction time is the interval from stimulus appearance to response, while complex reaction time requires identifying and selecting a response among multiple stimuli (Jayaswal, 2016). Attention influences reaction time by regulating activation, selection, and distribution of cognitive resources (Leckie et al., 2014).

Physiologically, visual reaction time involves the retina, visual pathways, motor cortex, and cerebellum, and varies with age, training, and fatigue. Simple reaction time is useful for selection and monitoring fatigue, while complex reaction time can be improved through training (Cojocariu & Honceriu, 2011; Cojocariu, 2011).

Human reaction time (RT) is influenced by age, gender, handedness, vision, practice, fatigue, exercise, personality, and intelligence (Jain et al., 2015). Its components, mental processing, nerve conduction, movement analysis, and device response, are affected by age, training, biological rhythm, and health (Cojocariu & Honceriu, 2011; Balakrishnan et al., 2014; Darbutas et al., 2013; Badau et al., 2014; Abbasi-Kesbi et al., 2017).

Studies show that reaction time can be improved through physical and sports activities, which train this ability (Jain et al., 2015; van de Water et al., 2017; Walton et al., 2018; Lynall et al., 2018). Exercise also enhances cognitive functions and attention (Reloba-Martínez et al., 2017).

Reaction time is a relevant component both in individual sports such as swimming and athletics (Nuri et al., 2013; Tønnessen et al., 2013), but this is essential in collective sports and with direct adversity, because athletes have to make quick decisions to be successful in their actions (Ruschel et al., 2011; Mudric et al., 2015).

Research in the field states that reaction time improves with age (Adleman et al., 2016) through adequate training, which is justified by the maturation of the central nervous system (Hülsdünker et al., 2018).

In performance sports, especially open-skill ones, quick decision-making and movement execution are crucial. Research shows no major differences in movement speed across skill levels, suggesting that physical ability alone isn't decisive (Djaoui et al., 2017; Kempton et al., 2017). Instead, cognitive processing speed and accurate interpretation of environmental information are key for optimal performance (Light et al., 2014; Roca et al., 2016; Hayashibe & Shimoda, 2014).

Memory and attention help athletes process information faster by improving focus and information discrimination. Technological tools and structured training protocols have been developed to measure and enhance perceptual-cognitive abilities in sports practice (Clark et al., 2015; Broadbent et al., 2015; Khanal, 2015; Parsons et al., 2014).

Reaction time is a physical ability closely linked to attention and varies with stimulus type, body state, and sensory modality (Reigal et al., 2019; Jiménez & Silva, 2018). A study on 31 teenagers found a moderate correlation between reaction time and attention capacity (Huerta Ojeda et al., 2022).

Studies have shown that there are significant differences in terms of reaction time to visual stimuli between men and women (Huerta Ojeda et al., 2022). Also, studies have shown that those who practice sports activities obtained better reaction time results compared to those who do not practice sports (Szabo et al., 2021).

In performance sport, decision making involves selecting the correct option to perform an action effectively. Although there are studies that suggest that the reaction time of the left upper limb is better compared to that of the right limb (Al-Hashel et al., 2016), there are also authors who demonstrate the opposite (Asai et al., 2010). There are also studies that state that men have better results in terms of reaction times compared to women (Nikam & Gadkari, 2015).

A separate study examined the reaction times of elite male taekwondo and kickboxing athletes, with an average age of 17, and found that the auditory reaction time of taekwondo athletes using their dominant hand was faster than that of kickboxing athletes (Çimen Polat et al., 2018).

A study on athletes from various sports (boxing, gymnastics, judo, karate, wrestling, taekwondo) found faster simple reaction times with the left hand, but better recognition and cognitive reaction times with the right hand, regardless of dominance. Reaction times were influenced by laterality, stimulus type, and sport practiced (Badau et al., 2018).

A study on 15-year-old boys and girls found that boys had faster reaction times in both hands than girls, and for both sexes the right hand was quicker than the left. Reaction time was shown to vary with age, gender, and intellectual traits (Taskin, 2016).

A study on 10-12-year-old students found that simple and complex reaction times are linked to weekly physical activity, as well as to physical fitness, attention, and concentration (Zwierko et al., 2014; van de Water et al., 2017; Westfall et al., 2018).

Another study aimed to compare the reaction times of the dominant hand among karate athletes based on age, gender, and skill level. The results revealed significant differences in both simple and complex reaction times across the three categories, children, juniors, and seniors. It was also concluded that male athletes tend to have better reaction times and faster decision-making abilities, which can be improved with practice (Coşkun et al., 2014).

Studies indicate that choice reaction time to visual stimuli is key in contact sports and can be improved through training. Research on students and judo athletes found no significant differences between athletes and non-athletes, or between dominant and non-dominant hands (Cojocariu & Abalasei, 2014).

In many sports such as football, handball or rugby, the defenders have to anticipate the movements of the opponents with the help of visual information, before the attacker changes the running direction (Runigo et al., 2010), developing in this sense anticipation skills through specific experiences from training but also from the field, studies demonstrating that experienced athletes generally obtained a better reaction time than beginner players (Fujii et al., 2014).

Rugby requires bilateral skills since players run forward but pass backward. Successful passing also depends on reactive agility, as players may need to quickly adjust planned actions. Thus, passing skill tests should include a cognitive component for validity (Pavely et al., 2009).

A developmental study on reactive agility in netball revealed that reactive agility testing was more effective in distinguishing between highly skilled and less skilled groups (Farrow et al., 2005). The quicker decision-making and movement times demonstrated by more experienced players in both pre-planned and reactive agility tests were later confirmed by a study on reactive agility in rugby league players (Gabbett & Benton, 2009).

A study on elite rugby players showed that dominant-side reaction times were faster than non-dominant, and skilled players had quicker decisions and movements without losing accuracy. Their superior anticipation indicates a greater ability to extract relevant visual information, highlighting the usefulness of reactive agility tests for evaluating perceptual agility (Gabbett & Benton, 2009).

A study on national rugby players tested a neurocognitive training program designed to improve visual perception, information processing, and decision-making. Results showed that perceptual-cognitive training is essential in open-skill sports, where performance depends not only on physical abilities but also on the ability to interpret and react quickly to game situations (Moya-Vergara et al., 2019).

Research shows that expert rugby players have faster and more accurate reaction times than intermediate or novice players. Differences across skill levels and ages suggest that extensive sport-specific experience develops perceptual expertise (Gabbet & Abernethy, 2013).

## MATERIAL AND METHODS

The aim of this paper is to investigate the choice reaction time in the upper and lower limbs in adolescent rugby players, both girls and boys.

We hypothesize that there are statistically significant differences between the U13 and U15 age categories in terms of choice reaction time development. Additionally, we hypothesize that we will identify statistically significant differences in the choice reaction time values between dominant and non-dominant upper and lower limbs.

### *Participants*

In this study, the choice reaction time of 113 adolescent rugby players was investigated, including 55 players in the U13 age category—10 girls and 45 boys—and 58 players in the U15 age category—12 girls and 46 boys. It is important to note that the data is analyzed based on age category, not gender, as rugby teams in these two age groups are mixed, comprising both girls and boys. The study was approved by the Ethics Committee, and informed consent was obtained from all participants prior to their inclusion in the research.

### *Procedure and materials*

The choice reaction time of the players' upper and lower limbs was evaluated using the T-Reaction software (Cojocariu, 2011), through two tests, with the implementation protocol de-scribed below. The subject is seated with their hands positioned above the keyboard, fingers close together, and the look directed at two circles on the screen. When the colour of one of the circles changes, the subject must press the right or left key as quickly as possible, depending on the location of the stimulus. The test involved 20 executions over one minute, with a 2-second interval between each, and the arithmetic mean of the dominant and non-dominant hand executions was calculated. The same protocol was applied in evaluating the reaction time of the lower limbs, with the subject seated comfortably in a chair, feet positioned above the two keyboards. We chose to use two stimuli in testing complex reaction time because, in rugby, situations may arise where a player needs to avoid contact with an opponent by moving to the left or right, or situations where a player must receive the ball from a teammate coming from one side or the other.

### *Data analysis*

The statistical analysis was conducted using the SPSS IBM Statistics V20 software, performing statistical tests such as the Shapiro-Wilk test to check the normality of the data distribution, the one-way analysis of variance (ANOVA) to identify statistically significant differences in the mean values between groups based on the gender and age of the athletes, the Independent Samples T test to determine the differences between the two age categories in mean values, and the Paired Samples T test to identify differences between the dominant and non-dominant limbs of the players.

## RESULTS

Following the application of the Shapiro-Wilk statistical test, we observe that the data regarding the choice reaction time of the upper and lower limbs for the players has a nor-mal distribution, with a p-value greater than 0.05 in both the U13 age category and the U15 age category for both girls and boys.

According to Table 1, following the application of the Independent Samples T test, we observe statistically significant differences between the mean values obtained in the two age categories, U13 and U15, regarding choice reaction time in the upper and lower limbs, as indicated by the significance threshold p value being less than 0.05. As is natural, with the processes of growth and development, there is also a notable enhancement in cognitive processes, such as attention and speed of thought, as well as neural processes during this maturation period, which may explain the highlighted differences.

**Table 1.** Statistical differences between the two age categories, U13 and U15

| | U13 (N=55) | | | U15 (N=58) | | | |
|---|---|---|---|---|---|---|---|
| | **Mean** | | **Std. Dev.** | **Mean** | | **Std. Dev.** | **P** |
| **CRT NON-DOMINANT UPPER LIMB** | 465.81 | ± | 56.53 | 401.57 | ± | 40.15 | **0.000** |
| **CRT DOMINANT UPPER LIMB** | 478.54 | ± | 59.07 | 408.84 | ± | 39.87 | **0.000** |
| **CRT NON-DOMINANT LOWER LIMB** | 496.14 | ± | 75.97 | 436.63 | ± | 46.40 | **0.000** |
| **CRT DOMINANT LOWER LIMB** | 494.50 | ± | 77.53 | 432.57 | ± | 57.48 | **0.000** |

**CRT= choice reaction time*

After applying the Paired Samples T test, according to table 2, we observe that there are no statistically significant differences between the mean values obtained for the dominant and non-dominant upper limbs, nor between the mean values for the dominant and non-dominant lower limbs, with p values greater than 0.05.

**Table 2.** Statistical differences between dominant and non-dominant limbs, both upper and lower

| | | U13 (N=55) | | | | U15 (N=58) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Mean** | | **Std. Dev.** | **P** | **Mean** | | **Std. Dev.** | **P** |
| **P1** | **CRT NON-DOMINANT UPPER LIMB** | 465.81 | ± | 56.53 | 0.062 | 401.57 | ± | 40.15 | 0.182 |
| | **CRT DOMINANT UPPER LIMB** | 478.54 | ± | 59.07 | | 408.84 | ± | 39.87 | |
| **P2** | **CRT NON-DOMINANT LOWER LIMB** | 496.14 | ± | 75.97 | 0.838 | 436.63 | ± | 46.40 | 0.537 |
| | **CRT DOMINANT LOWER LIMB** | 494.50 | ± | 77.53 | | 432.57 | ± | 57.48 | |

**CRT= choice reaction time*

This can be explained by the fact that the athletes undergo comprehensive training, utilizing both dominant and non-dominant limbs with equal efficiency during gameplay. Additionally, in rugby, technical skills such as passing and catching the ball, tackling, throwing in from the sideline, and clearing the ball involve the use of both upper limbs.

Also, following the application of the one-way analysis of variance, no statistically significant differences were identified between girls and boys in the U15 age category, with the significance threshold being greater than 0.05.

In the U13 age category, statistically significant differences were found in the choice reaction time of the non-dominant upper limbs with p = 0.044, the dominant upper limbs with p = 0.005, and the non-dominant lower limbs with p = 0.001. However, for the choice reaction time of the dominant lower limbs, the average values between girls and boys were similar (p = 0.170).

## DISCUSSION

The average results obtained by participants for upper limbs were analyzed by age and gender, with approximate values as follows: U13 boys- 460 ms, U13 girls- 500 ms, U15 boys- 405 ms, U15 girls- 408 ms. Thus, we observe an improvement in choice reaction time with age, with statistically significant differences identified between the two age groups (p=0.000), an aspect also supported by the specialized literature (Cereatti et al., 2009). In rugby, this aspect has been studied from another perspective, specifically based on game experience, with differences found between novice and elite players (Gabbett & Abernethy, 2013). This could serve as a future research direction, potentially analyzing adolescent rugby players based on their years of experience in the sport. Choice reaction time may yield better results as age increases, due to the physical and cognitive growth and development processes they undergo.

Regarding gender differences, in our study, statistically significant differences were highlighted between girls and boys only in terms of the choice reaction time of the upper limbs, in the U13 age category (p<0,05). In this regard, there are studies indicating differences between men and women in the development level of reaction time to visual stimuli (Huerta Ojeda et al., 2022; Szabo et al., 2021), with men showing better results than women (Nikam et al., 2015; Taskin, 2016; Coşkun et al., 2014). However, we interpret our data with caution, as the number of girls is considerably lower than that of boys in both age categories. This is due to the fact that, in these age groups, rugby XV is played in mixed teams, and the number of female players is generally smaller, which may represent a limiting factor in our study.

Additionally, no differences in reaction time were identified between the dominant and non-dominant limbs of the evaluated players ($p>0.05$). This may be explained by the fact that rugby players undergo comprehensive training, preparing them to make contact or evade opponents from both sides, as well as to receive the ball from teammates on both the dominant and non-dominant sides. However, there are authors who have identified significant differences between the reaction time of dominant and non-dominant limbs among elite rugby players (Gabbett & Benton, 2009), therefore, we consider it necessary to study this skill in more detail across other age categories or different levels of playing experience.

Since we did not find specialized studies analyzing reaction time in the lower limbs, the obtained data cannot be compared or discussed; however, they may be analyzed in future scientific articles.

## CONCLUSIONS

This study was based on two main hypotheses: first, that there would be identifiable differences in players' reaction times based on gender and age category, and second, that there would be identifiable differences in reaction times between dominant and non-dominant, upper and lower limbs.

In this regard, the statistical analysis demonstrated that the choice reaction time of players in the U13 age category is significantly higher than that of players in the higher age category. Additionally, concerning the dominant and non-dominant limbs, the reaction times are similar, with no statistically significant differences identified between them. Regarding gender differences, some variations were found in the U13 age category, which could be further explored in the future.

Thus, we can conclude that the research results confirm the first hypothesis, identifying differences in the reaction time of rugby players' upper and lower limbs based on age category and gender. Regarding the second focus of the study, the results disprove the proposed hypothesis, as no statistically significant differences were found between the dominant and non-dominant limbs of the rugby players.

We consider the analysis of choice reaction time among rugby players to be important because, during the game, they must respond quickly to various stimuli that may arise on the field. Good reaction time can facilitate the rapid execution of game phases and the effective performance of technical actions specific to rugby.

We consider it necessary to investigate choice reaction time in senior teams as well, including a larger sample of both female and male players. Additionally, another perspective would be to analyze this parameter in association with players' ability to change direction in response to a stimulus, as this reflects a more field-applicable situation.

**AUTHOR CONTRIBUTIONS**

All authors have equal contribution.

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