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Cognitive and Motor Capacities Are Poorly Correlated with Agility in Early Pubertal Children: Gender-Stratified Analysis

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Abstract: This research aimed to identify relations of cognitive and power capacities with reactive agility in pubescent boys (n = 55) and girls (n = 46). Cognitive abilities were evaluated by the Stroop test, while the BlazePod system was used to evaluate agility performance conducting 20 yard shuttle and triangle tests of non-reactive (TCODS) and reactive agility (TRAG), respectively. Performance in jumping power was assessed through the squat jump (SJ), countermovement jump (CMJ), and drop jump (DHJ) utilising the Opto Jump system (Microgate, Bolzano, Italy), while sprinting ability over distances of 10 and 20 m was measured using a photocells system. A principal component was extracted from the four Stroop test variables using factor analysis. Forward stepwise multiple regression analysis was conducted separately for boys and girls to evaluate the multivariate relationships among the predictors and the criterion. Among boys, 80% of the TRAG variance was explained (MultipleR = 0.9), with TCODS and SJ as significant predictors (β = 0.53 and −1.01, respectively). For girls, the TCODS was the significant predictor (β = 0.65), explaining 43% of the variance (MultipleR = 0.65). These results show that (i) cognitive abilities measured with the Stroop test were not a reliable tool for predicting TRAG, (ii) jumping power was a significant predictor of TRAG in boys, and (iii) TCODS was a significant predictor of TRAG in girls. The findings indicated that cognitive abilities do not significantly influence reactive agility in pubescent children. It seems that power features have a greater influence on reactive agility, particularly in boys who have more developed motor skills at this age compared to girls.

Keywords: CODS; RAG; Stroop test; squat jump; regression analysis; cognition

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Citation: Pavlinović, V.; Foretić, N.; Kovačević, N.; Galić, T.; Lušić Kalcina, L.; Mihanović, F.; Modric, T. Cognitive and Motor Capacities Are Poorly Correlated with Agility in Early Pubertal Children: Gender-Stratified Analysis. *Appl. Sci.* **2024**, *14*, 3148. https://doi.org/10.3390/app14083148

Academic Editor: Alessandro de Sire

Received: 23 February 2024
Revised: 2 April 2024
Accepted: 6 April 2024
Published: 9 April 2024

1. Introduction

Agility refers to the rapid alteration of velocity or direction in response to a stimulus, representing a key aspect of athletic performance [1]. This characteristic encapsulates two facets of agility: pre-planned, characterised by the change of direction speed (CODS), and non-planned, which involves reactive agility (RAG) [2–5]. It marks the contrast between movements executed in response to familiar patterns and those performed in reaction to unpredictable stimuli. The duality of agility highlights the fact that it depends on a wide range of fundamental capabilities, such as strength, power, coordination, and notably, cognitive and perceptual abilities [6].

The crucial role of agility in sports is more important than physical strength; it serves as a significant indicator of potential success across various sport disciplines [7]. This has induced scientific inquiry into identifying the determinants of agility, with the goal of improving prediction models that can accurately forecast sport performance. Studies have consistently demonstrated that while CODS is largely influenced by morphological and motor characteristics, RAG is linked with cognitive and perceptual capacities [8]. This distinction highlights the complex nature of agility and its crucial role in improving competitive effectiveness and performance.

Cognitive capacities, which include processes such as attention, memory, and decision-making, are crucial to an athlete's ability to perform well under pressure [9]. These capacities are influenced by a wide range of factors including genetic predispositions, training, and overall mental well-being. Research on the relationship between cognitive abilities and reactive agility can be particularly interesting because it suggests that improved perceptual abilities can have a big influence on an athlete's reactive agility [10].

The relationships between cognitive abilities and agility continue to be established by latest research, providing a deeper understanding of how these domains interact to influence athletic performance. For example, research has shown that specific cognitive predictors, such as spatial awareness and reaction time, are essential elements of RAG [11]. These results point to a mutually beneficial relationship in which cognitive training may improve RAG and help athletes to reach new levels of performance. In summary, agility is the result of a complex interaction between an athlete's physical and cognitive abilities, each working together to enable the athlete to meet the high standards of dynamic sports.

Studies conducted thus far have highlighted the importance of agility in sports, confirming the significant influence of CODS and RAG on success in sports [12]. The mentioned research has not only established the specific functions that physical characteristics play in athletic performance, but it has also created opportunities to investigate the relationships between agility and cognitive processes. Meanwhile, there is certain evidence suggesting that cognitive capacities, such as decision-making speed and perceptual speed, might have a substantial influence on agility performance, particularly in RAG [13]. These findings suggest that cognitive processes can improve an athlete's reactive agility by improving their ability to react to unpredictable stimuli.

However, the majority of research examining correlations between cognitive capacities and agility has predominantly focused on adult athletes. These investigations, to explore the link between cognitive abilities and agility, have been assessed mainly using the Stroop test and generic CODS and RAG tests in trained populations [14–16]. This focus has provided valuable data, but it has also identified a lack of research examining the link between the agility and cognitive abilities in puberty-age children who are still not involved in specific athletic training [17,18]. Enhanced comprehension of the underlying factors contributing to reactive agility (RAG) will facilitate the development of more precise tests for RAG and enable improved guidance for talented children towards sports emphasising agility. The aim of this study was to investigate the correlation between cognitive capacities, as measured by the Stroop test, as exploratory variables, and the assessment of reactive agility (RAG) as the criterion, in pubescent boys and girls. Exploring these connections in early pubertal children, who are at a crucial developmental stage, offers a unique opportunity to identify possible cognitive abilities that contribute to agility. It allows for the early detection of potentially talented individuals based on a wider range of indicators than physical ability alone.

2. Materials and Methods

2.1. Participants

A simple random sampling technique was used to choose one 7th grade and one 8th grade class with total of 101 students, comprising 55 elementary school boys (mean age 13.99 $\pm$ 1 years) and 46 girls (mean age 13.93 $\pm$ 1.05 years), all from the same city school in Split, Croatia. This was 54.74% of all 7th and 8th graders in the school and this sample percentage should represent the whole population of students of this age in the particular elementary school well. All participants were in good health and some were engaged in after-school sports, information on which was collected through the subjective statements of the participants. Since general medical examinations are required in Croatian elementary schools at the start of each academic year, the PE teacher's information about the participants' health was also evaluated. Additionally, all selected children regularly attended physical education classes. Out of 101 respondents, 68 individuals reported participation in organised sports. Among these, the majority (36 respondents) are involved in team sports. Additional activities include martial arts (13 participants), aesthetic sports and athletics (each with 7 participants), rock climbing (3 participants), and aquatic sports (2 participants). The rest of them, 33 respondents, were reported not to participate in organised training. The inclusion criteria stipulated no evident motor abnormalities, an absence of health-related issues (confirmed by the school's medical staff), no recent locomotor injuries within two weeks before testing, consistent involvement in physical activity, and reliable attendance records for physical education classes, as verified by the PE teachers. Certain individuals were excluded due to meeting exclusion criteria, which included recent musculoskeletal disorders, illness within the past two weeks, current discomfort, and/or feelings of weakness, all of which were assessed through verbal reports from respondents.

Approval for the investigation was obtained from the Ethical Board of the Faculty of Kinesiology, University of Split, Croatia (Ethical Board Number: 2181-205-02-05-22-0021). Participants were briefed on the study's objectives and potential risks, and verbal consent was obtained from them, while their guardians or parents provided written consent prior to participation.

Table 1 displays the characteristics of the participants.

Table 1. Participants' characteristics.

Sample	**All (*n* = 101)**	**Girls (*n* = 46)**	**Boys (*n* = 55)**
Variable	mean (95% CI) ± SD	mean (95% CI) ± SD	mean (95% CI) ± SD
Age (years)	13.96 (13.76–14.17) ± 1.02	13.93 (13.62–14.25) ± 1.05	13.99 (13.72–14.26) ± 1.00
OffT (s)	60.34 (58.81–61.86) ± 7.73	59.15 (57.33–60.98) ± 6.14	61.32 (58.95–63.70) ± 8.77
OnT (s)	72.81 (70.09–75.53) ± 13.78	72.51 (68.31–76.70) ± 14.13	73.06 (69.38–76.73) ± 13.61
Off + OnT (s)	133.14 (129.11–137.18) ± 20.44	131.66 (125.92–137.40) ± 19.34	134.38 (128.59–140.17) ± 21.42
On − OffT (s)	12.47 (10.69–14.25) ± 9.01	13.35 (10.38–16.33) ± 10.03	11.73 (9.54–13.92) ± 8.09
BH (cm)	166.72 (164.76–168.67) ± 8.90	164.18 (161.78–166.57) ± 7.29	168.91 (165.98–171.84) ± 9.64
SBH (cm)	86.42 (85.43–87.40) ± 4.49	85.98 (84.66–87.30) ± 4.01	86.80 (85.32–88.28) ± 4.88
BM (kg)	59.65 (56.22–63.08) ± 13.95	55.24 (51.34–59.14) ± 10.45	63.32 (58.08–68.57) ± 15.50
Bfat (%)	21.39 (20.03–22.74) ± 5.50	24.46 (22.81–26.11) ± 4.43	18.83 (17.13–20.52) ± 5.01
S10 (s)	2.07 (2.04–2.10) ± 0.15	2.11 (2.06–2.16) ± 0.15	2.03 (1.99–2.08) ± 0.15
S20 (s)	3.67 (3.59–3.74) ± 0.34	3.75 (3.65–3.86) ± 0.32	3.59 (3.48–3.70) ± 0.35
20Y BP (s)	4.98 (4.79–5.17) ± 0.85	5.14 (4.88–5.40) ± 0.79	4.84 (4.57–5.12) ± 0.89
TCODS (s)	2.74 (2.65–2.83) ± 0.40	2.81 (2.69–2.93) ± 0.35	2.68 (2.55–2.81) ± 0.43
TRAG min (s)	3.47 (3.37–3.58) ± 0.47	3.59 (3.45–3.72) ± 0.42	3.38 (3.23–3.53) ± 0.49
SJ (cm)	25.66 (24.38–26.95) ± 5.85	23.91 (22.19–25.62) ± 5.22	27.18 (25.36–29.00) ± 5.99

Table 1. *Cont.*

Sample	All (n = 101)	Girls (n = 46)	Boys (n = 55)
CMJ (cm)	26.28 (24.91–27.65) ± 6.23	24.17 (22.49–25.85) ± 5.10	28.11 (26.11–30.11) ± 6.59
DJH (cm)	25.23 (24.00–26.45) ± 5.58	23.71 (21.90–25.51) ± 5.50	26.54 (24.91–28.17) ± 5.36
RSI	0.93 (0.85–1.02) ± 0.40	0.87 (0.73–1.02) ± 0.44	0.99 (0.88–1.10) ± 0.37
PMS (s)	−0.00 (−0.20–0.20) ± 1.00	0.04 (−0.25–0.34) ± 0.99	−0.04 (−0.31–0.24) ± 1.01

Legend: OffT—psychomotor ability, OnT—response inhibition and motor speed, Off + OnT—composition measure of psychomotor speed and response inhibition, On − OffT—psychomotor speed, BH—body height, SBH—seated body height, BM—body mass, Bfat—body fat, S10—sprint 10 m, S20—sprint 20 m, 20Y BP—20 yards BlazePod, TCODS—triangle test change of direction speed, TRAG min—triangle test of reactive agility, SJ—squat jump, CMJ—countermovement jump, DJH—drop jump height, RSI—reactive strength index, PMS—psychomotor speed factor.

2.2. Measures and Procedures

Four anthropometric tests were conducted: body height (BH), seated body height (SBH), body mass (BM), and body fat (BFat). The ability to accelerate was tested with a 10 and 20 m sprint (S10 and S20). Agility was tested by conducting three tests: the 20 yard shuttle agility test (20Y) and triangle test of change of direction speed (TCODS) were used to test generic agility, and the "triangle" RAG test (TRAG) to test reactive agility [19]. To evaluate muscular performance, the Opto Jump system (Microgate, Bolzano, Italy)—an optical measurement system for assessing jump performance and timing—was used for three tests: squat jump (SJ), countermovement jump (CMJ), and drop jump (DHJ). As a measure of explosive strength, the reactive strength index (RSI) was calculated; it is calculated by dividing the jump height by the ground contact time during the DHJ. The Encephal App Stroop application was used to assess the cognitive functioning of the participants [20]. The Stroop application was downloaded from the Google Play app store (Encephal App Stroop, version 2.0.7).

Height measurements (BH and SH) were obtained using a Seca Instruments stadiometer. Body mass (BM) and body fat percentage (BFat) were evaluated using a Tanita Pro MC-780U body composition analyser (Tanita Corp., Tokyo, Japan). This device provides a print-out of the measured body mass and calculates body fat. Participants' gender, age, and body height were inputted into the device, and participants stood barefoot in an upright, stable position. The device utilised impedance, age, and height to estimate the percentage of total body fat.

For the assessment of S10 and S20, a Brower timing system (Salt Lake City, UT, USA), a widely utilised and previously validated system, was employed [21]. Two electronic timing gates were positioned at intervals of 1, 11, and 21 m from the starting line. These photocells were installed 1 m above floor level, in accordance with the maximum height of the manufacturer's standard tripods. Participants were instructed to sprint as swiftly as possible for the specified distance, with their preferred leg positioned on the starting marking.

The BlazePod reactive light training system (Play Coyotta Ltd., Tel Aviv, Israel) was utilised for the 20Y, TCODS, and TRAG agility assessments. For the 20Y test, three 50 cm cones with lighting pods mounted on top were positioned along a line 4.57 m (5 yards) apart. Participants initiated the test from a two-point stance, beginning after touching the middle pod, and then sprinted as quickly as possible 4.57 m to the left. They subsequently ran 9.14 m to touch the illuminated cone on the right before concluding by returning and touching the middle pod.

To conduct the TCODS and TRAG tests, three lighting pods were affixed to 50 cm cones arranged in an equilateral triangle formation, with equal sides and angles of 60° (refer to Figure 1).

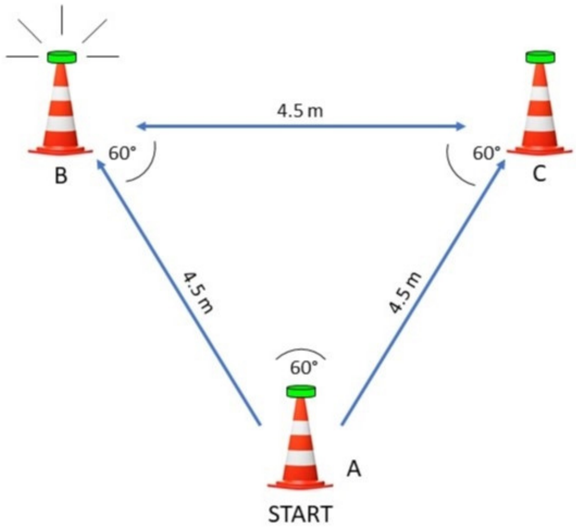

Figure 1. Scheme of the TRAG and TCODS testing.

To set the angles, a universal plastic goniometer with 360° accuracy and 1° precision (European Product) was utilised. The distance between the cones was standardised at 4.5 m. In the TCODS test, participants were familiarised with the scenario in advance (first trial: A–B–C, second trial: A–C–B), and upon initiation, they were required to move from one cone to another, touching the lighting pods to deactivate the lights.

For the TRAG test, participants were not informed of the scenario in advance (four different scenarios). Nevertheless, identical templates were employed for each participant's assessment. Participants were instructed to commence the test with their preferred foot positioned adjacent to the starting cone. To begin the TRAG, participants tapped the first lighting pod (Cone A), proceeded to the next illuminated cone, and touched the designated pod, which activated the last cone. TRAG scenarios were presented in a random order, with all participants undergoing testing in all four scenarios (Figure 1).

Testing was conducted in groups of 4–5 participants to allow for appropriate rest intervals between tests and trials. The rest interval between trials was no less than 20 s.

The assessment of SJ, CMJ, and DHJ was carried out using the Opto Jump system (Microgate, Bolzano, Italy), a sophisticated platform renowned for its precise measurements. The accompanying software allows for seamless storage of all test data and immediate retrieval when needed. Prior to testing, participants were briefed on the procedure through explanations and demonstrations, and they were given three practice attempts for each test to familiarise themselves with the process. Participants were encouraged to exert maximal effort during each attempt to achieve optimal results.

All measurements were performed in an indoor gymnasium with a wooden floor to ensure consistent testing conditions. Prior to the test, participants engaged in a 5 min warm-up routine consisting of running, light jumping, skipping, lateral running drills, and dynamic stretching. The testing protocol remained uniform for all participants, and tests were conducted at the same time of day (between 8:45 a.m. and 12:20 p.m.) to minimise variations in biorhythms and fitness levels. Participants were allowed one practice trial for each test, using their preferred sports shoes. For tests administered automatically by the Brower timing system, Opto Jump, and the BlazePod system, the same examiner assessed all participants.

Cognitive abilities were evaluated by the Stroop test using the Encephal App Stroop application [20,22,23]. The test was performed in the quiet, bright room with enough space between participants, so they could concentrate fully on the task and they were organised in groups of a maximum of nine pupils. The 7 inches tablet screens (HD C80 MeanIT, Zagreb, Croatia) were used to conduct the Stroop test. Before the test, the examination battery was thoroughly explained to the participants through a PowerPoint presentation by the trained researcher. Throughout the test, the researcher ensured its accurate and quiet conduct and responded to any additional questions. The participants reported no prior experience with the Stroop test.

The task encompassed two distinct components: the "Off" and the "On" states, contingent upon the congruence or incongruence of the stimuli. Each component followed two training runs. In the "Off" state, participants encountered a neutral stimulus, hashtag signs (###), presented in red, green, or blue, one at a time. Their objective was to swiftly touch the matching colour displayed at the bottom of the screen. These colours were randomised, not fixed to specific positions, and the task concluded after 10 presentations constituting one run. The total time taken for the run and individual responses were recorded. Any erroneous colour selections necessitated restarting the run, and achieving five correct runs marked the completion of the "Off" state.

In the "On" state, incongruent stimuli were introduced in nine out of ten instances. Here, participants were required to accurately select the colour of the word displayed, which differed from the actual name of the colour presented. For instance, if the word "RED" appeared in blue, the correct response would be blue, not red. Similar to the "Off" state, participants underwent two training runs, followed by task completion after achieving five correct runs.

The Stroop test yielded specific outcomes: OffTime: Total time for five correct runs in the "Off" state, primarily assessing psychomotor ability; OnTime: Total time for five correct runs in the "On" state, a measure of response inhibition and motor speed; OnTime minus OffTime: A measure of cognitive processing, controlling for psychomotor speed; OffTime plus OnTime: A composite measure reflecting both psychomotor speed and response inhibition.

2.3. Statistics

The distribution for all variables was confirmed to be normal through a Kolmogorov–Smirnov test. Descriptive statistical parameters are presented as means and standard deviations. Exploratory factor analysis was conducted to extract one principal component from the four Stroop test variables. Multivariate relationships among predictors and the criterion (TRAG) were evaluated via forward stepwise multiple regression analysis, conducted separately for boys and girls. Initially, multiple regression was computed using half of the observations (boys: $n = 28$, girls: $n = 23$; randomly selected validation sample). Subsequently, the regression model equations were applied to the remaining half of the observations (boys: $n = 27$, girls: $n = 23$; cross-validation sample). The actual performance scores of the cross-validation sample were correlated with their predicted (calculated) performance scores. Finally, a t-test for dependent samples was employed to compare the calculated and achieved performance scores. STATISTICA Version 13 (StatSoft, Tulsa, OK, USA) was utilised for all calculations.

3. Results

The factor analysis of the four Stroop variables resulted in the extraction of one significant principal component (Factor 1), explaining 83% of the total variance. The On − OffT had the lowest correlation with the principal component ($r = -0.79$), followed by OffT ($r = -0.85$). OnT and Off + OnT had the highest correlation with principal component (both $r = -0.99$). The extracted factor is defined as psychomotor speed and will be addressed in further text as PSM variable (Table 2).

Table 2. Factorial structure of psychomotor variables in the Stroop test.

Variable	Factor 1
OffT	−0.85
OnT	−0.99
Off + OnT	−0.99
On − OffT	−0.79

Legend: OffT—psychomotor ability, OnT—response inhibition and motor speed, Off + OnT—composition measure of psychomotor speed and response inhibition, On − OffT—psychomotor speed.

When multiple regression was performed for TRAG in the validation subsample of boys, the predictors accounted for 80% of the variance in the criterion. Significant partial regressors included T_CODS (β = 0.53) and SJ (β = −1.01). The regression model for TRAG obtained in the validation subsamples was as follows: TRAG = 2.11 + 0.65 × TCODS − 0.10 × SJ + 0.06 × DJH + 0.13 × 20Y BP. Upon applying the regression model to the cross-validation subsample, a common variance of 44% ($p < 0.05$) was observed between the calculated and observed scores. In the subsequent phase, a comparison of the calculated and observed scores for TRAG revealed no significant difference in the cross-validation subsample (3.37 ± 0.49 and 3.29 ± 0.35, $p = 0.43$; respectively). This confirmed the appropriateness of the regression modeling for TRAG in boys (Table 3).

Table 3. Forward stepwise linear regression of TRAG was conducted for the validation sample, separately for boys.

	β	SE (β)	b	SE (b)	t-Value	*p*-Value
Intercept			2.11	0.73	2.89	0.01 *
TCODS	0.53	0.14	0.65	0.17	3.80	0.00 *
SJ	−1.01	0.31	−0.10	0.03	−3.30	0.01 *
DJH	0.63	0.31	0.06	0.03	2.01	0.07
20Y BP	0.20	0.16	0.13	0.10	1.27	0.23
R	0.90					
R^2	0.80					
p	0.001					

Legend: TCODS—triangle test change of direction speed, SJ—squat jump, DJH—drop jump height, 20Y BP—20 yard BlazePod, β—regression coefficient, SE (β)—standard error of the regression coefficient, * indicates the statistical significance of $p < 0.05$.

When multiple regression was performed for TRAG in the validation subsample of girls, the predictors accounted for 43% of the variance in the criterion. The significant partial regressor was CODS (β = 0.65). The regression model for TRAG obtained in the validation subsamples was as follows: TRAG = 1.42 + 0.78 × TCODS. Upon applying the regression model to the cross-validation subsample, a common variance of 42% ($p < 0.05$) was observed between the calculated and observed scores. The calculated and observed scores for TRAG were compared using a t-test for dependent samples. No significant difference was found between the calculated and observed scores for the cross-validation subsample (3.70 ± 0.30 and 3.68 ± 0.40, $p = 0.81$, respectively). This confirmed the appropriateness of the regression modeling for TRAG in girls (Table 4).

Table 4. Forward stepwise linear regression of TRAG calculated for validation sample separately for girls.

	β	SE (β)	b	SE (b)	t-Value	*p*-Value
Intercept			1.42	0.71	1.99	0.07
TCODS	0.65	0.20	0.78	0.24	3.22	0.01 *
R	0.65					
R^2	0.43					
p	0.006					

Legend: TCODS—triangle test change of direction speed, β—regression coefficient, SE (β)—standard error of the regression coefficient, * indicates the statistical significance of $p < 0.05$.

4. Discussion

4.1. Correlates of Cognitive Abilities and Agility

The majority of studies dealing with this issue were conducted on athletes in team sport games. In those studies, cognitive abilities were supposed to be a very important facet in successful reactive agility performance. According to Young et al. (2015), the importance of the cognitive element in agility, particularly in team sport games, plays a crucial role, with RAG tests being better at discriminating between higher- and lower-standard athletes than CODS tests [6]. Additionally, Scanlan et al. (2014) state that cognitive abilities, especially response time and decision-making, have been consistently identified as key factors in reactive agility performance in adolescent basketball players [17]. These findings are further supported by Zwierko et al. (2022), who found that the complex reaction time, which belongs to perceptual capacities, significantly contributes to reactive agility in young male volleyball players [24,25]. Despite the huge amount of studies declaring cognitive abilities as an important factor influencing reactive agility performance, our research did not confirm these findings. Psycho-motor speed variables measured with the Stroop test did not predict results in generic reactive agility in girls or in the boys' sample.

To the best of our knowledge, there is just one study that researched the relations of cognitive abilities and reactive agility in untrained youth subjects. Horička et al. (2020) estimated the cognitive capability of adolescent boys and girls with the Stroop test and did not find a significant relationship between reactive agility and cognitive abilities [18]. Actually, the correlation between reactive agility and cognitive abilities was very weak ($r = -0.12$). The authors assume that in the non-sporting adolescent population, these abilities are not sufficiently developed, as in sport populations, to justify their conditionality. Therefore, we may conclude that in our study, reactive agility performance was supported primarily by motor skills rather than cognitive abilities.

4.2. Correlates of Power Abilities and Agility

Although some authors have reported poor relationships between power qualities and agility performance, the majority of previous research found positive correlations [26–28]. In studies conducted on both young and adult athletes, researchers stress that agility, speed time, and jumping ability belong to the same physical attribute [29–32]. From all measured power indices in our study, only the squat jump test proved to be significant predictor of reactive agility in the boys' sample. Results like this are consistent with the literature review. For example, Köklü et al. (2015) found a strong correlation ($r = -0.71$) between SJ and the zigzag agility test performed without the ball in young soccer players [33]. The authors explained this through the similarity of muscle actions and short duration in both tests; namely, to perform a jump or to change the direction of movement, one needs to use a lot of muscle power in a short period of time [1]. According to the results of our study, we may say that more powerful preadolescent boys perform better on a generic reactive agility test. In previous research, authors found positive effects of jumping training on agility performance. Obviously, plyometric training enhances muscle neural adaptations and the enhancement of motor unit recruitment [34,35]. Both features are very important for fast and effective change of direction movements. We assume that those features, along with those mentioned before, make a difference between a good and bad agility performer of this particular age and gender.

Linear regression calculation did not find any significant power predictor for reaction agility in the girls' sample. Apparently, the girls' results in the TRAG test are possible to predict only with the CODS test. Therefore, it is expected that girls rely less on power and more on some other motor qualities to execute this specific reactive agility task. Actually, several authors have proposed that different agility manifestations in pubescent girls should be observed as relatively independent qualities since the percentage of the common variance between the observed agility tests rarely exceeded 50% [18,36].

The absence of running speed influence on reactive agility performance in both genders should be contextualised with TRAG test movement characteristics. During the TRAG test, subjects move short distances (4.5 m between the polygons' cones) and are not able to develop any significant linear speed such as during sprinting tests. Also, the number of steps in the TRAG test ranges from 3 to 5, and those steps are pretty short due to the speed decrement and accelerations during stop-and-go movements. Contrarily, during sprint tests, subject move larger distances (10 to 20 m) which they cover with 10 to 15 steps. One of the studies that corroborates our assumption was conducted by Born et al. (2016). The authors found that sprinting ability can enhance CODS and RAG in young football players only if trained in a multidirectional manner and over distances similar to those in agility tests [37].

4.3. Correlates of Non-Reactive and Reactive Agility

Along with other tests, two generic non-reactive agility tests were involved in regression analysis calculation: CODS and 20Y BP. In both samples, only CODS proved to be a significant predictor of the TRAG result. It can be stated that if performed on the same polygon, the generic agility test is highly influential on reactive agility performance in pubescent boys and girls. This finding agrees with the literature review. Thus, Krolo et al. (2020) found significant and strong correlations between specific football CODS and RAG tests in young football players. The correlations were stronger in the older age category (U13; r = 0.42, U15; r = 0.58). This analysis leads to the conclusion that the younger group lacked the specific skills required to effectively perform CODS and RAG manoeuvres [38]. The authors posited that a direct consequence of longer involvement in football and systematic training is that the older group possesses a higher level of skill. This elevated skill level enables them to effectively perform RAG and CODS manoeuvres while also incorporating the necessary conditioning capacities.

In our research, we did not have a different age category but different genders. We can assume that boys are much more familiar with stop-and-go movements since they practice it through organised and unorganised sport games much more than girls do. Boys are inclined more toward playing team sports games such as football, basketball, or handball, which are saturated with stop-and-go movements [39–41]. That is the most likely cause why CODS explained a significantly higher proportion of RAG in boys (80%) than in the girls' sample (43%).

Due to the relatively small portion of shared variance observed in the girls' sample, the authors suggest that a significant portion of reactive agility variance is likely influenced by independent factors not examined in this study. Prior research indicates that such factors could include factors like balance, mobility, perception, or intelligence [18,36]. Furthermore, participants were selected based on gender criteria, leading to considerable diversity among them, with some engaging in agility-focused sports while others did not. To some extent, this could provide noisy data and limit the study's conclusive generalisations. The primary constraint of this study lies in its cross-sectional design, necessitating intervention studies to elucidate the causal relationships between the variables under scrutiny. Additionally, future research should delve into unexplored factors potentially affecting RAG performance, such as intelligence or perception. Future research should focus on competitive young athletes and consider factors such as practice duration, weekly frequency, and competition level to deepen our understanding of how cognitive abilities, power, and reactive agility are interconnected. Despite the acknowledged limitations, this study is among the first to utilise highly reliable assessment tools (Opto Jump, BlazePod, Power Timer system) to evaluate power, agility, and cognitive abilities in school children with the primary objective to identify the connections and potential influences among these variables. The gathered data could be used not only to explore the impact of cognitive abilities on RAG performance but also to better our understanding of gender disparities in power abilities during this critical phase of motor development.

5. Conclusions

This is likely one of the first studies that has examined correlations between cognitive capacities, speed/power abilities, and generic reactive agility in pubescent girls and boys. The primary aim of this study was to examine the connections between cognitive abilities, treated as exploratory variables, and generic reactive agility, considered as the criterion, in pubescent girls and boys. With this objective, the research has three major findings: (i) Our results indicate that cognitive abilities, measured by the Stroop test, are not a reliable tool for predicting results on the TRAG test among pubescent students. (ii) Jumping power is a significant predictor of generic reactive agility exclusively in the boys' sample. (iii) CODS is the only variable that can be used as a predictor of generic reactive agility in pubescent girls. The findings of the research indicate that in elementary school pubescent boys and girls, cognitive abilities do not play a significant role in reactive agility performance. It seems that speed and power features have a greater influence on RAG, particularly in boys who have more developed motor skills at this age. The data obtained indicate a necessity for delving deeper into understanding how cognitive abilities influence reactive agility, which is the primary contribution of the study to the domain of agility development and training. Nevertheless, PE teachers and coaches that work with pubertal age children should not neglect the possible influence of cognitive abilities on reactive agility performance. Hence, training this ability should always contain cognitive-perceptual effects such as reactions to unpredictable visual, kinaesthetic, or audio stimuli.

Author Contributions: Conceptualisation, N.F. and V.P.; methodology, T.G., F.M., N.K. and V.P.; software, F.M.; formal analysis, N.F., T.M. and N.K.; investigation, T.G., F.M. and V.P.; data curation, V.P.; writing—original draft preparation, V.P. and N.F.; writing—review and editing, T.G., L.L.K., F.M. and T.M.; supervision, N.F. and L.L.K.; project administration, V.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Croatian Science Foundation (IP-2018-01-8330, DOK-2021-02-5442).

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of the University of Split, Faculty of Kinesiology (Ethical board number: 2181-205-02-05-22-0021).

Informed Consent Statement: Informed consent was obtained from all participants involved in the study. Parents provided written consent for the inclusion of their children in the research.

Data Availability Statement: The authors will provide data to all interested parties upon reasonable request.

Acknowledgments: The authors are particularly grateful to the principal of OŠ Ravne njive-Neslanovac, Miljenko Bitanga, and all the P.E. teachers for their overall help: Antonio Bilić-Pavlinović, Sanja Šafradin and Edo Trivković.

Conflicts of Interest: The authors declare no conflicts of interest.

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