SPORTS' RELATIONSHIP WITH REACTION TIME AND WORKING MEMORY CAPACITY

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This paper examines different relationships between reaction time and working memory capacity in athletes and non-athletes. It also examines relationships between reaction time and working memory with different types of athletes sorted by time spent playing sports and the sport the athlete plays. This experiment found evidence that supports current theories that athletes have faster reaction times than non-athletes. It found no relationship between working memory capacity and athletes, however certain sports showed potential. Athletes with more years of sports experience performed worse on each task, although most were not significant. Finally, Basketball players were found to have significantly faster reaction time than non-athletes and Football players significantly outperformed non-athletes on one working memory task. Soccer and Volleyball players all had higher average mean scores on the three working memory tasks than non-athletes. However these were not significant. Football players also outperformed non-athletes on two of the three working memory tasks, one of which was significant and barely underperformed on the other task. These findings indicate there might be a potential for athletes from these three sports to have higher working memory capacity than non-athletes. This study struggles due to small sample sizes for specific sports. Future studies should aim to recruit a set amount of athletes from each different sport to prevent this issue.

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Introduction

Reaction time and Working Memory Capacity are skills needed in life-or-death situations and sports. This research looks to see if there is a correlation between participation in athletics and an improvement in these skills. If a link can be found between the skills, it means either athletes improve these cognitive skills, or athletes are simply better at these skills on average. Previous research on the topic has found that athletes tend to have lower reaction times than non-athletes. There have also been studies on the correlation between the skills and athletes of specific sports, but the findings have been inconsistent. There is little research done on athletes and working memory. In the few studies that have been done, it has been found that athletes tend to have higher working memory capacities than non-athletes. This thesis will not only look to replicate the findings of these correlations but also add a few variables to both skills, such as the specific sport played and the amount of time the sport was played for. I hypothesize that this study will find a correlation between; athletes and higher working memory capacity and athletes and lower reaction time. A stronger or weaker correlation for these skills depends on the sport played. Finally a stronger correlation between athletes that have played sports for over 10 years and working memory capacity and a stronger inverse correlation between athletes that have played for more than 10 years and reaction time.

Literature Review

Sports Non-Athletic Benefits

Athletics provide people, especially young people, with an opportunity to develop many different skills. To perform at one's best, athletes must learn to navigate their physical environment, the game, and their social environment. Sports are so important because they provide a unique opportunity for people to develop a whole different magnitude of skills. With proper guidance, sports can not only improve social competence, but also reduce self-destructive behaviors (Petitpas, & Champagne. 2000). Eime, Young, and Harvey. did a study that also found that sports improve young participants' social skills (Eime, Young, Harvey, *et al.* 2013). Outside of social skills, sports have been found to increase levels of happiness (Ruseski, Humphreys, Hallman, Wicker, Breuer. 2014).

Importance of reaction time

Reaction time is a useful skill in many life-or-death situations. Police officers need to make split-second decisions when bringing in armed suspects. Usually, the officers are not able to react in time if the suspect attempts to shoot the officer (Blair, Pollock, Burns. 2011). This means that officers are either getting shot or relying on other methods to determine if they shoot, such as stereotypes. Both of which are bad situations. Lower reaction times have also been found to correlate with fewer accidents and less damage done when accidents occur (Droździel, Paweł, Tarkowski, Sławomir, Rybicka, Iwona, Wrona, Rafał. 2020). Whilst these situations are not the most common, having a quicker reaction time may mean life or death. Because of this, it is important to study possible methods of lowering one's reaction time to protect them and others in these circumstances.

Correlation between Sports and lower reaction time

There are many studies that have found athletic participation to be correlated with lower reaction times. Sports have been found to be correlated with a lower reaction time. Female athletes showed lower reaction times than their non-athlete counterparts (Youngen, Lois. 2020). Athletes on average have lower auditory, whole body, and visual reaction time (Gavkare, Ajay, et al. 2013), (Rahman, Hamidur, Muhammad Shahidul Islam. 2021), (Atan, Tülin, Pelin Akyol. 2019). There is evidence for and against a differing reaction times among different sports. Atan, Tülin, and Pelin Akyol found there to be no difference in reaction time between branches of sports, except in Judokas (Atan, Tülin, Pelin Akyol. 2019). Nuri, Leila, et al. found that closed sports athletes show better reaction time than their open sports counterparts (Nuri, Leila, et al. 2013). The previous literature seems relatively clear-cut that athletes show an improved or lowered reaction time compared to their non-athletic counterparts. However, whether or not different sports or different groups of sports lead to differing reaction times are still unclear.

What is Working Memory and why is it important?

Working Memory can be described as mechanisms dedicated to holding selective information for further processing (Chee. 2010). Working Memory has the ability to move information into Long Term Memory (LTM), which contradicts previous models of short-term memory (Baddeley, Hitch. 1974). Working Memory capacity has been thought to have been seven plus or minus two for the past 50 years. However recent studies have led to the belief that the true working memory capacity is around 3 or 4 (Farrington, 2011). Working memory has been found to affect attention. Players tended to make decisions based on internal templates held in the working memory. This shows a greater relationship between attention and working memory that affects decision-making. This experiment showed the relationship to be a “central mechanism” for “everyday purposeful activities” (Furley, Philip, Greg Wood, 2016).

Correlation between working memory capacity and sports

It has been found that the ability to control attention is very important during challenging tasks, such as sports. (Furley, Philip, Greg Wood, 2016). As previously mentioned, many studies have found that working memory plays a role in attention. Athletes with high working memory capacity were found to be better at focusing on their decision-making to tactical decision-making while ignoring auditory distractions and adapting their tactical decision-making to the situation (Furley, Philip, Daniel Memmert, 2012). Another study found athletes with higher working memory capacity to perform better under pressure (Bijleveld, Veling, 2014). Athletes have also been found to have better working memory capacity on average. This correlation is even stronger the higher the level the athlete plays at (Vaughan, Laborde, 2020). However, a very influential sports psychologist theorized that "This view specifically states that athletes with years of experience in an activity such as team sports only differ in cognitive processing skills directly related to their field of experience and no differences should be observable in 'basic' cognitive abilities such as memory capacity, perceptual acuity, or intelligence (e.g., Eccles, 2006; Ericsson et al., 2006; Feltovich, Prietula, & Ericsson, 2006)" (Furley, Philip, Greg Wood, 2016). This theory would infer that athletes, no matter the level, should not show an increase in working memory capacity as it is a "basic" cognitive skill. This theory has also been challenged by other psychologists (Furley, Philip, Greg Wood, 2016). Even though Ericsson theorized that improved "basic" cognitive skills would not be correlated with athletics, all the other literature points in another direction. These "basic" cognitive skills have been shown to be not only correlated to athletes with more experience, but also to be essential in athletics and sporting in general.

Limitations and improvement

The previous studies in this field have done a lot of good work and laid important groundwork for my own study. However, whilst researching the literature I was not able to find a study that examined if the amount of time spent playing a sport had an effect on a correlation. It seemed as though they grouped all athletes into one pool as if they had had similar experiences. My study will do more than just try and replicate previous findings. It will look to examine if there is a relationship between the number of years spent playing a sport and reaction time and working memory. I hypothesize that athletes with more experience in sports will tend to have a higher working memory capacity and a lower reaction time. As shown in the previous research there is a correlation between lower reaction time and working memory is an essential skill in sports. I believe that playing sports longer means that, participating in the sport leads to the development of these skills as they are essential for the activity, or players with better working memory capacity and lower reaction time will perform better and thus play for longer. My study will also examine if there is a relationship between the amount of time spent playing a sport and the sport itself. Essentially, do some sports emphasize different cognitive tasks more than others? Overall my thesis looks to confirm and expand upon previous research done regarding the correlations between reaction time and sport and working memory and sport. Of course, my study has its own limitations. The main of which being the participant pool. As we have gathered participants only from the University of Oregon's human subject pool SONA the sample will be inherently biased to Western Educated Industrialized Rich and Developed (WEIRD) beliefs. Because of this, results might not be applicable to all cultures. Another problem is the participants will be mostly psychology students. The subject of study may be another variable related to reaction time and or working memory. Because of these implications, I would recommend further studies be done to replicate these findings. These studies should be done in many different countries and be done with participants in college, with college experience, and with no college experience.

Methods

Participants

We had 134 participants for the study, of which 51 were athletes. The study had 8 football players, 9 basketball players, 13 soccer players, 1 baseball player, 3 softball players, 8 tennis players, 4 dancers, 4 volleyball players, 11 track athletes, 2 cross country runners, 2 wrestlers, 1 boxer, 1 wushu artist, 3 lacrosse players, 1 cheerleader, 1 golfer, 2 water polo players, 1 kickboxer, 2 swimmers, 2 skiers, 3 weightlifters, and 2 hockey players. The participants were gathered from the University of Oregon human subject pool, SONA. There was not a set number of athletes or non-athletes recruited for each condition. The participants will be rewarded for completing all the tasks with 2 credit hours.

Materials

Informed Consent (IC). Before the other tasks, each participant had to agree to an informed consent form. This form provided participants with information about the tasks they will be required to do in the experiment.

Demographics Form (DF). Before starting with any other tasks, each participant had to fill out a demographic form. This form includes Gender, Age, Medication that may affect results, eyewear, and athletic history. Athletic history asked what sports each participant had played and for how many years.

After the *IC* and *DF*, participants will complete 12 tasks. Of these 12 tasks only 4 of them were used to measure either reaction time or working memory capacity. This paper will only analyze the results from the four tasks related to either reaction time or working memory capacity.

Psychomotor vigilance task (PVT). This task is used to measure participants' reaction time. In this task, participants were presented with a row of zeros on screen. After a variable amount of time, the zeros began to count up in 17 ms intervals from 0 ms (as determined by the 60 Hz monitor refresh rate). The participant's task was to press the spacebar as quickly as possible once the numbers started counting up. After pressing the spacebar the response time was left on the screen for 1 s to provide feedback to the participants. Interstimulus intervals were randomly distributed and ranged from 1 s to 10 s. The entire task lasted for 10 min for each individual (roughly 75 total trials). The dependent variable was the average RT for the slowest 20% of trials (Dinges & Powell, 1985; Unsworth et al., 2010).

Analyzing Reaction Time Data. To analyze our data we looked at a number of different correlations. We examined the correlations between reaction time and sport, reaction time and years played of the sport, and reaction time of athletes vs non-athletes. We had 3 null hypotheses, one for each correlation. Them being; there is no difference in reaction time between athletes from different sports, there is no difference between the reaction time of athletes with more experience and athletes with fewer experiences and there is no difference in reaction time between athletes and non-athletes. We then compared these correlations to look for significant differences on a 95 percent confidence level ($p=0.05$).

The first of three working memory capacity trials is *Operation span (Redick et al., 2012; Unsworth, Heitz, Schrock, & Engle, 2005)*. Subjects had to solve a math equation, and then encode a to-be-remembered letter. After three to seven math–letter elements, subjects were required to recall the letters in the order in which they were presented. The score was the number of letters recalled in the correct order.

Continuous counters (Garavan, 1998; Unsworth & Engle, 2008). Subjects were instructed to keep a running count of each of the number of squares, circles, and triangles presented on a given trial (15 trials total). Shapes were presented individually, and subjects must add to the existing count for each type of shape. This was made difficult by randomly switching shape type six or seven times within each trial and presenting an unpredictable number of stimuli for each trial. At the end of the trial, subjects were asked to report in order the number of squares, circles, and triangles presented. The correct final counts on each trial varied between three and seven on each trial. The correct proportion of correct final counts were used as the dependent variable.

Change detection (Morey & Cowan, 2004; Shipstead et al.,2012). Subjects were presented for 250 ms with a display of four, six, or eight colored (white, black, red, yellow, green, blue, purple) squares on a light gray background. The display disappeared for 900 ms, and then the array reappears with all squares in the same locations. One of the reappearing squares is circled, and subjects had to report whether the circled squares are the same color as it was when originally presented. There were 60 total trials in the experimental block, evenly divided among the three set sizes (four, six, eight) and answer type (color change, color same). Proportion correct is used as the dependent variable.

Analyzing Working Memory Capacity Data. To analyze our data we looked at a number of different correlations. We examined the correlations between working memory capacity and sport, working memory capacity and years played of the sport and working memory capacity of athletes vs non-athletes. We had 3 null hypotheses, one for each correlation. Them being; there is no difference in working memory capacity between athletes from different sports, there is no difference between the working memory capacity of athletes with more experience and athletes with fewer experiences and there is no difference in working memory capacity between athletes and non-athletes. We then compared these correlations to look for significant differences on a 95 percent confidence level ($p=0.05$).

Results

After conducting my research, I used Jamovi to analyze the results. I used sample-independent t-tests as well as correlations, depending on the data. An Independent sample t-test is a method used to measure the difference between precisely two groups (Frost, 2021), whereas correlation measures the relationship between two or more continuous variables.

The first analysis done was on athletes versus non-athletes. As predicted, athletes showed a significantly faster reaction time on the vigilance task when compared to non-athletes (T statistic = 2.59, p = 0.011). These results can be seen in figure 1, with 0 bar representing non-athletes and the 1 bar representing athletes.

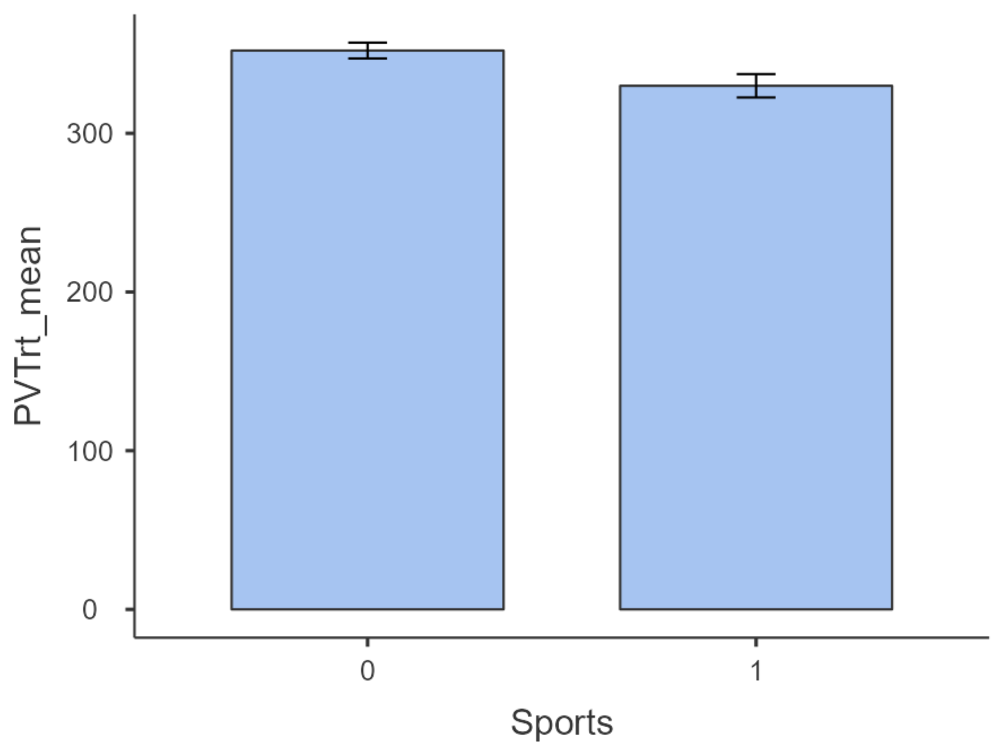

Figure 17: PVTrt scores for Athletes and Non-athletes in Eugene, Oregon

The effect size of this relationship was found to be medium (Cohen's D = 0.465). On average athletes were found to be around 20 milliseconds faster, athletes also had a median score that was around 30 milliseconds faster than non-athletes. However, the working memory results were not as previously predicted. Athletes showed no significant difference on any of the three working memory tasks when compared to non-athletes (OSPAN p = 0.212, CD p = 0.315, CounterAcc p =0.099). For the CD and CounterAcc tasks, non-athletes performed worse than athletes (CD T statistic = -1.01, CounterAcc T statistic = -1.66). OSPAN was the only task where non-athletes managed to perform above athletes (OSPAN T statistic = 1.26).

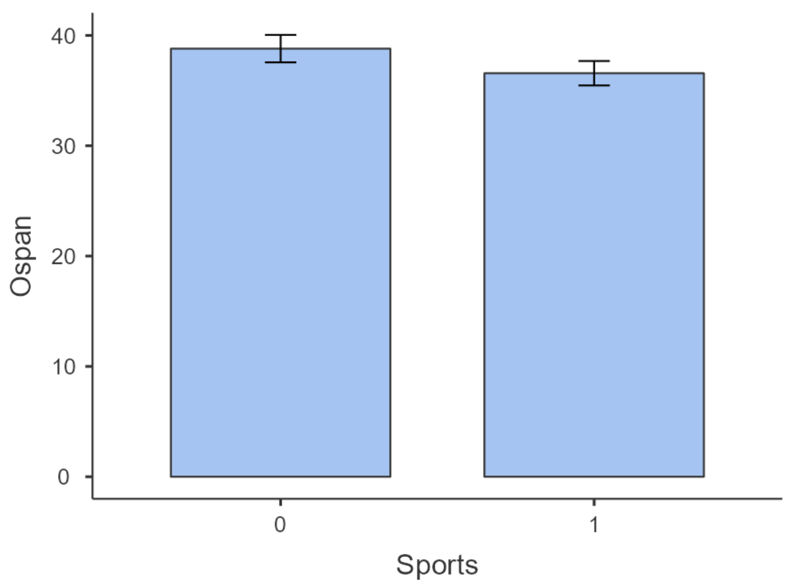

Figure 18: OSPAN scores for Athletes and Non-athletes in Eugene, Oregon

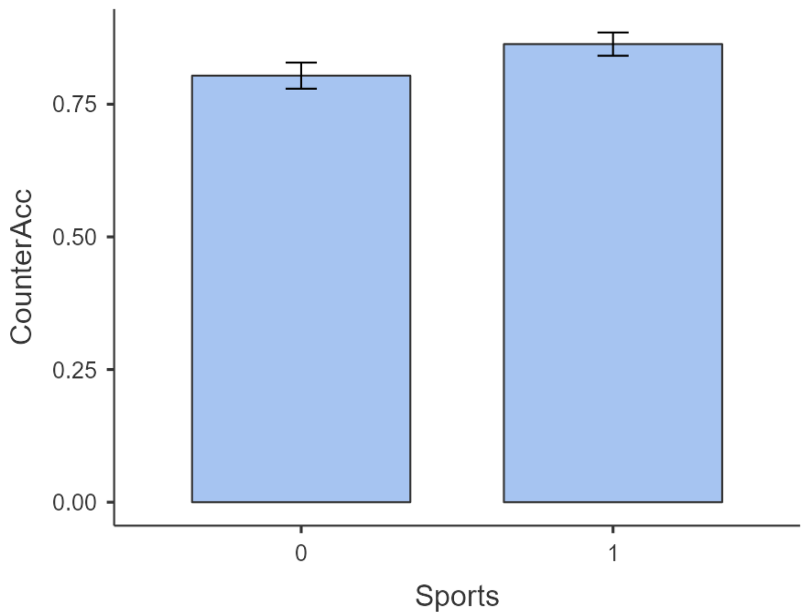

Figure 19: CounterAcc scores for Athletes and Non-athletes in Eugene, Oregon

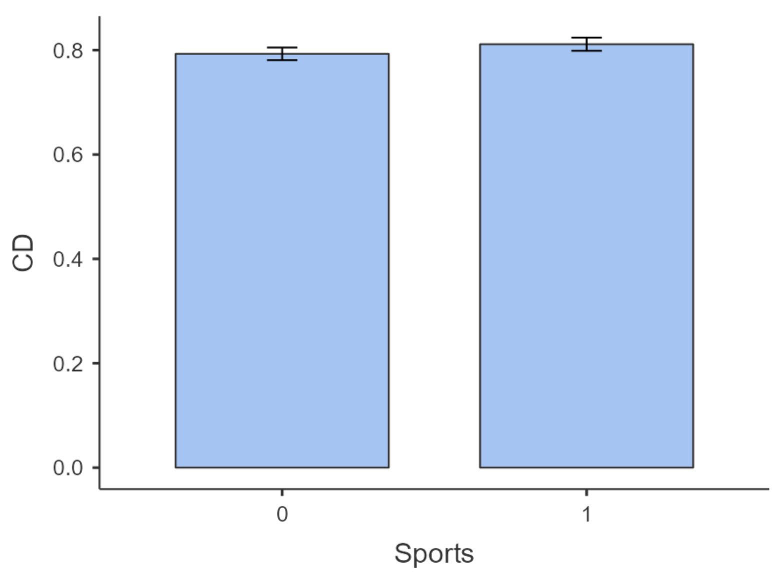

Figure 20: CD scores for Athletes and Non-athletes in Eugene, Oregon

After comparing non-athletes to athletes, we looked at relationships within our athlete participants. First, I examined how much experience each athlete has relates to their performance on the tasks. To measure experience, I counted the total number of years spent playing sports. For example, if someone has played baseball and basketball for 15 years, they would have 30 years of experience. This obviously does not make sense with all of our participants ranging from 18-26, however, this method rewards people for spending more time of the year playing sports. In the previous model, an athlete who only played one sport in one season of every year for 15 years would have the same score as someone who played a sport in 4 different seasons every year for 15 years. This yielded more consistent results, although they were the opposite of what was hypothesized. All the working memory tasks had negative correlations with total years in sports (OSPAN Pearson's R = -0.115, CD Pearson's R = -0.090, and CounterAcc Pearson's R = -0.131). However, once again none of these results were significant based on the hypothesis that Athletes would outperform non-athletes (OSPAN p = 0.777, CD p = 0.730, CounterAcc p = 0.812). The vigilance task also was not significant for our hypothesis (p-value = 0.989, Pearson's R = 0.329). However, the results would be significant when testing for any other hypothesis (hypothesized the variables were correlated in any way p value = 0.021, hypothesized the variables correlated positively p value = 0.011). These findings are strong evidence against my hypothesis.

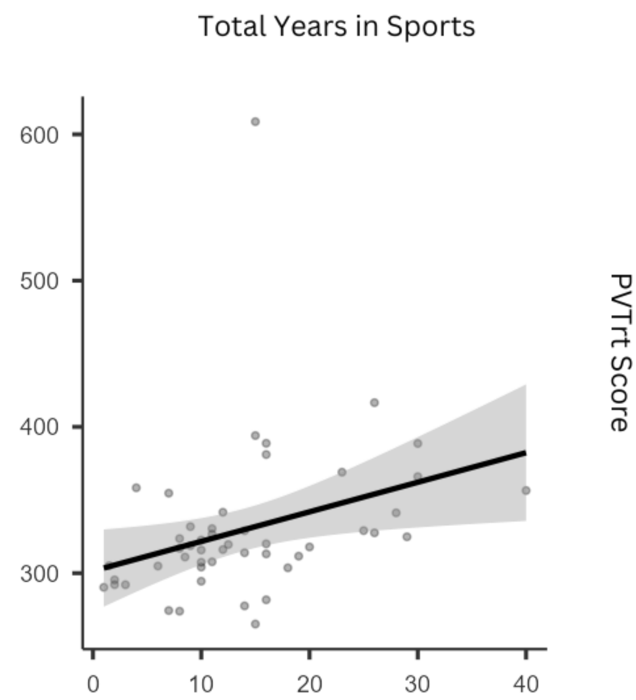

Figure 21: PVTrt scores based on total years spent playing sports in Eugene, Oregon

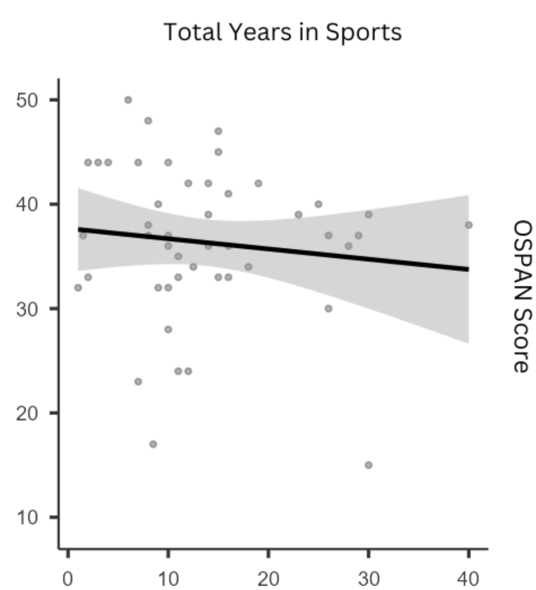

Figure 22: OSPAN scores based on total years spent playing sports in Eugene, Oregon

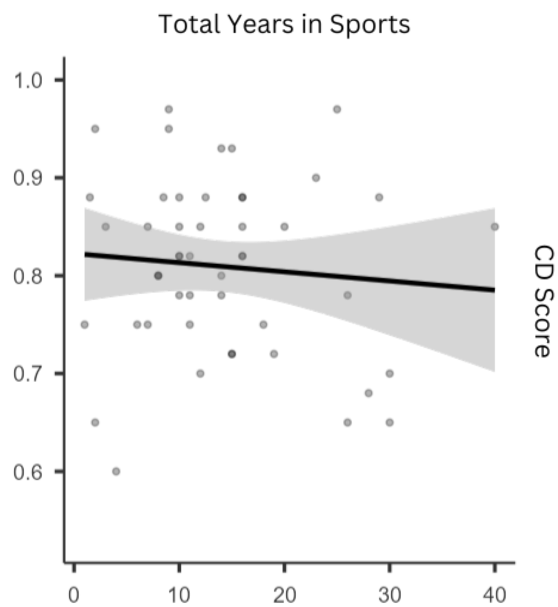

Figure 23: CD scores based on total years spent playing sports in Eugene, Oregon

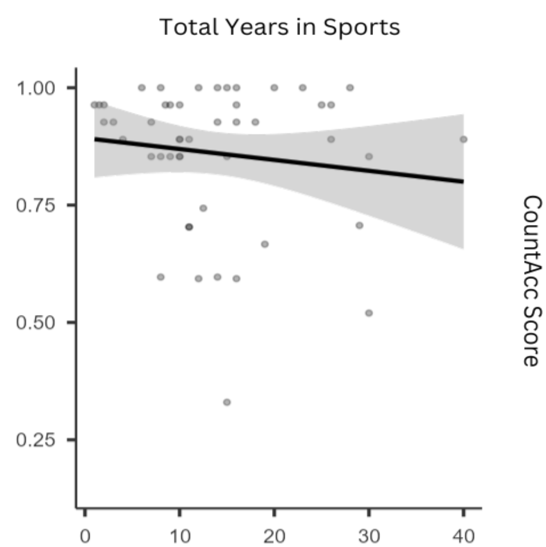

Figure 24: CounterAcc scores based on total years spent playing sports in Eugene, Oregon

I also wanted to test using an alternate model for the experience. The total years model disadvantages athletes who played 1 sport year round as they could only rack up 1 year's worth of experience, whilst a kid who played 3 sports during 3 different seasons would get 3 years' worth of experience. Neither of these models are perfect for encapsulating how much experience athletes had, however combining both of them could get us the best results. To group the athletes, I gave each athlete a score based on the average number of years they played per sport played. The results were very similar to the total years model. None of the working memory tasks yielded significant results (OSPAN p = 0.890, CD p = 0.656, CountAcc p = 0.866). Experienced athletes performed worse on all three working memory tasks (OSPAN Pearson's R = -0.184, CD Pearson's R = -0.059, CounterAcc Pearson's R = -0.163). The vigilance task found a medium positive significant correlation between average years played and reaction time. PVTrt results were also not significant based on the hypothesis of a negative correlation between average years per sport and scores on the task (p-value = 0.999 and Pearson's R = 0.424). When tested with another hypothesis, that being either there is some relationship between the two variables or the variables are positively correlated, the results were found to be significant (With p values of 0.002 and 0.001 respectively).

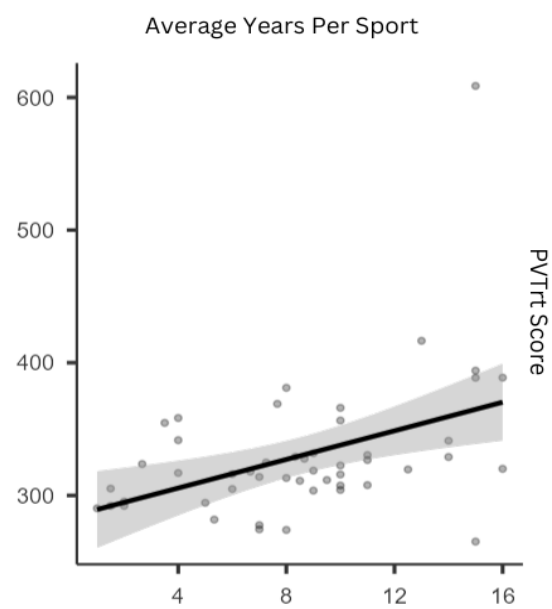

Figure 25: PVTrt scores based on average years spent playing sports in Eugene, Oregon

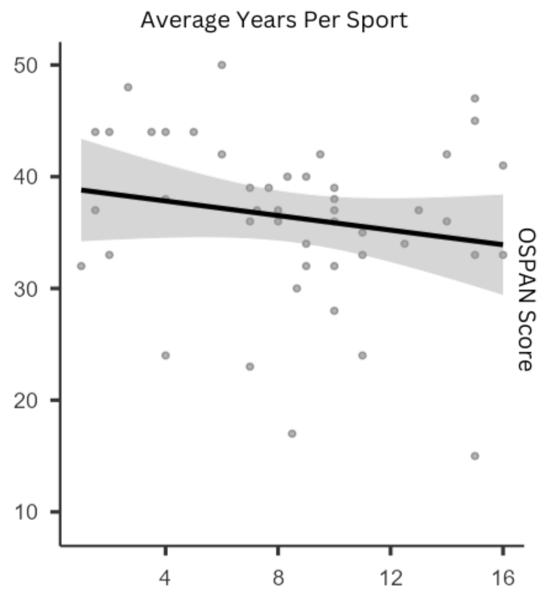

Figure 26: OSPAN scores based on average years spent playing sports in Eugene, Oregon

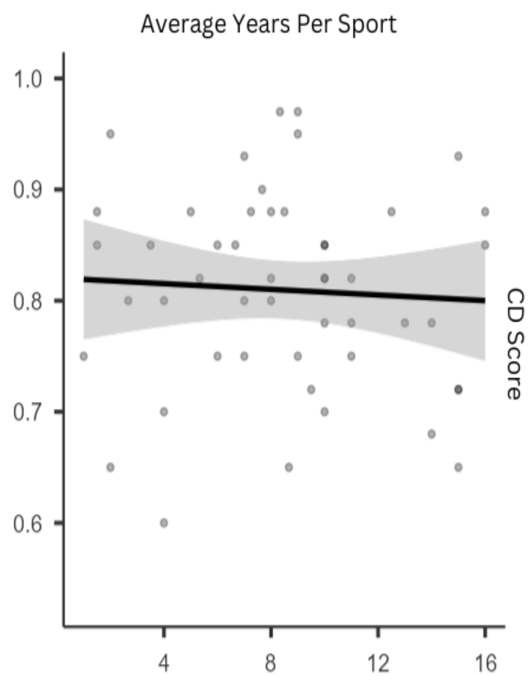

Figure 27: CD scores based on average years spent playing sports in Eugene, Oregon

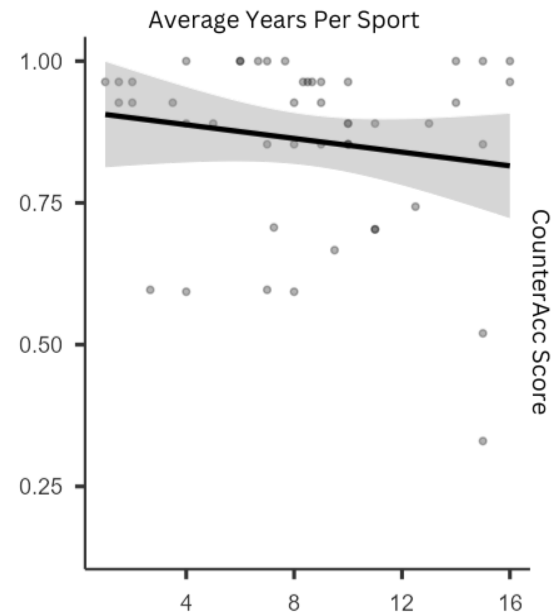

Figure 28: CounterAcc scores based on average years spent playing sports in Eugene, Oregon

Finally, I wanted to compare the sports side by side, to see if some sports performed better on tasks than others. To do this I conducted a one-way ANOVA with my categorical value being the sport played and the continuous values being the scores on each task. The complete findings can be found in the tables below. I would like to draw attention to the two significant findings. First, Basketball players were found to have significantly faster reaction times than non-athletes (PVTrt Mean Difference = -34.61, PVTrt p value = 0.042), and Football players performed significantly better on CounterAcc than non-athletes (CounterAcc Mean Difference = 0.1815, CounterAcc p-value = <0.001). Unfortunately, due to the sample size for each sport, there were not many significant conclusions to be drawn. However, these results did provide evidence that certain types of athletes may have better working memory capacities than non-athletes.

Games-Howell Post-Hoc Test – PVTrt_mean

		Football	Other	Soccer	Track	Basketball	Tennis	Dance	Volleyball	N/A
Football	Mean difference	—	-17.3	-3.48	-5.61	5.89	11.84	-20.99	-2.44	-28.72
	p-value	—	0.999	1.000	1.000	1.000	0.997	0.995	1.000	0.444
Other	Mean difference		—	13.84	11.71	23.21	29.16	-3.67	14.88	-11.40
	p-value		—	1.000	1.000	0.992	0.977	1.000	1.000	1.000
Soccer	Mean difference			—	-2.12	9.37	15.32	-17.51	1.04	-25.24
	p-value			—	1.000	0.998	0.986	0.998	1.000	0.516
Track	Mean difference				—	11.50	17.44	-15.39	3.17	-23.12
	p-value				—	0.960	0.904	0.999	1.000	0.125
Basketball	Mean difference					—	5.94	-26.88	-8.33	-34.61 *
	p-value					—	1.000	0.972	0.999	0.042
Tennis	Mean difference						—	-32.83	-14.28	-40.56
	p-value						—	0.945	0.992	0.135
Dance	Mean difference							—	18.55	-7.73
	p-value							—	0.998	1.000
Volleyball	Mean difference								—	-26.28
	p-value								—	0.648
N/A	Mean difference									—
	p-value									—

Note. * p < .05, ** p < .01, *** p < .001

Table 5: Different Sports' Performances on PVTrt

Games-Howell Post-Hoc Test – Ospan

		Football	Other	Soccer	Track	Basketball	Tennis	Dance	Volleyball	N/A
Football	Mean difference	—	2.47	-1.56	3.000	-2.422	1.09	9.05	-3.45	-1.003
	p-value	—	0.990	0.999	0.993	0.983	1.000	0.757	0.906	1.000
Other	Mean difference		—	-4.03	0.533	-4.889	-1.38	6.58	-5.92	-3.469
	p-value		—	0.761	1.000	0.584	1.000	0.918	0.417	0.840
Soccer	Mean difference			—	4.564	-0.859	2.65	10.61	-1.89	0.561
	p-value			—	0.879	1.000	0.997	0.610	0.991	1.000
Track	Mean difference				—	-5.422	-1.91	6.05	-6.45	-4.003
	p-value				—	0.770	1.000	0.965	0.618	0.925
Basketball	Mean difference					—	3.51	11.47	-1.03	1.419
	p-value					—	0.985	0.550	1.000	0.998
Tennis	Mean difference						—	7.96	-4.54	-2.089
	p-value						—	0.903	0.943	0.999
Dance	Mean difference							—	-12.50	-10.053
	p-value							—	0.484	0.646
Volleyball	Mean difference								—	2.447
	p-value								—	0.943
N/A	Mean difference									—
	p-value									—

Note. * p < .05, ** p < .01, *** p < .001

Table 6: Different Sports' Performances on OSPAN

Games-Howell Post-Hoc Test – CD

		Football	Other	Soccer	Track	Basketball	Tennis	Dance	Volleyball	N/A
Football	Mean difference	—	-0.0108	0.0108	0.0597	0.06767	0.00667	0.06167	-0.0508	0.0387
	p-value	—	1.000	1.000	0.935	0.929	1.000	0.974	0.972	0.989
Other	Mean difference		—	0.0217	0.0705	0.07850	0.01750	0.07250	-0.0400	0.0495
	p-value		—	0.999	0.529	0.619	1.000	0.839	0.951	0.709
Soccer	Mean difference			—	0.0488	0.05683	-0.00417	0.05083	-0.0617	0.0279
	p-value			—	0.843	0.871	1.000	0.960	0.646	0.972
Track	Mean difference				—	0.00800	-0.05300	0.00200	-0.1105	-0.0210
	p-value				—	1.000	0.728	1.000	0.115	0.995
Basketball	Mean difference					—	-0.06100	-0.00600	-0.1185	-0.0290
	p-value					—	0.795	1.000	0.169	0.993
Tennis	Mean difference						—	0.05500	-0.0575	0.0320
	p-value						—	0.933	0.664	0.899
Dance	Mean difference							—	-0.1125	-0.0230
	p-value							—	0.468	0.999
Volleyball	Mean difference								—	0.0895
	p-value								—	0.181
N/A	Mean difference									—
	p-value									—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 7: Different Sports' Performances on CD

Games-Howell Post-Hoc Test – CounterAcc

		Football	Other	Soccer	Track	Basketball	Tennis	Dance	Volleyball	N/A
Football	Mean difference	—	0.139	0.13561	0.12567	0.1027	0.1691	0.2520	0.10450	0.1815 ***
	p-value	—	0.309	0.133	0.390	0.394	0.256	0.476	0.710	< .001
Other	Mean difference		—	-0.00361	-0.01356	-0.0366	0.0299	0.1128	-0.03472	0.0423
	p-value		—	1.000	1.000	1.000	1.000	0.975	1.000	0.998
Soccer	Mean difference			—	-0.00994	-0.0329	0.0335	0.1164	-0.03111	0.0459
	p-value			—	1.000	1.000	1.000	0.961	1.000	0.988
Track	Mean difference				—	-0.0230	0.0435	0.1263	-0.02117	0.0559
	p-value				—	1.000	1.000	0.953	1.000	0.983
Basketball	Mean difference					—	0.0665	0.1493	0.00183	0.0789
	p-value					—	0.987	0.884	1.000	0.791
Tennis	Mean difference						—	0.0829	-0.06464	0.0124
	p-value						—	0.996	0.994	1.000
Dance	Mean difference							—	-0.14750	-0.0705
	p-value							—	0.916	0.996
Volleyball	Mean difference								—	0.0770
	p-value								—	0.919
N/A	Mean difference									—
	p-value									—

Note. * p < .05, ** p < .01, *** p < .001

Table 8: Different Sports' Performances on CounterAcc

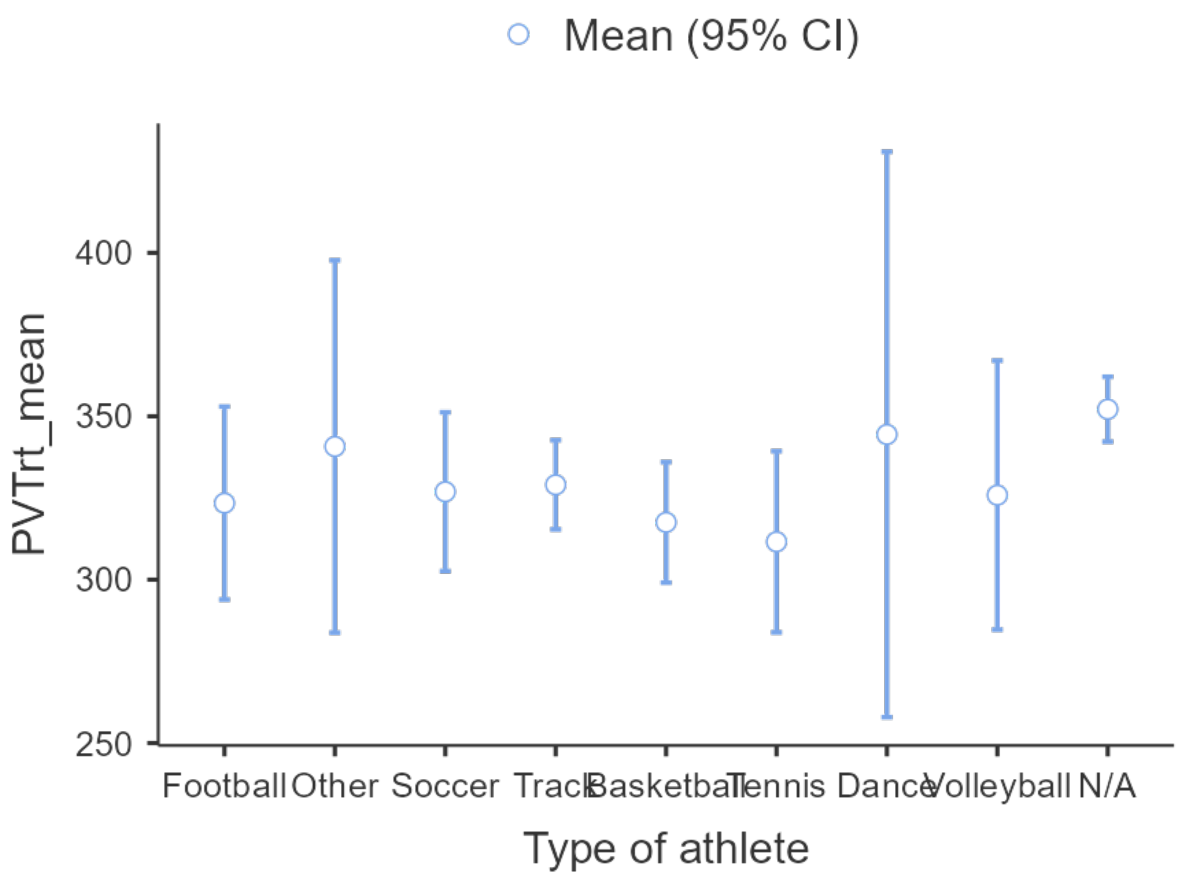

Figure 29: Different Sports' Performances on PVTrt

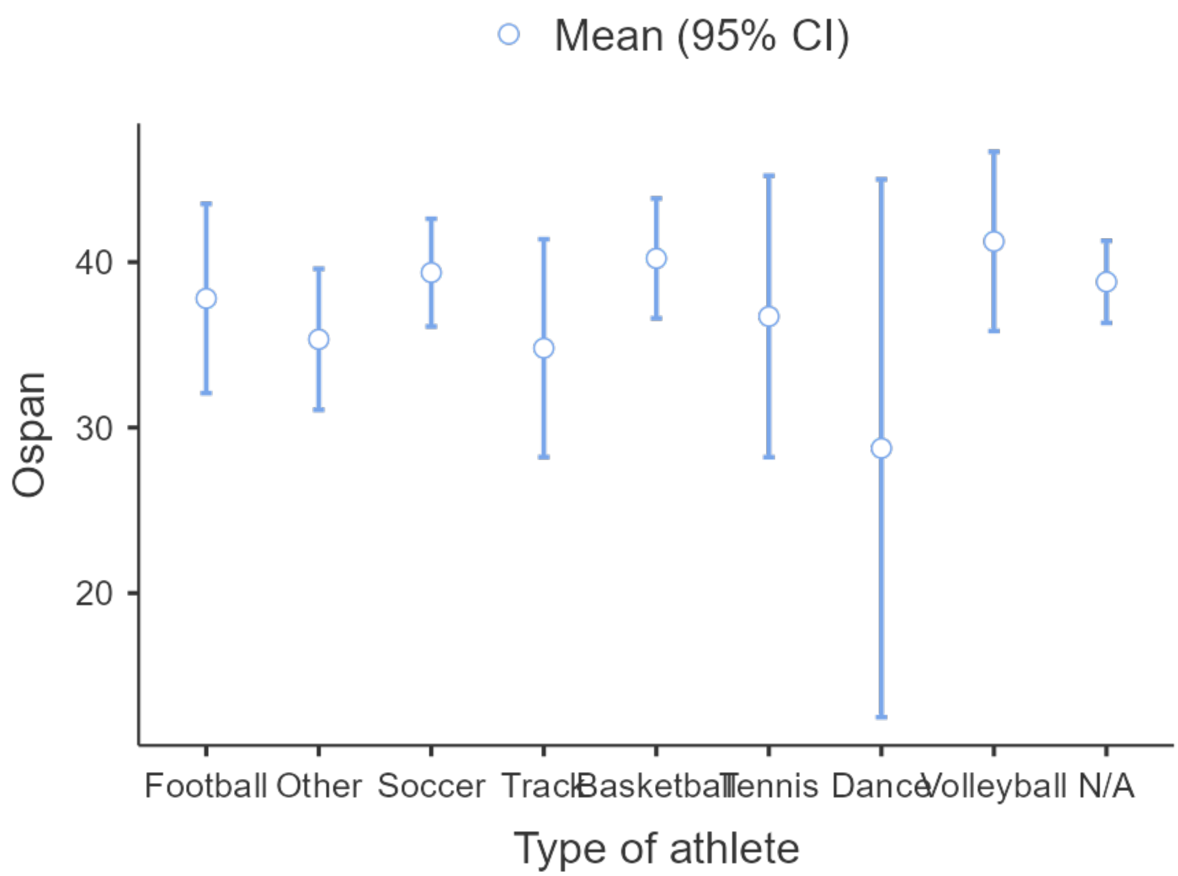

Figure 30: Different Sports' Performances on OSPAN

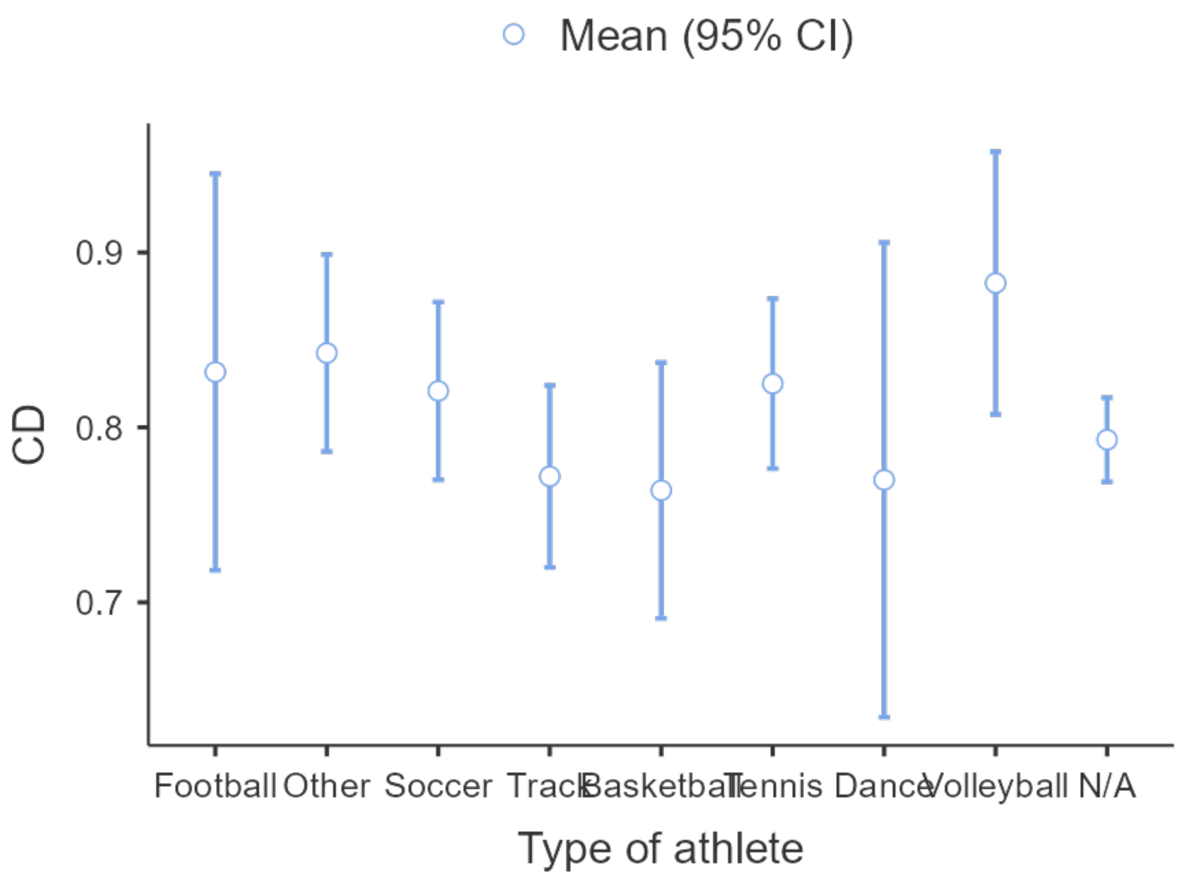

Figure 31: Different Sports' Performances on CD

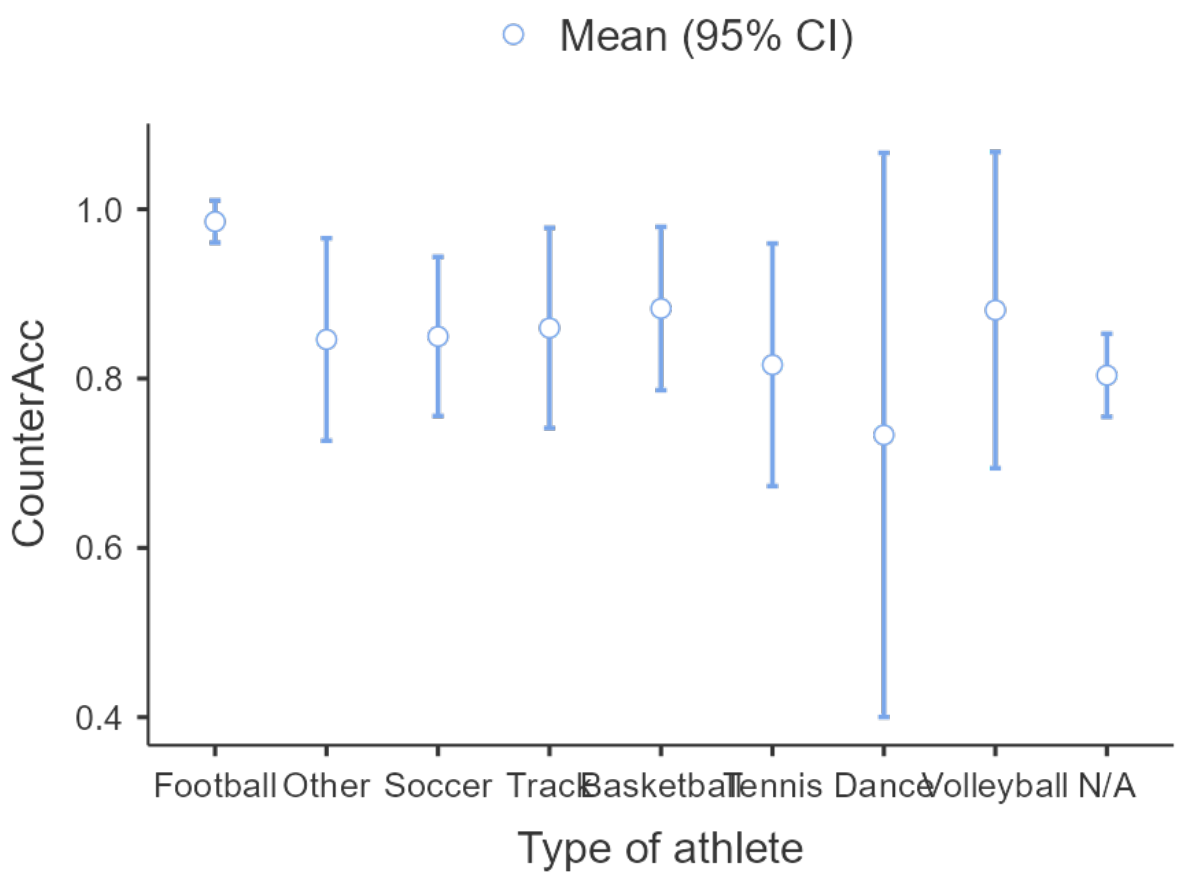

Figure 32: Different Sports' Performances on CounterAcc

Discussion

This research was not able to answer all of the research questions originally proposed. However, it was able to narrow the search. Firstly, this study is evidence in favor of the previous findings that athletes have a better reaction time than non-athletes (Gavkare, Ajay M., et al. 2013), (Rahman, Md. Hamidur, and Muhammad Shahidul Islam. 2021), (Atan, Tülin, and Pelin Akyol. 2019). Second, this study is strong evidence that the total number of years spent playing sports does not decrease reaction time or increase working memory capacity. All other findings were not significant. Whilst they weren't necessarily significant they still provide some evidence that some hypothesized relationships do exist between certain sports. Due to limited sample sizes, the potential ranges for the true mean for each individual sport are incredibly large. However, certain sports did have a higher average mean than the non-athletes on the working memory tasks. Volleyball and Soccer average means at or above the average mean for non-athletes for all 3 working memory tasks. Football players performed significantly better on the CounterAcc task than non-athletes (p-value = <0.001). Football players also outperformed non-athletes in the CD task. While this is not the strongest evidence that athletes from these sports have larger working memory capacity. It does indicate there is a potential. Future studies should examine the working memory capacity of specifically these sport's athletes. With proper sample sizes, a relationship may be discovered, or it may show that there truly is no relationship. The other findings relating to working memory capacity are too inconsistent to draw any conclusions. With some tests favoring athletes and other tests favoring non-athletes.

This study does have a few limitations to be considered. Firstly, this was done on a WEIRD sample or a Western Educated Industrialized Rich, and Developed sample. This means the results from this paper might not be applicable to people who live in non-WEIRD cultures. A second limitation is the lack of sample size for specific sports. There were only 7 sports represented by 4 or more athletes, even the most represented sports failed to have at least 15 athletes. This leaves the numbers to be very susceptible to outliers. Thirdly, the wording of the demographic question seemed to confuse some of the participants. The question stated, "Do you play any sports?". The question is asking about sports participation in the present when we are truly wondering about their sports participation in the past. While most participants were able to figure out the true intentions of the question, some may have been misrepresented as non-athletes when they truly were athletes. Finally, the experiment itself was around 2 hours long, with all the tasks being measured coming in the later half of the experiment. This fatigue and lack of focus may have had impacts on the results for both athletes and non-athletes. Future research should aim to create experimental designs that can avoid these limitations.

Sample size issues are the main limitation that future studies should aim to avoid. Because of the small sample sizes, it would be difficult to find significant results for specific sports. To do this, I would make sure to recruit a certain number of participants from each sport. You can randomly select participants from each sport, but identifying a specific number of each type of athlete would help have a healthier sample size. Second, I would design the study to only include working memory capacity tasks and reaction time tasks. This way the test can be shorter and fatigue will have less of an effect on the results.

Summary

This study examined the differences between athletes and non-athletes. It also examined the differences between different types of athletes. This study provided more evidence in support of previous findings that athletes tend to have faster reaction times than non-athletes. The study found no evidence to suggest that there is a major difference between athletes and non-athletes in working memory capacity. There was no evidence to suggest that more experienced athletes have larger working memory capacity or faster reaction time than less experienced athletes, in fact, it provided some evidence to the contrary. While there were no significant findings found relating to individual sports, there was some evidence that indicates promise for studies with more robust sample sizes. Due to the findings in this study as well as previous studies, I feel confident in suggesting that athletes tend to have significantly faster reaction times than non-athletes. Due to the lack of exploration of working memory capacity in athletes, I feel more studies should be done, targeting specific sports listed in the discussion section of this paper.

While this paper indicates there is no difference between athletes and non-athletes, there are some studies that provide evidence for the contrary and more research should be done on the topic.

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