

A Study on Football Players: Concussions and Working Memory

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Abstract

Research shows that brain damage can have serious long- and short-term effects on a person's memory and overall function of life. Football has the most recorded concussion injuries of any other sport. What has yet to be examined is the relationship between playing football and working memory recall when there is no concussion. This study looked at 56 college football players and 28 non-football players to examine the effect concussions have on a person's working memory. This study found a significant interaction between group type (football player or non-football player) and concussion status (history of concussion or no history of concussion) with respect to working memory performance. Specifically, non-football players with no concussions earned the highest working memory test scores, followed by non-football players with concussions, then by football players with concussions, and finally football players with no concussions. Possible reasons for these findings are discussed. Further research is needed to understand why these outcomes occurred.

Keywords: concussions, football, working memory, brain damage

A Study on Football Players: Concussions and Working Memory

A concussion is a type of traumatic brain injury (TBI) caused by a bump, blow, or jolt to the head or neck (Barry & Tomes, 2015). There are well documented effects of concussions on working memory. Sport related concussions are the most common form of concussions. There are an estimated 1.6 to 3.8 million documented cases of concussions annually that are sports related (Tremblay et al., 2014). Concussions can be extremely damaging to a brain but have not always been treated as a dangerous injury. Only in the past decade have return to play decisions been addressed and implemented into sports programs (Tremblay et. al., 2014). It is well known that football is one of the most popular contact sports for male athletes to participate in. Because of the high frequency of contact collegiate football athletes who have competed for years have a higher probability of suffering from short term and long term physical and psychological consequences (Covassin, Elbin, Beidler, LaFevor, & Kontos, 2017). High school and college programs have adopted more strict concussion protocols in the past decade in order to better protect athletes.

The NFL (National Football League) is one of the most popular televised sport in the United States and Canada. In a study done on former NFL athletes, former players with a history of concussions reported more memory problems than former players who did not have concussions (Barry et. al., 2015). It is clear that concussions negatively impact memory but one area that has yet to be researched as deeply as other areas is the overall impact that football has on memory when no concussion occurs. It is important to understand how damaging concussions, and the sports that they are most prevalent in, can be to the well-being of the athlete.

The current study assesses the relationship between playing football and working memory recall in college football athletes who have no reported concussions. In a study conducted by Tremblay and colleagues, brains, specifically the white matter within the brains, of retired athletes who suffered from one or more concussions and who did not suffer from concussions were analyzed. All of the athletes participated in either ice hockey or football at the college level.

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The study revealed that there was a greater loss of white matter in the brains of concussed brains than non-concussed brains (Tremblay, et. al., 2014). This evidence of the breakdown of white matter shows how much of a physical effect concussions can have on the brain long-term.

Unfortunately this study falls short in the number of brains looked at. Brains are not easy to come by in studies so the experimenters only had access to 15 brains from past athletes (Tremblay, et. al., 2014). This study also never specified how the concussions that the athletes suffered from were reported. It is important to understand if the concussions were self-reported, diagnosed by a coach who may not have been certified in medical care or if they were diagnosed by a certified on staff athletic trainer, clinician, or medical doctor. It is important to consider how the concussion was diagnosed because of underreporting, misdiagnosis, or lack of basic knowledge of what a concussion is.

In a study done by Singh and colleagues (2014) other physical effects that concussions may have on the brain were examined. The relationship between college football and concussions was looked at by measuring hippocampal volume and cognitive performance (Singh et al., 2014). This study found that there was a relationship between the years of football played and the hippocampal volume size (Singh et. al., 2014). Another interesting finding of this study was that years of football experience also had a significant correlation with slower reaction times (Singh et. al., 2014). Slower reaction times found in college football players could be a sign that regardless of concussions, football has a negative impact on memory. In this study, it was found that cognitive functions were compromised when looking at athletes who suffered from concussions. A way that this study could go a step further, and what the current research will look at, is if there is a correlation between athletes who play football and who have not suffered from concussions and their cognitive functions.

In a study done by Barry (2015), autobiographical recall was looked at in regards to concussions. The study focused on recall based on details, vividness, completeness, and the ease

of recalling the memory (Barry, 2015). A self-administered questionnaire was used to analyze the participants' autobiographical recall. In this study, More than 84% of the reported concussions were sports related (Barry, 2015). This study found differences in the recall of memories based on if a person suffered from concussions or not. The participants who did suffer from concussions gave less detailed descriptions of the event than non-concussed participants (Barry, 2015). These results show how concussions can affect people later in life and how their memory is affected over time due to sport-related concussions.

The above study examines damage to the brain post athletic career but there has been new research that suggests we may be able to determine genetic factors that may contribute to head injuries (Arnett, 2019; Merritt & Arnett 2019). This new area of study looks at athletes possible genetic makeup that may influence overall concussion symptoms and their recovery process (Merritt, et. al., 2019). Everyone is different and every athlete may react to a concussion differently and present different symptoms, this research introduces the role of genetics in concussion response and recovery (Arnett, 2019). The research done by Merritt and Arnett (2019) looks at two main genes in athletes, the apolipoprotein E (APOE) gene and the catechol-o-methyltransferase (COMT) gene. Both of these genes have been linked to playing major roles in outcome and recovery in concussions in the release of dopamine in the brain (Merritt, et.a al., 2019). This research is in the very early stages but not a lot has been done in the sport injury field, this is what Merritt and colleagues (2019) hope to change. The possible contribution of many different genes in head and brain injuries and recovery are being studied and this research is promising in acquiring a better understanding of the possible relationship genes may have with TBI outcome and injury. Knowing about these genetic factors in an individual athletes could help to better prescribe post concussion treatment and management (Arnett, 2019). Though this area needs further development, it is important to mention with the current study due to possible genetic components that we may not have all the information on yet.

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There have been many studies done on the physical effects of concussions, but not as many studies on the psychological effects of concussions (Covassin, et. al., 2017). In a study done by Covassin (2017) the psychological factors of sport-related concussion in youth and college athletes were analyzed. There are many physical factors that play into memory loss due to concussion, but can the psychological issues also play into memory loss? According to Salinas (2012), focus on American Football and concussions is understandable because: (1) football teams represent the largest rosters of participants across sports, (2) collisions involving the head occur on every play in football, (3) injuries of the head lead to the threat of banning football in the early 1900's, and (4) professional and college/university football teams participate in concussion management programs for athlete protection. The increased awareness of concussion damage has led to improved protective equipment and safety protocols (Salinas & Webbe, 2012). Though these new protocols have been put into place, concussions are still a frequent injury in the sport of football and the sport itself could be harmful to the health of the athletes.

Athletes are often held to high standards and are often put under a lot of pressure. A study done by Kroshus and colleagues (2015) looks at the rate of under-reporting of concussions by college athletes due to outside pressure from coaches, teammates, fans and parents. The results of this study showed that one in four athletes who experienced a concussion in the previous season experienced pressure from an outside source to continue playing after a head impact (Kroshus, et. al., 2015). Athletes who experienced pressure from teammates, parents and fans reported that they were less likely to report symptoms of a future suspected concussion (Kroshus, et. al., 2015). It is obvious that there are outside pressure that affect concussion reporting by athletes. This can be extremely dangerous for the athletes health and future brain function. This study uncovered just how often athletes under-report head injuries.

The nature of the sport of football is aggressive. There is a higher potential of risk of concussion when playing football compared to playing, for example, golf (Salinas, 2012). The combined speed and movement involves constant thinking and working memory. Previous

studies show that football and volleyball at the college level have a higher demand of working memory processing than other sports (Mayers, Redick, Chiffriller, Simone, & Terraforte, 2011). However other studies on college football athletes indicated that after years of playing football there was a positive correlation with the development of slower reaction times (Singh, et. at., 2014). It is clear from research that college football is a difficult and physical sport to partake in.

With such high concussion rates, and the possibility of unreported concussions it is hard to argue that playing the sport is safe for the athletes. However where these studies fall short in the research is the effect that football has on the athletes even when concussions are not present in the players history. There is well supported evidence that there are lasting long-term memory effects and physical effects on the brain when an athlete experiences a concussion. But is it only the concussions that are damaging to the athletes? The current study looks at the working memory of athletes who have a history of concussions and who do not have a history of concussions in order to determine the effect of the sport of football on athletes' memory.

This study will investigate the relationship between concussed football players and non-concussed football players and their working memory recall. We hypothesize that regardless of concussion history college football athletes will still have a lower working memory recall score than non-athletes who do not play football.

Methods

Participants

Data were collected from 84 undergraduate students 71 males undergraduate students and 13 female undergraduate students. The control group consisted of 28 individuals, 15 males and 13 females, who do not play college football. The control group consisted of 9 individuals who had suffered from a concussion and 19 individuals who reported never having a concussion. The experimental group consisted of 56 individuals, all of which were male, who did play college football. Of these individuals 28 reported having suffered from a concussion in the past and 28

reported never having a concussion. None of the athletes had experienced their concussions two months prior to the survey. This is important as none of the individuals were experiencing postconcussive symptoms.

Participants were excluded if they did not complete the first part of the first survey that included demographic questions and concussion history information. There were two surveys that were excluded from this study due to incomplete demographic pages. Participants surveys were also excluded if it appeared that they skipped a page of the survey or chose not to complete the survey. One survey was excluded due to lack of participation in the working memory part of the survey. Using this uncompleted survey could have resulted in a skew of the data if the survey was incomplete and did not receive full points for lack of completion.

Participants from the control group were recruited through an introduction to psychology course. Participants in the experimental group were recruited by contacting the coach of the on campus football team to inform them about the study. The study was voluntary and there was no compensation for participation.

Materials

Materials for this study consisted of two self-administered questionnaires. The first questionnaire consisted of demographic information such as age, gender and concussion history. This self-report concussion inventory was developed for this study. Participants answered a series of questions about their concussion history including the amount of concussions they had sustained, the length of time recommended for rest from the most severe concussion, the activity they were engaging in when the concussion was sustained, and the date of the most recent concussion. The second questionnaire consisted of a combination of two previously created working memory capacity assessments; The VAMC SLUMS examination and the Self

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Administered Gerocognitive Examination (SAGE form) (Scharre, 2007; Tariq, 2006). This questionnaire was created to analyze the participants working memory recall. The questionnaire consisted of eight questions. Some of the questions were asked verbally and answered on paper, and some questions were asked and answered on paper. The participants were scored out of 18 possible points.

Design

This study was a between groups design. A two-way ANOVA was used to measure the effect of having a concussion or not having a concussion and football players or non-football players. This information was used to determine working memory. A survey was used to measure the working memory of all of the participants.

Procedure

All data was collected on a paper questionnaire. Participants were testing in groups of up to 56 individuals. The procedure for all groups were identical. The researcher first administered an informed consent form that the participants had to read and sign before participating in the study. Once the informed consent form were collected the researcher administered the survey questionnaire. The demographic questionnaire was completed first and then the working memory questionnaire was completed. During the memory questionnaire the research had to read of a series of the questions in order for the participants to answer. Once the questionnaires were completed the participants handed in their surveys. The participants were debriefed on the nature of the study. The survey took approximately 15 min to complete.

Results

A two-way ANOVA with an alpha set at .05 was used to determine the effect of football on working memory recall. Specifically we looked at the relationship between type of person (football player or non-football player), concussion history (concussion or no concussion) and the interaction of these factors on a test measuring their working memory recall.

We looked at the concussion history of people regardless of whether they are football players or non-football players. Our two-way ANOVA found that there was no significant difference in scores on the working memory survey of people with concussions ($M=14.49$, $SD=2.34$) and people with no concussions ($M=14.79$, $SD=2.41$). The inferential statistics show $F(1,80)=.56$, $p=.46$.

We looked at the groups of people football players compared to non-football players regardless of concussion history. Our two-way ANOVA found that non football players ($M=13.84$, $SD=2.32$) had significantly higher scores on the working memory survey than football players ($M=16.29$, $SD=1.61$). The inferential statistics show $F(1,80)=18.74$, $p< 0.001$.

We looked at the relationship between concussion history, having a previous concussion or no previous concussion, and the groups of people, football players or no-football players. See Table 1 for the descriptive statistics. The inferential statistics show $F(1,80)=5.70$, $p=.02$. The highest score on the surveys came from non-football players who did not have concussions ($M=16.79$, $SD=.92$). The lowest score on the surveys came from football players who did not have concussions ($M=13.42$, $SD=2.15$). There was a significant difference in the scores of the relationship between concussion status and group of people.

Discussion

The purpose of this study was to assesses the working memory of college football athletes who have a history of concussions and who do not have a history of concussions in order to determine the overall effect that football has on athletes working memory. We hypothesized that regardless of concussion history college football athletes will still have a lower working memory recall score than non-athletes who do not play football. After conducting this study and investigating the relationship between concussed football players and non-concussed football players and their working memory recall it was found that our hypothesis was supported.

It was found that football players as a group did have significantly lower scores on the

working memory questionnaire than non-football players. Out of all four of the different groups that were tested, football players who did not have concussions scored the lowest on the working memory questionnaire. Non-football players who had not suffered from a concussion scored the highest on the working memory questionnaire.

It would be expected that football players who had suffered from concussions would have the lowest scores, yet football players who had not suffered from concussions had lower scores. The most likely reason for this finding could be lack of concussion reporting. Some of the football players who reported never having suffered from concussions may not have reported the head injuries. This could be because they did not want to sit out of their sport or they felt pressure from an outside source to continue playing (Kroshus, 2015). Brain injuries like concussions are dangerous yet it is a common trend for athletes to not report head injuries (Kroshus, et. al., 2015; Mayers, 2011).

An additional reason for this finding could be that the football players who had reported a history of concussions were provided with the time to heal properly. It is likely that when the athletes did report their concussions to a coach, athletic trainer, or doctor that they received proper treatment. This treatment could include testing for a possible TBI or concussion and sitting out for a recommended amount of time in order for the brain to heal properly. Football players who had no reported concussions could have played through their injury without reporting it or taking any medical precautions that could have further injured the brain and their overall memory (Mayers, 2011).

It is likely that non-football players who have not suffered from concussions have not had as much exposure to head to head contact which in turn makes them less likely to have suffered from injuries to the brain. This lack of injury to the brain could be one of the reasons why their working memory scores are so high.

There was a substantial amount of evidence in my research that supported past research

studies (Barry, 2015; Covassin, 2017; Tremblay et. al., 2014). There has been a lot of research on this topic, but there is still no clear evidence on just how much of an impact football has on the brain. Football is an extremely popular sport in America but if there are serious negative effects on people later in life due to head trauma, is it worth the risk? Concussion protocols are being implemented into more programs across the country but they may not be catching all head injuries.

Some study limitations include a small sample size of both football players and non-football players. With a larger sample size we could acquire more accurate results. There was also an uneven amount of each group of participants, more even number of groups could fix any possible skews in the data. Another limitation is the data collection from the football players. The time that we met the team for the distribution of the surveys was immediately following their weight training session. This could have resulted in a possible lack of focus for some of the participants.

Future research efforts are needed to provide more accurate findings about the effect of football on the brains working memory. Regardless of concussion history there still seems to be some impact on the football players as a group. This data is important to look at and understand due to the danger that football players may be at risk of.

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Table 1

Descriptive Statistics Interaction Between Concussion Status and Group of People

Condition	M	S.D
Football player*concussion	14.25	2.44
Football player*no concussion	13.43	2.15
Non-football player*concussion	15.22	2.22
Non-football player*no concussion	16.79	0.92

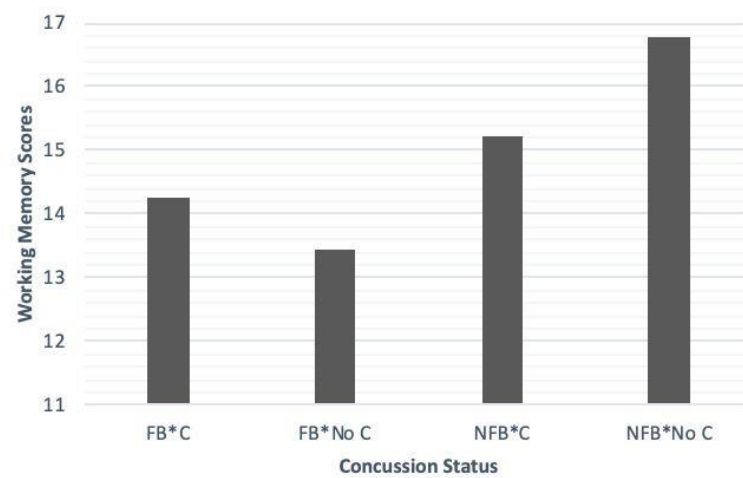


Figure 1. Bar chart shows the working memory scores of football players with and without concussions and non-football players with and without concussions.

Appendix A

Working Memory Survey-Researcher Version.

Age _____

Date of your most recent concussion?

Gender: (circle one)

1. Male
2. Female
3. Transgender
4. Other: _____

_____ (e.g 1/5/18 or May 2012)

Have you ever had a medically diagnosed concussion? (circle one)

- A. YES, due to a sport
- B. YES, due to incident other than a sport
- C. NO

If you answered yes, what sport? (e.g. basketball, football, climbing, skiing, etc.)

If so, how many in your lifetime? (circle one)

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5 or more _____ (list how many)

How long were you “out” based on medical advice? (longest duration of time if there were multiple concussions)

- A. One week to two weeks
- B. Three to four weeks
- C. Five to six weeks
- D. 7 weeks or more

PLEASE PUT DOWN YOUR
PEN/PENCIL AND WAIT FOR FURTHER
INSTRUCTION BEFORE MOVING ON

Now you are going to have a short 2 page questionnaire. Read each question carefully as you will need some instruction in order to answer some of the questions. At the bottom of the last page, before you turn in your survey, write “I have finished”. Do you understand?

1. (3pts- 1pt each) What is the date? Month_____ Day_____ Year_____
2. (1pt)What state are we in?_____

When you have finished answering the first two questions put your pencil/pen down so I know you are ready for the next step.

3. I am going to tell you 5 objects to remember, I will read them off twice.

APPLE PEN TIE HOUSE CAR (read x2)

4. (buffer)Please write down as many animals as you can in one minute.

I am going to start the timer, write down as many animals as you can. Don't worry about spelling. You may begin.

5. (4pts - 1pt each)**There are 4 blank spaces. I am going to say a series of numbers. I would like you to write them down backwards. For example: I say 42, you write 24.**

49 (94) 217 (712) 6,401 (1,046) 15,938 (83,951)

6. I am going to tell you a story. Listen carefully because afterwards I'm going to ask you some questions about it.

STORY: Jill was a very successful stockbroker. She made a lot of money on the stock market. She then met Jack, a very handsome man. She married him and had three children. They lived in Chicago. She then stopped work and stayed at home to bring up her children. When they were teenagers, she went back to work. She and Jack lived happily ever after.

(4 pts - 1pt each) **You may turn the page and answer the remaining questions**

What was the woman's name? _____(Jill)_____

What work did she do? _____(Stockbroker)_____

When did she go back to work? _____(After kids were teens)_____

What state did they live in? _____(Illinois)_____

7. (5 pts - 1pt each)What were the five objects I asked you to remember.

1 APPLE

2 PEN

3 TIE

4 HOUSE

5 CAR

(1pt) All done? "Iamfinished"

Points are calculated out of a possible 18