

FUNK, DANIELLE CHRISTINA, M.S. Fans' Perception and Understanding of American Professional Tackle Football, Concussions, and Chronic Traumatic Encephalopathy (2019)
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Due to potentially dangerous consequences, the American public has become concerned with concussions in American tackle football. Scientists have identified repeated concussions as a potential contributor to Chronic Traumatic Encephalopathy (CTE), a progressive neurodegenerative disease related to negative health changes, premature death, and suicide (Omalu et al., 2005; Omalu et al., 2006; Omalu et al., 2010). In response to growing concerns about the risk of concussion, the NFL has established a comprehensive set of protocols related to diagnosis, management, and ongoing education of NFL personnel and players (Play Smart, Play Safe, 2017). This improvement in the NFL Concussion Diagnosis and Management Protocol highlights the NFL's efforts to improve the safety of NFL players and reduce the number of head injuries associated with playing in the NFL.

Because the concussion issue has garnered public attention, it is important to understand public perceptions and knowledge on concussions, CTE, and the NFL. This is the first study evaluating these topics within the general public and fan populations. Therefore, objectives of this study were to (1) describe the current NFL fans' perceptions and understanding of concussions, CTE, and the NFL response to CTE, and (2) assess fans' opinions regarding concussion topics. The primary hypothesis was that participants with direct current or former experience (i.e., current or former player, current or former coach, current or former medical team member) would score higher on the concussion

knowledge portion of the questionnaire as compared to participants with fan experience only (i.e., current or former fan with no playing, coaching, or medical team experience). The secondary hypothesis was that coaches would score lower on the perceptions section of concussion and CTE (i.e., believe that concussions are not significant or dangerous) than current or former players.

Participants were recruited primarily via online modalities resulting in 232 participants being sampled for this study and 206 participants meeting inclusion criteria for data analysis. All participants completed an online, anonymous questionnaire including participant demographics and perceptions and knowledge of the topic areas. Overall, results from this study revealed differences in perception and knowledge between different subgroups of individuals familiar with American tackle football. Interestingly, results of this study showed that direct experience had opposing effects when analyzing current or former coaches and players, as current or former coaches had increased understanding and more positive perceptions of rules for concussions and CTE compared to current or former players. This indicates that, while players are provided education materials, players may not be retaining or implementing the information in the education materials in their idea of American tackle football and the NFL.

FANS' PERCEPTION AND UNDERSTANDING OF AMERICAN PROFESSIONAL
TACKLE FOOTBALL, CONCUSSIONS, AND CHRONIC TRAUMATIC
ENCEPHALOPATHY

by

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Approved by

Committee Chair

APPROVAL PAGE

The thesis written by DANIELLE CHRISTINA FUNK has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair _____
Dr. Jennifer L. Etnier

Committee Members _____
Dr. Christopher K. Rhea

Dr. Adam P. Berg

Date of Acceptance by Committee

Date of Final Oral Examination

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CHAPTER I
INTRODUCTION

Statement of Problem

Concussions, caused by impact forces to the brain which can affect internal brain structures (Goldberg, 2008; Yengo-Kahn et al., 2016), can negatively affect quality of life and daily functioning (Iverson & Lange, 2003). In American tackle football, concussions occur frequently (Colello et al., 2018), and there was a 62% increase in reporting of sport-related concussions from 2001 to 2009 (Macdonald & Hauber, 2016). However, concussions are still underreported (Colello et al., 2018) especially in high-contact sports, such as football, to reinforce masculinity and strength (Anderson & Kian, 2012; Trujillo, 1991; Tjonndal, 2016; Furness, 2016). While it is important to consider the number of head collisions compared to the number of sustained concussions in the NFL when evaluating frequency, there is a necessity to improve the practices regarding concussions to better protect NFL players.

While concussions can be damaging on their own, Omalu and colleagues (2005; 2006; 2010) have shown that repeated concussions may lead to the development of chronic traumatic encephalopathy (CTE) in National Football League (NFL) players. CTE, a progressive neurodegenerative disease, is a postmortem diagnosis based on brain tissue examination from autopsies (Omalu et al., 2005; Omalu et al., 2006; Omalu et al., 2010). From their case studies in 2005, 2006, and 2010, Omalu and colleagues

highlighted the traumatic, progressive decline in functioning, including potential premature death or suicide, which may be related to CTE. In addition, CTE has been found in two collegiate football players (Armour, 2018; Kercheval, 2018). Both aforementioned collegiate football players were 21 years old at the time of their suicides, and one player was diagnosed with having a brain comparable to that of a 65-year-old individual (Armour, 2018; Kercheval, 2018). Also, a study of 202 participants from a brain bank revealed 110 of 111 NFL players in the sample had CTE and the majority of those NFL players had severe (i.e., stage III or stage IV) CTE (Official NFL Concussion Settlement, 2019).

With the increase in research on concussions and CTE, there has been a push to protect players' brains and brain health better such as with return to play, contact rules, diagnosis, and education. The NFL, therefore, became the focus of many research articles and media stories based on current and previous concussion protocols and reported concussion rates. Over 1,000 former NFL players filed lawsuits against the NFL for inadequate treatment, protection, and education on concussions and CTE as well as failure to meet the requirements set forth in the NFL Player Retirement Plan and NFL Player Supplemental Disability Plan (Telis, 2014; Goldberg, 2008).

While the NFL began distributing data on reported NFL concussions in 2012, the distribution of this data, in addition to other research and reports, also made the public more aware of continuing concussion issues such as the 73% rise in reported preseason concussions in 2017-2018 as compared to the 2016-2017 season (Seifert, January 2018; Alper, 2018; Seifert, June 2018). The NFL now requires all games to be monitored by an

unaffiliated neurotrauma consultant (NFL News, 2017) and all concussed athletes to undergo testing prior to returning to action, but the NFL originally did not have extensive league-wide concussion rules including preseason rules (Goldberg, 2008). However, the NFL Head, Neck, and Spine Committee's Concussion Diagnosis and Management Protocol was updated in 2017 to have a more comprehensive set of protocols related to diagnosis and management (Play Smart, Play Safe, 2017). These new protocols put an emphasis on education of NFL personnel and players regarding concussions and included descriptive plans for recognition, diagnosis, and treatment of concussions including the immediate removal of concussed players from action (Play Smart, Play Safe, 2017). It is also required that all NFL organizations have an Emergency Action Plan, pre-season education and assessment, protocols for evaluation and recovery processes, and final evaluations and follow-up for medical clearance (Play Smart, Play Safe, 2017). In addition to the 2011 Madden Rule which requires all concussed players be removed and taken to a quiet locker room with medical supervision, no distractions, and no press conversations, the NFL established rules to allow the two certified athletic trainer spotters in the booth to help identify injuries during games and require medical time-outs if a booth-identified, injured player does not receive immediate medical attention (Play Smart, Play Safe, 2017). This improvement in the NFL Concussion Diagnosis and Management Protocol highlights the NFL's efforts to improve the safety of NFL players and reduce the number of head injuries associated with playing in the NFL.

It is important to understand the public perceptions and knowledge on concussions and CTE in the NFL, because fan perception of sport organizations can

either positively or negatively affect the organizations' success or failure (Walker and Kent, 2009). Fan influence can occur with situations in which the fans disagree with decisions by the NFL such as during previous issues with abuse and illegal drug use. While fans can influence the NFL to potentially improve concussion care and prevention, many fans do not have educational understanding of concussions, CTE, or their role with the NFL (Macdonald & Hauber, 2016; Sandel et al., 2017). Fans, however, can potentially influence the NFL to improve rules and policies regarding the treatment of concussions to create a safer environment for NFL players. Therefore, it is imperative to gain an understanding of the perceptions and knowledge regarding concussions, CTE, and the NFL from the general public, including fans. Currently, there is no research evaluating the perception and understanding of fans within the general public. Filling this research gap can provide necessary information for future research endeavors such as improving educational models for knowledge transfer.

Objectives and Hypotheses

The objectives of this study are to (1) investigate the relationship between fans, the NFL, concussions, and CTE, (2) describe the current NFL fans' perceptions and understanding of concussions, CTE, and the NFL response to CTE, and (3) assess fans' opinions regarding concussion topics.

Hypothesis 1: Participants with direct current or former experience (i.e., current or former player, current or former coach, current or former medical team member) will score higher on the concussion knowledge portion of the questionnaire as compared to

participants with fan experience only (i.e., current or former fan with no playing, coaching, or medical team experience).

Hypothesis 2: It is hypothesized that coaches will score lower (i.e., being less likely to support rule and protocol changes to better treat concussions, less likely to encourage concussed players from discontinuing play to seek treatment, and less likely to believe that concussions and CTE have a negative impact on the health of individuals and society) on the perceptions section of concussion and CTE than current or former players.

CHAPTER II

REVIEW OF THE LITERATURE

Overview

This literature review introduces the current knowledge on concussions and chronic traumatic encephalopathy (CTE) as well as the concussion crisis in sport and the National Football League (NFL). Next, this literature review discusses the legal situations in the NFL related to concussions and CTE including current rules and the resulting impact on continuing the concussion crisis. Then, this literature review discusses the fan influence in the NFL by first introducing the fan response to a controversial 2016 situation and extrapolating the ability to influence other issues in the NFL such as that of the concussion crisis. The literature review highlights that it is crucial to explore the current perceptions and understanding of concussions, CTE, and the NFL in order to better tailor future research, work to resolve the concussion crisis, and develop more applicable educational interventions. Finally, this literature review addresses the current gaps in the literature and the objectives of this thesis to fill the current literature gaps.

Concussions

A concussion is an injury to the brain caused by impact forces to the head which can affect the internal structures within the brain (Goldberg, 2008). Approximately 1.6 to

3.8 million sport-related concussions occur annually in the United States (Langlois, Rutland-Brown, & Wald, 2006) and about 57 million people globally suffer from traumatic brain injuries (TBI) (McCrea, H.J., Perrine, K., Niogi, S., & Hartl, R., 2013). Sport-related concussions and traumatic brain injury reporting increased by 62% from 2001 through 2009 (Macdonald & Hauber, 2016). However, many concussions still go unreported. This is because concussions are not typically externally visible and lack a clearly defined method for medical assessment, diagnosis, and return to play (Covassin et al., 2017) and may also be influenced by masculinity perspectives.

Even with underreporting, concussions occur at a high frequency in football (Colello et al., 2018). While it is important to consider how the relativity of concussion rates per head contact may influence the concussion statistics in football, it is necessary to explore concussion occurrences in football. This can present dangerous situations for football players who do not report concussion symptoms, return to play too soon, or do not receive the necessary medical care. For example, concussions can lead to a set of symptoms which can negatively impact daily functioning, including sleep, memory, and concentration issues, retrograde amnesia, vertigo, mood disturbance, anxiety, depression, and suicide (Covassin, Elbin, Beidler, LaFevor, & Kontos, 2017; Iverson & Lange, 2003; Yengo-Kahn et al., 2016).

Chronic Traumatic Encephalopathy (CTE)

Concussions, repeated concussions, and sub-concussive hits can have lasting effects throughout life. Concussions have been associated with depression and changes in brain composition and structure (Yengo-Kahn et al., 2016). Omalu and colleagues

(2005; 2006; 2010) have shown a connection between repeated concussions and the development of chronic traumatic encephalopathy (CTE) in National Football League (NFL) players. CTE is a progressive neurodegenerative disease related to mental, psychological, and emotional turmoil which can lead to premature death or suicide (Omalu et al., 2005; Omalu et al., 2006; Omalu et al., 2010).

Omalu and colleagues (2005; 2006; 2010) presented the first three known cases of CTE, which can only be confirmed with brain tissue examinations from autopsies, in retired NFL players. Because CTE can only be confirmed from autopsies, it is currently impossible to estimate the prevalence of CTE in living individuals. These case studies involving autopsies present a unique opportunity to examine this interaction of concussions and CTE on a neuropathological level (Omalu et al., 2005; Omalu et al., 2006; Omalu et al., 2010). The subject in the 2005 study was a 50-year old retired NFL player who died about 12 years post retirement from a 17-season long NFL career in which the subject played a total of 245 games, including 177 consecutive games, mostly as an offensive lineman (Omalu et al., 2005). The subject in the 2006 study was a 45-year old player who retired after 14 years in the NFL (Omalu et al., 2006). The subject in the 2010 study was the youngest NFL player to pass away from CTE-related suicide at 44 years old and had the shortest NFL career at 9 years of duration and died 11 years post-retirement (Omalu et al., 2010). Across all three cases, the subjects experienced brain deterioration and topography changes, signs of mTBI, including paranoia, suicidal tendencies and actions, and signs of Parkinson disease. All three subjects experienced multiple concussions throughout their NFL careers, but the third subject frequently

concealed concussions and even returned to practice within two days of having a concussion. In addition, the third case reinforced the possible link between CTE and professional football (Omalu et al., 2005; Omalu et al., 2006; Omalu et al., 2010).

Recently, deceased 21-year-old Washington State quarterback, Tyler Hilinski, was diagnosed posthumously with CTE (Armour, 2018; Kercheval, 2018). With Hilinski's diagnosis, two active college players have been diagnosed with CTE following suicide (Armour, 2018). Pennsylvania State University defensive end, 21-year-old Owen Thomas, also was diagnosed with the early stages of CTE (Armour, 2018). Startlingly, Hilinski's diagnosis revealed that his brain was comparable to the brain of a 65-year-old individual (Kercheval, 2018; Armour, 2018). Washington State has since announced that their spring game would be utilized to promote suicide and mental health awareness (Kercheval, 2018). With confirmed CTE in two collegiate 21-year-old football players, it is necessary to continue researching concussions, CTE, and the impact it may have on American tackle football such as with the NFL.

In a 2017 case study of 202 former American tackle football players, 110 of 111 former NFL players (99%) were neuropathologically diagnosed with CTE postmortem through two independent tests with blinded researchers (Mez et al., 2017). Of the 110 former NFL players diagnosed with CTE, 95 (86%) were diagnosed with severe (i.e., stages III and IV) CTE. These findings reinforce a potential link between CTE and repeated head traumas associated with participation in American tackle football, especially the NFL. While this study was the largest CTE case study as of 2017 and successfully controlled for sport type by only including tackle football players, it is

important to note that the participants were obtained from a convenience sample where participants may have only agreed to participate if CTE was already suspected prior to death. This potential bias may have resulted in a sample that is not entirely representative of all tackle football players, including NFL players. In addition, the sample was oversaturated with NFL and other professional tackle football players while most American tackle football players do not play collegiate football or in the NFL. However, Binney and Bachynski (2019) extrapolated the results from the Mez et al. (2017) study as well as death records of NFL players during the time of the Mez et al. (2017) study to find an estimated CTE prevalence of 19.3% in NFL players. Of the estimated 19.3% CTE prevalence among NFL players, Binney and Bachynski (2019) found that NFL players with CTE were 461 times more likely to participate in a brain bank donation program than those without CTE. If this donation rate is overestimated and the true brain donation rate is closer to 90% of all CTE cases donating their brains to research, the estimated prevalence of CTE in NFL players is 10.7% (Binney & Bachynski, 2019). Both of these studies highlight an important consideration related to a potential association between participation in the NFL and CTE that needs to be further explored to improve the safety and treatment of NFL players.

The National Football League (NFL)

Due to the NFL's inadequate acknowledgement of the dangers of concussions and playing decisions that may allow players to participate too soon following concussions, the NFL has become the focus of many research articles which attempt to understand factors that influence the underreporting of concussions and early return to play. Concussion

occurrence in the NFL has garnered attention following the combination of players' premature retirements, CTE research, and the formation of the 1994 mTBI Committee. The NFL formed the mTBI Committee, later replaced with the Head, Neck, and Spine Committee, to research possible links between prolonged exposure in the NFL, concussions, and CTE (Yengo-Kahn et al., 2016).

Some research focuses on tracking changes in concussion rates from chronic participation in football. Yengo-Kahn and colleagues (2016) investigated the change in reported concussion rates between the years of 1996-2001 and 2002-2007 through a systematic review of literature with 31 studies and approximately 5,250 NFL athletes. The researchers found that there was a 7.6% decrease (i.e., 0.42 versus 0.38 concussions per game) in concussion incidence during NFL games from the first time-period (i.e., 1996-2001) to the second time-period (i.e., 2002-2007). However, the decrease was not statistically significant (Yengo-Kahn et al., 2016). The decrease in concussions may be related to the gradual increase in research and information on concussion dangers.

Yengo-Kahn and colleagues (2016) also found that player position (i.e., quarterbacks, wide receivers, tight ends), impact type (i.e., tackle, block), and rule change may influence the risk of concussion. Between 1996 and 2007, tackling accounted for 56.5% and blocking accounted for 32.3% of in-game concussions. In addition, concussions occurred most commonly during kickoffs in 2002-2007 which the researchers related to the correlating NFL rule change to move up the kick-off line (Yengo-Kahn et al., 2016). Because concussion incidence can be affected by many different factors, it is important that more research is conducted to further the

understanding of concussions and how different positions, rules, and participation in contact sports, such as the NFL, can affect concussion risk.

In 2017, the NFL experienced the most reported concussions during a single season since the first distribution of concussion data in 2012 with a 73% rise in preseason concussions (Seifert, January 2018; Alper, 2018; Seifert, June 2018). With 291 reported concussions from both the preseason and regular season, there were more concussions during Thursday night games which reduce the number of rest days between games for players (Seifert, 2018). However, most of the concussions occurred during the 11-on-11 drills in practices prior to the preseason games (Alper, 2018; Seifert, June 2018).

Legal Ramifications

While researchers are focused on better understanding concussions, there is also a concern about the role of professional sport organizations with concussion prevalence. Many current and former players are questioning the NFL's role in protecting and educating the players and methods of addressing concussions and CTE (Goldberg, 2008). More than 1,000 former NFL players have brought charges against the NFL in individual lawsuits based on the NFL's treatment of concussions (Telis, 2014). The lawsuits are based on former players' accusations that the NFL should have reasonably understood and disseminated information on the dangers of concussions and CTE and that failure to do so is related to the NFL's wrongful death of players from CTE (Telis, 2014). Many players also accuse the NFL and NFL Players' Association (NFLPA) of not addressing retired players' concussion and CTE related needs or providing disability benefits (Goldberg, 2008).

Following his death, Mike Webster's estate sued the NFL for failure to follow the NFL Player Retirement Plan and NFL Player Supplemental Disability Plan which led to the NFL denying Webster active disability benefits (Goldberg, 2008). The NFL claims that it is not responsible for the failure to protect players from CTE because of preemption clauses in the Collective Bargaining Agreement (CBA) that all players sign to participate in the NFL (Telis, 2014). The NFL claimed that Webster's case did not warrant disability benefits and that any brain injury was not directly linked to the NFL, but the court ruled that the NFL did not follow the retirement and disability policies by failing to acknowledge the medical evidence of Webster's health (Goldberg, 2008).

In addition, the NFL is considered an unincorporated, nonprofit association which does not own individual organizations (i.e., teams) which places the responsibility and duty to protect players on the individual organizations instead of the NFL (Telis, 2014). Players' concerns also emphasize the dichotomy between the NFL's promotion of players during their active years in contrast to the NFL largely ignoring retired players with concussions and CTE (Goldberg, 2008) and the priorities of the team physicians (Goldberg, 2008; Washington, 2016). Team physicians can be paid directly by the team organizations which may lead to team physicians being more focused on their job security and pleasing the team than the well-being of the athletes (Goldberg, 2008; Washington, 2016).

However, because the NFL formed the mTBI Committee, some NFL players have claimed that the NFL was assuming a legally binding role in protecting and informing the players about concussions and CTE. Following the CTE research by Omalu and

colleagues (2005; 2006; 2010), the mTBI Committee refuted the findings and claimed that same-day return to play is safe for concussed players (Goldberg, 2008). The NFL maintains that the mTBI Committee does not automatically warrant any legal responsibility, because the Committee was not created with the purpose of serving the players. In 2007, the NFL published a pamphlet about concussions and distributed the information to all the current NFL players. Ironically, this may lead to assumed responsibility for the NFL (Telis, 2014).

Despite the legal turmoil regarding concussions and CTE, the NFL has begun addressing the concerns brought to them in both legal cases and general comments. As of March 2019, the NFL has settled to over \$634,000,000 in monetary awards through different lawsuits (Official NFL Concussion Settlement, 2019). The NFL has continued to implement changes and address issues to improve the safety of NFL players and reduction of concussions and CTE. Continued positive efforts will create better playing conditions and more awareness of the concussion and CTE issues associated with repeated head injuries.

The NFL, Concussions, and CTE

Media

One main underlying influence of the continuing concussion problem in sports, such as the NFL, is the representation of NFL players. With all of the information on the impact of concussions in the NFL, polarizing media response shows the different societal views on the issue. Sport media can be influential on the NFL to either promote or disapprove of concussion reporting. The reproduction of masculinity through sport

media reinforces the idea that concussions are inevitably intertwined with football and that players understand and accept the risks of the game (Furness, 2016) which may increase underreporting of concussions and decrease the perceived severity of concussions and CTE among tackle football players.

The NFL and NFL media rely on highlighting NFL players' physicality, bodies, strength, masculine characteristics, and lack of weakness (Anderson & Kian, 2012). Trujillo (1991) explains that these traits can lead to the perception of heroism in which athletes are presented as superhuman and gallant examples of men. The reproduction of masculinity may be more accepted in high-violence and high-contact sports, such as football, due to the idea that the nature of the sport requires players to personify strength and masculinity to be successful (Tjonndal, 2016). In the documentary *League of Denial: The NFL's Concussion Crisis*, created in collaboration with ESPN, the NFL is ridiculed for disregarding retired players with brain injuries from concussions or CTE (Furness, 2016). The mTBI Committee is also accused of being created and influenced by the NFL with the sole purpose of producing research to support the NFL's denial of any link between the NFL, concussions, and CTE.

In addition, Roger Goodell, the NFL Commissioner, attempted to block ESPN journalists from helping with the creation of the documentary, denied any connection between concussions and CTE, and made no comment after the documentary was released (Furness, 2016). The unwillingness for Goodell to address or acknowledge the film implies that he may have been attempting to protect the image of the sport rather than the safety of the players. Reinforcing expectations of masculinity creates a risk

culture for the tolerance of pain and injury as well as the extreme commitment to sport above the health of the player (McGannon, Cunningham, & Schinke, 2013). Risk culture has negative implications for concussions as concussions are both seen as invisible injuries and may reflect weakness, so athletes may be more likely to refrain from reporting concussion symptoms (McGannon, Cunningham, & Schinke, 2013).

Rules

Because the dangers of concussions have only recently become publicized, there was not originally a high priority to establish league-wide rules for the NFL. Within the NFL, the implementation of rules and protocols regarding concussions was also often inconsistent due to concussion rules and protocols being created at the level of the individual team organizations instead of the level of the League. Many NFL players, fans, and coaching staff claim that the NFL does not adequately address player safety with the current rules (Goldberg, 2008).

For other contact sports, however, there are more clearly defined guidelines for concussions and player safety. The Nevada State Athletic Commission (NSAC) rules for boxing are designed to prevent boxers who have sustained severe concussions or head trauma from competing by implementing a permanent medical suspension and requiring boxers to meet important medical prerequisites prior to being allowed to fight again (Goldberg, 2008). World Rugby emphasizes the importance of adequate care for concussions by explaining that all concussions are serious injuries and that all players should seek the highest level of medical care available for their injuries (World Rugby Concussion Guidance, 2015). The World Rugby Concussion Guidance (2015) guidelines

also explain that concussed players are required to be immediately removed from the playing field and are not permitted to return until at least one full week of rest, completion of the Graduated Return to Play program, and resolution of symptoms (World Rugby Concussion Guidance, 2015). In 2017, the National Association for Stock Car Auto Racing (NASCAR) updated its policy on concussions (Tucker, 2017). In addition to the previously established concussion policies, NASCAR now requires all of the infield medical staff to utilize the same concussion measure to increase the consistency and reliability of driver concussion data (Tucker, 2017). Similar to the rules of rugby, the U.S Ski and Snowboard organization also requires all concussed athletes to leave games or practices immediately and not return until qualified medical personnel conduct a thorough evaluation and clear the player for return to play (US Ski and Snowboard, 2018). The rules also specify that the medical professional overseeing the player's care must produce documentation verifying up-to-date concussion education in the form of continuing education course completion within three years of the written clearance (US Ski and Snowboard, 2018).

In contrast, the NFL heavily relied on each organization to form their own guidelines regarding a player's eligibility after a concussion with the only League-level protocols being the requirement for concussed athletes to undergo testing prior to returning to action (Goldberg, 2008) and all games to be monitored by an unaffiliated neurotrauma consultant (NFL News, 2017). Because individual organizations were once able to create their own guidelines for player eligibility, there had been many incidents in which concussed players are not removed from games or return to play the same game

even with visible signs of concussions. As one example, Ted Johnson, a former New England Patriots linebacker, accused the Patriots' head coach, Bill Belichick, of intimidation and abuse of power which led to Johnson returning to play too soon and experiencing another concussion (Goldberg, 2008). Johnson claims that Belichick admitted to knowing Johnson was not healthy enough to play but pressured him to return sooner anyway. Johnson was already showing signs of Alzheimer disease at the age of 34 years old (Goldberg, 2008). This is just one of potentially many cases in which concussed NFL players continued to play, and in cases like Johnson's where players interpreted pressure from the coach to play injured. This can show a potentially dangerous abuse of power that can pose harm to the players' health.

However, the NFL has attempted to improve the concussion rules and guidelines to create a more cohesive plan regarding player injury, return to play eligibility, and treatment. All players who experience an impact seizure or fencing response (i.e., unnatural and uncontrolled arm positions following a concussion) must be removed permanently from the current game (NFL News, 2017). The NFL and NFLPA also introduced a new penalty of up to \$150,000 for a first-time violation and a minimum of \$100,000 for repeat offenses associated with failure to follow the protocol (Belson, 2016). While this penalty is a step towards better protection of players, some still argue that the fines are too small to significantly impact an organization's decision about following the concussion protocol and rules.

Fans

Influence

It is important for fans to understand how to influence a positive change in concussion treatment. NFL players have become more active in the movement for better concussion care. However, fans also have an opportunity to promote the safer treatment of concussions and CTE. It is necessary to understand fans' perception on the NFL, concussions, and CTE, because this perception may be able to influence improvements in policies and safety for players. In addition, the NFL is a business and, therefore, is also focused on customer retention and fan satisfaction. Customer retention and consumption behaviors lead to increased company longevity (Gray & Wert-Gray, 2012). As the targeted audience of the NFL, fan satisfaction is important to the success of the NFL.

Walker and Kent (2009) highlight that companies, especially sport organizations, are being viewed more closely by the public and expected to behave appropriately. Sport organizations experience the pressure to focus on increasing revenue, maintain fan support, and consider the impact of the popularity of athletes. Fan perception of sport organizations can impact financial status, the business model, fan involvement, and the continuation of fan presence (Walker & Kent, 2009).

A survey of 300 fans of 40 different collegiate and professional teams indicated that team identification (i.e., loyalty) is significantly influential on fan consumption behaviors (i.e., merchandise purchasing, in-game attendance, media involvement, future behavioral intentions, and word-of-mouth perceptions). The fans in this study were from seven different sports including football. Because fan consumption behaviors are

significant to the success of sport organizations, organizations try to increase the public favorability of the organization (Gray & Wert-Gray, 2012). This dynamic between sport organizations and fans can reveal the influential power fans can exert on sport organizations.

Fan Knowledge on Concussions and CTE

If fans can influence the NFL, it may seem surprising that there is the continuing problem with concussions and CTE from the NFL. One explanation for the lack of fan involvement may be that not all fans understand the basics of the dangers of concussions and CTE. While researchers are still learning about concussion and CTE danger, there has been information shared publicly that may not have been fully comprehended by the fans. While the term concussion has appeared more frequently in sport reports, the reports do not always translate to fans' comprehensive understanding of concussions and concussion dangers. This gap in understanding from reports to fan knowledge is also seen in youth sport leagues. For example, concussions in children are largely underreported due to the lack of parental understanding about concussions and misconceptions that concussions are not severe injuries (Macdonald & Hauber, 2016).

Macdonald and Hauber (2016) sought to test the current knowledge of parents on concussions and provide an educational session to inform parents on the dangers of concussions. Prior to the educational session, many of the subjects, all of whom were parents, scored concussions as being mildly critical to not critical. However, following the educational session, the subjects reported concussions as critical (Macdonald & Hauber, 2016). Sandel and colleagues (2017) also recommended implementing

educational sessions to inform players, coaching staff, and family members about concussion signs, symptoms, and health risks. It is necessary to ensure that fans, parents, and people involved in American tackle football understand concussions in order to increase the likelihood of concussed players receiving the treatment and care needed to recover. Also, increasing the understanding of concussions through educational sessions may lead to improved concussion treatment protocols.

In addition to the Macdonald and Hauber (2016) and Sandel and colleagues (2017) studies, previous research studies have highlighted the importance of concussion education to cope with the lack of knowledge on concussions and CTE. Therefore, the current research study will investigate the relationship between fans, the NFL, concussions, and CTE. The primary aim is to describe current NFL fans' perceptions and understanding of concussions, CTE, and the NFL response to concussions and CTE. In addition, fans' opinions regarding the concussion topics will also be assessed. The main hypothesis is that participants with direct current or former experience (i.e., current or former player, current or former coach, current or former medical team member) will score higher on the concussion knowledge portion of the questionnaire as compared to participants with fan experience only (i.e., current or former fan with no playing, coaching, or medical team experience). If enough current or former coaches and current or former players participate in the study to be compared, the hypothesis is that coaches will score lower on the perceptions of concussion and CTE than current or former players. This means it is expected that coaches will report being less likely to support rule and protocol changes to better treat concussions, less likely to encourage concussed

players from discontinuing play to seek treatment, and less likely to believe that concussions and CTE have a negative impact on the health of individuals and society as compared to players.

By targeting participants from the general public, this study will provide information on the overall public. The large sample size of the present study will also allow for categorization of large groups of participants (i.e., fans, non-fans, former or current coaches or players, etc.) which will help for future studies comparing certain groups and tailoring educational interventions for specific groups. The questions in the current questionnaire will be tailored to specifically focus on the topics of the study. The results of this study will be extrapolated to infer the potential for fans to create a movement in the NFL toward better care of concussions and treatment.

Summary of Gaps in the Literature with Regards to this Thesis

The current literature is lacking in empirical evidence relating to fans' perceptions and knowledge on concussions, CTE, and the NFL. While there is current literature on medical professionals' and coaches' opinions on concussions, these studies investigate one population only without the specific focus of the NFL. Therefore, filling this literature gap will provide necessary information on the general public including fans. The lack of information on the current topics inhibits a more complete understanding of the general public and fans' perception and understanding of relevant main topics in the NFL currently. Contributing to the current literature and providing information in this literature gap area will assist with tailoring future research and educational modalities to meet the specific populations' knowledge and perception needs on concussions, CTE,

and the NFL. Improving future research and educational modalities through the results of this thesis can strengthen the impact of knowledge transfer with the general public or specific sub-populations.

CHAPTER III

PILOT STUDY

Pilot data for the current study was collected during July and August 2018. The pilot data was used to build the methods of the current study.

Participants

The study was open to anyone 18 years of age or older with reasonable familiarity of the NFL. Participants were recruited through flyers, emails, and word of mouth. Information was primarily based around the University of North Carolina at Greensboro (UNCG) campus. Individuals were not recruited from courses at UNCG in which the instructor was involved with the study.

Materials and Procedures

The questionnaire was designed through Qualtrics and was only accessible through an anonymous link provided to prospective participants via email. This allowed the research team to be able to provide information prior to the questionnaire and limit the chances of participants under 18 years of age from participating. The questionnaire was also designed to “prevent ballot stuffing” which prevented multiple questionnaire responses from the same participant. Data was only collected on 30 participants. Once the questionnaire received 30 participants, the lead researcher closed the questionnaire. The questionnaire utilized in this study was heavily based on the Yorke, Littleton, and Alsalaheen (2015) questionnaire regarding perception and understanding of concussions

among physical therapists. Because the 2015 Yorke, Littleton, and Alsalaheen questionnaire was utilized with physical therapists, questions specifically related to physical therapists were eliminated or altered to be more applicable to the participants, fans, in this study. The questionnaire consisted of demographic questions and data on concussion, CTE, and NFL knowledge and attitudes. The entire questionnaire consisted of an introduction prompt with the informed consent file, a mandatory informed consent question, and 37 content questions. If participants selected “no” to the informed consent question, the questionnaire automatically directed to the exit prompt. If participants selected “yes” to the informed consent question, the questionnaire began as normally with the first of a minimum 37 content questions. The informed consent was the only forced-response question.

Based on the Qualtrics software, the expected questionnaire duration was ten minutes. However, participants who consented to the questionnaire were able to complete the questionnaire at their own pace. While the base of the questionnaire included 37 content questions, specific responses to some of the questions would add expansion questions to the content questions. For example, if a participant indicated they were a current or former player of American tackle football, a new page with extra questions would appear next prompting the participant to expand on the number of years, ages, and levels (i.e., youth, high school, college, professional, etc.) the participant spent in this role. If participants selected every response which prompted extra questions, the maximum number of questions that could be presented to a participant was 45 questions.

These expansion questions were included to gain deeper understanding of the participants' selected answers.

In the concussion knowledge section, participants were asked 13 multiple choice and true-false questions related to basic concussion information. For example, the first question asked participants to choose the answer which defined what a concussion is (i.e., an injury to the spinal cord, an injury to the brain, or unsure) while other questions asked participants to respond true, false, or unsure to common concussion symptoms. These 13 questions were not based on perceptions, and therefore, could be categorized for a total score of correct answers out of 13. Participants were awarded one point for a correct point and zero points for an incorrect answer.

Results

Of the 30 participants, 16 self-identified as female, 12 self-identified as male, 1 selected "prefer not to answer," and 1 did not respond. To determine age, participants were asked to type their birth year. Two participants did not respond to the question, and one participant did not answer the question with a birth year. Of the remaining participants ($n=27$), the average age was 39.63 years old ($SD=16.78$). The average time of completion for the questionnaire was 10.661 minutes with a standard deviation of 10.66 minutes ($SD = 7.93$ minutes). All of the following statistics were based on the sample of 27 participants with the three excluded participants which were only excluded based on a reported lack of knowledge or interest in American tackle football and the NFL.

To test if there were differences in concussion knowledge scores between groups with different levels of familiarity with American tackle football, participants were categorized into two groups. Group 1 (n=23) included participants who responded as fans only with no current or former experience as a football player, coach, or coaching staff member. Group 2 (n=4) included participants who indicated having experience as a former or current player, coach, or coaching staff as well as a fan. There was no statistically significant difference in concussion knowledge scores as a function of the groups based on familiarity with football, $t(25)=0.058$, $p>0.05$ ($p=0.449$), two-tailed. The average concussion knowledge score for Group 1 ($M=11.30$, $SD=1.66$, range: 8-13) was not significantly different from the average concussion knowledge score for Group 2 ($M=11.25$, $SD=2.06$, range: 9-13).

Participants were asked to use two sliding scales (0-100) to select the number that most closely represents their perceived level of fan enthusiasm for American tackle football and the NFL respectively. These scores were used to determine an average level of fan enthusiasm for each participant. The top 50% of average scores (values = 69.00 and higher) were grouped into the High Fan category (n=13) while the bottom 50% of average scores (values = 68.99 and lower) were grouped into the Low Fan category (n=14). There was no statistically significant difference in concussion knowledge scores as a function of level of fan enthusiasm based on the High Fan and Low Fan categories, $t(25)=-0.258$, $p>0.05$ ($p=0.975$), two-tailed. The average concussion knowledge score for High Fan ($M=11.38$, $SD=1.66$, range: 9-13) was not significantly different from the average concussion knowledge score for Low Fan ($M=11.21$, $SD=1.76$, range: 8-13).

In the perceptions section, participants (n=27) were asked to respond to their confidence across different concussion topics as well as their opinions on different concussion related symptoms. Questions of similar content (i.e., “I believe that concussions have a significant impact on the health of the individual,” and “I believe that concussions have a significant impact on the health of society”) were grouped in order to compare results for similar topics. Figures 1, 2, 3, and 4 below display information on the results from questions grouped on content.

Figure 1. Results from the Concussion Confidence Grouped Questions.

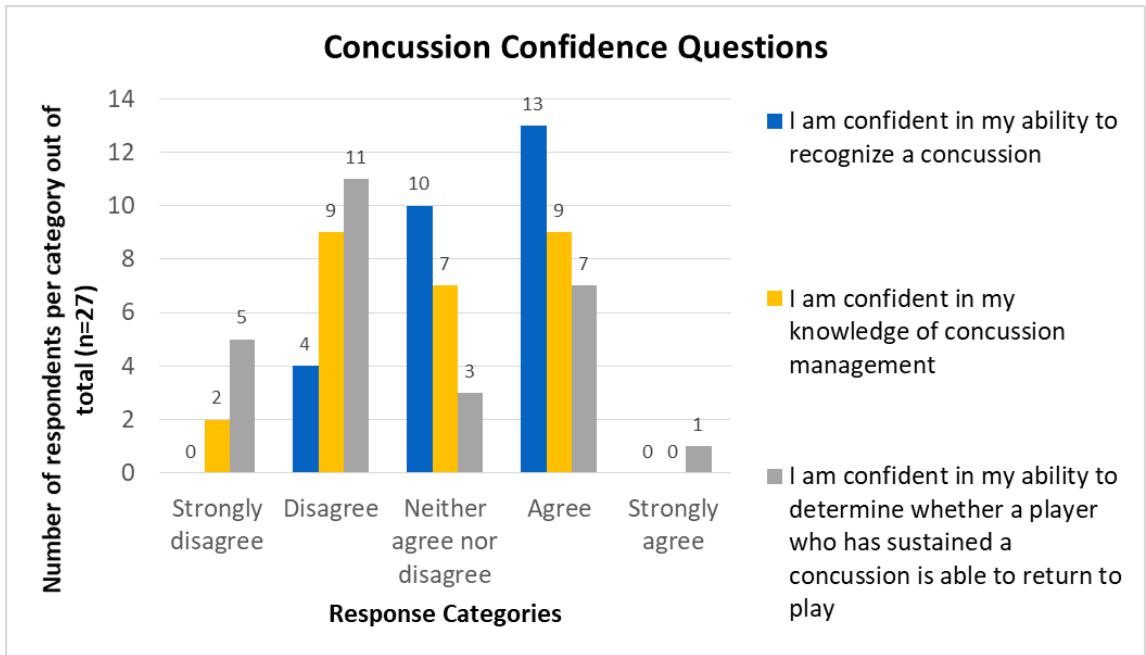


Figure 2. Results from the Health Impact of Concussions Grouped Questions.

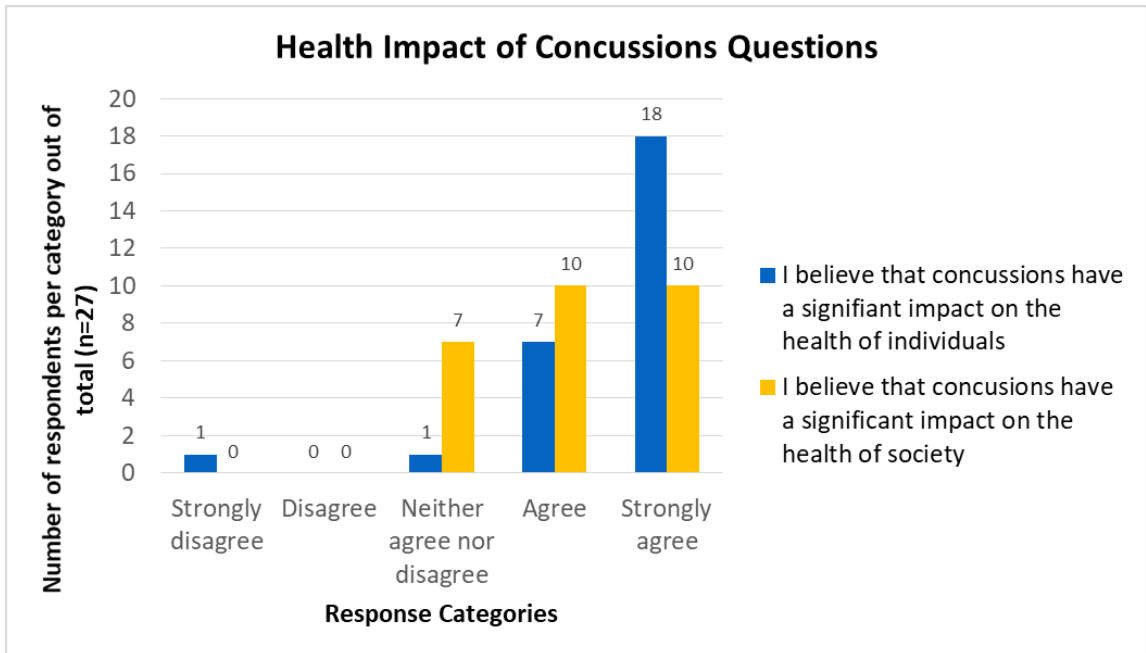


Figure 3. Results from the Return to Play Decision Making Grouped Questions.

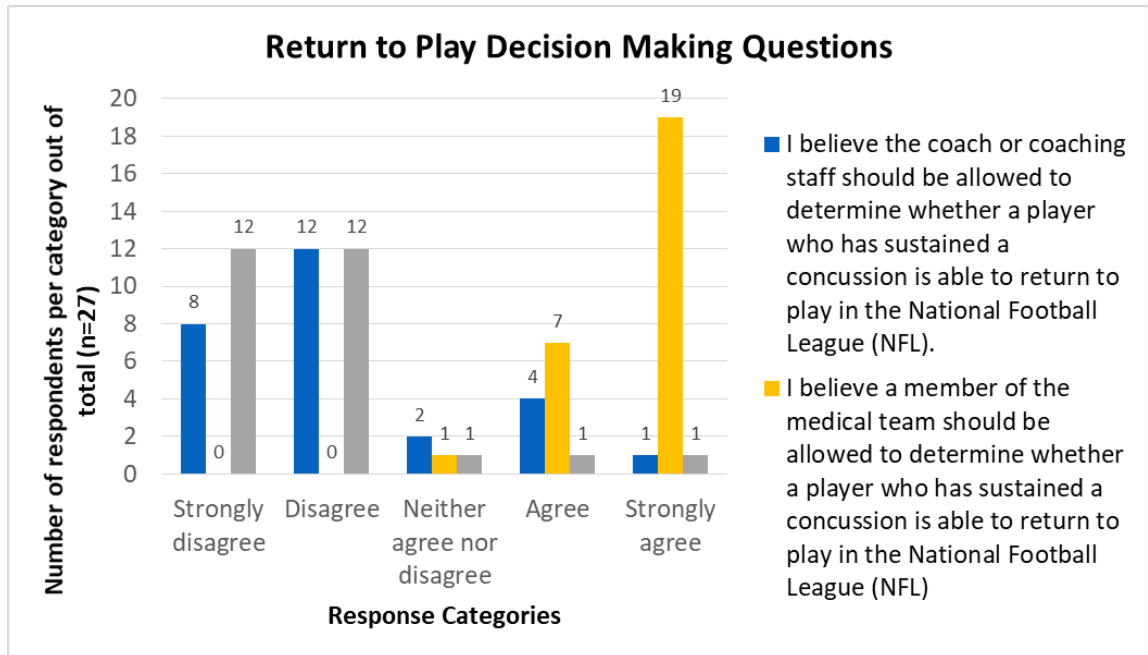
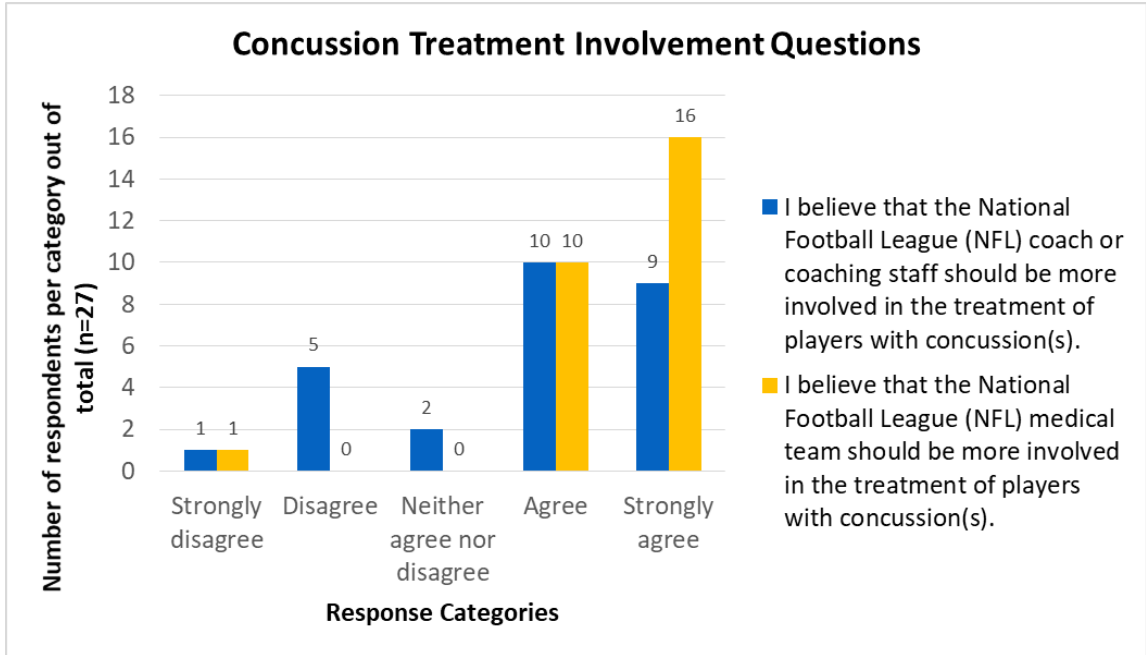


Figure 4. Results from the Concussion Treatment Involvement Grouped Questions.



The final two questions of the perceptions section asked about concussed players exiting a game to inform the coach or trainer and the quality of the NFL in addressing concussion safety, concussion rules, and chronic traumatic encephalopathy (CTE). The question about exiting a game while concussed contained a formatting error on the Likert scale which provided two additional response options instead of the standard five options provided in the other perceptions questions. Because of the change in Likert scale options, this question was not grouped with other questions as to prevent errors in comprehension and comparison. The results of this question are displayed in figure 5 below. The results of the question on the quality of the NFL in addressing concussion safety, concussion rules, and chronic traumatic encephalopathy (CTE) are displayed in figure 6 below.

Of importance to note, 14.8% (n=4) of participants responded strongly disagree, 40.7% (n=11) responded disagree, 25.9% (n=7) neither agree nor disagree, 3.7% (n=1) responded agree, and 14.8% (n=4) responded strongly agree to the final question on the quality of the NFL in addressing the topics. This shows that the majority of participants in this study are not satisfied with the NFL in relation to the concussion crisis.

Figure 5. Results from the Reporting of In-Game Concussions Question.

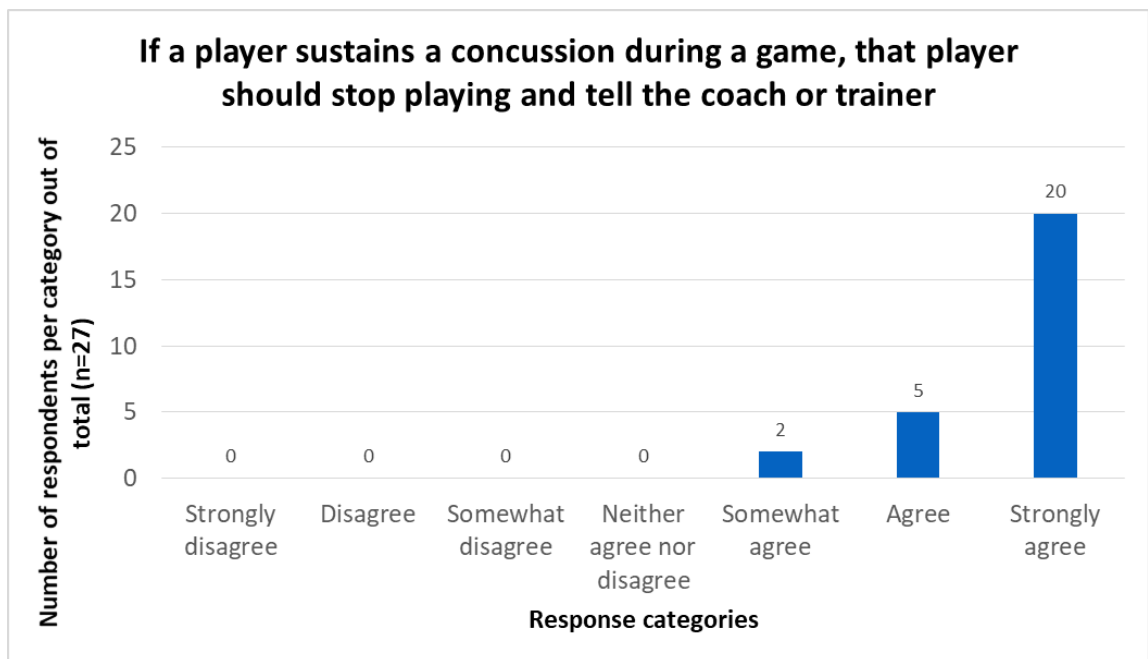
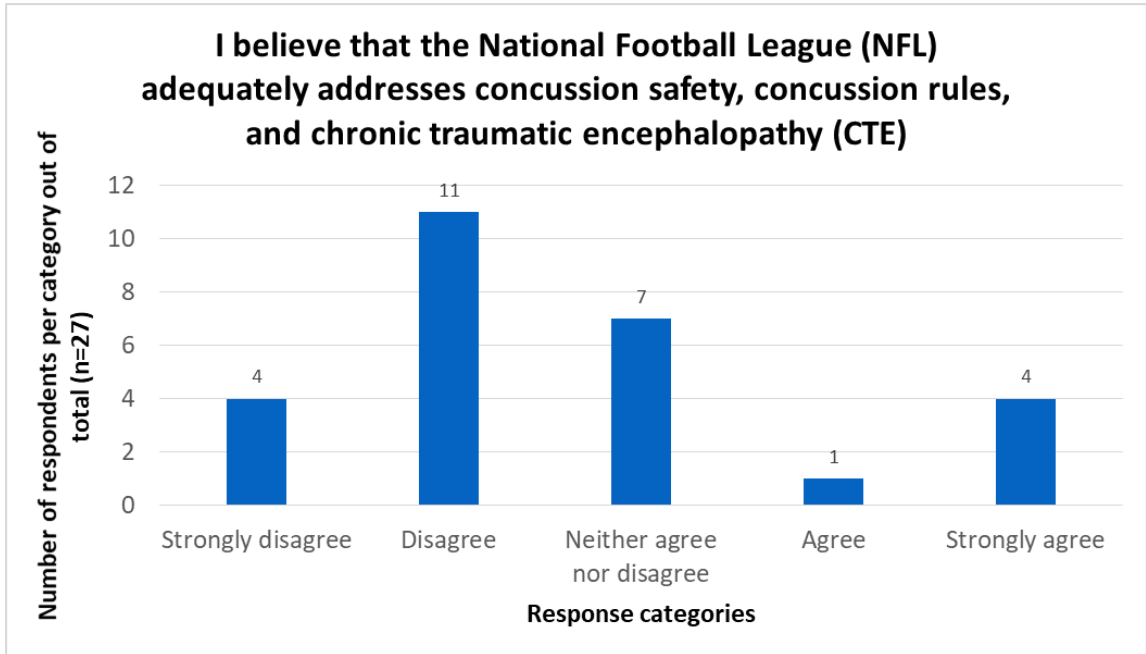


Figure 6. Results from the Quality of the NFL in addressing Concussion Safety, Concussion Rules, and Chronic Traumatic Encephalopathy (CTE) Question.



Discussion

One reason there may not have been statistical differences between levels of fan enthusiasm (High Fan versus Low Fan) or experience (Group 1 versus Group 2) in relation to concussion knowledge is the small sample size ($n=30$). In addition, recruitment was primarily focused around the UNCG campus during the summer session which may have limited the reach of the recruitment and variety of participants. The results on confidence in recognizing a concussion, preference to report concussions, preference to allow the medical team to assess the situation, and the perceived impact that concussions can have on health may have reflected a change in knowledge and understanding based on recent research.

CHAPTER IV

METHODS

The methods of the current thesis are based on the methods and results of the pilot study conducted in Summer 2018. Alterations to fix errors (i.e., two extra Likert scale options) and to expand on other topic areas (i.e., adding questions on CTE) were included in the thesis study.

Participants

The study was open to anyone 18 years of age or older with reasonable familiarity of the NFL. Participants were recruited through flyers, emails, social media, and word of mouth. Information was primarily posted through publicly accessible online modalities (i.e., social media, school webpages etc.) using tag phrases (i.e., concussion, concussions, CTE, NFL, football). Prospective participants did not have to search one of the tag phrases (i.e., hashtags on Twitter, Facebook, and Instagram, text phrases on Twitter and Facebook) to find the social media recruitment posts, but individuals who searched the tag phrases may have been more likely to find the posts. Prospective participants also did not have to search all the tag phrases to find the posts; searching just one phrase (i.e., “football”) increased the chances of finding the recruitment posts because the word “football” was already tagged in the post. Individuals were not recruited from courses at UNCG in which the primary investigator was the instructor.

The participants in this study were analyzed in three different groups for comparison through t-tests. The first comparison analyzed potential differences between fans with any form of involvement in American tackle football including coaching, playing, athletic trainer, or medical team member (i.e., Fan with Experience group) and fans without involvement experiences (i.e., Fan Only group). The second comparison analyzed potential differences between fans with current or former coaching experience (i.e., Fan and Coach) and fans with current or former playing experience (i.e., Fan and Player). Finally, the third comparison analyzed potential differences between participants who self-describe as more avid fans (i.e., High Fan) and fans who self-describe as less avid fans (i.e., Low Fan).

Materials

The questionnaire was implemented through Qualtrics and only accessible through an anonymous link. The questionnaire was set to “prevent ballot stuffing” which prevented multiple questionnaire responses from the same participant based on the IP address. Based on the pilot study, this questionnaire incorporated changes in questions and phrasing to expand on the topic areas and included some formatting corrections based on the results of the pilot study while still being primarily based on Yorke, Littleton, and Alsalaheen (2015) study. The questionnaire consisted of three sections (Appendix A) with a total of 46 questions. The beginning of the questionnaire included a brief description of the research study with a PDF of the IRB-approved informed consent form. The first section included 14 demographic questions of the participant, the second section included 16 questions regarding the participants’ attitudes toward concussions,

CTE, and the NFL, and the third section included 15 knowledge-based questions regarding concussions, CTE, and the NFL. In addition, some responses prompted follow-up questions to expand on the information provided. There was a final question at the end of the questionnaire to allow participants to provide any additional information on their experience with concussions, CTE, and the NFL. Based on the Qualtrics software, the expected questionnaire duration was ten minutes. However, participants who consented to the questionnaire were able to complete the questionnaire at their own pace.

Procedure

Prospective participants were provided an email containing a link to the online anonymous Qualtrics questionnaire via the recruitment announcement. The questionnaire provided a brief description of the study, the IRB-approved consent form, a disclaimer that participation was voluntary, and a confirmation that participants could choose to leave the questionnaire at any point without penalty. The questionnaire was estimated to take approximately 10 minutes to complete and had a consent question at the beginning of the questionnaire. If participants selected “yes” in response to the consent question, thus providing their consent, they were able to begin the questionnaire at any point and continue at their own pace with the option to save and continue the questionnaire later. If participants selected “no” in response to the consent question, they were automatically redirected to the exit prompt of the questionnaire. Data was collected on 232 participants.

The main hypothesis was that participants with direct current or former experience (i.e., current or former player, current or former coach, current or former

medical team member) would score higher on the concussion knowledge portion of the questionnaire as compared to participants with fan experience only (i.e., current or former fan with no playing, coaching, or medical team experience). The secondary hypothesis was that coaches would score lower on the perceptions of concussion and CTE than current or former players.

Statistical t-tests were used to examine the concussion knowledge portion and the perceptions portion of the questionnaire. These t-tests were used to analyze any differences that may exist between different groups of participants (i.e., current or former fan with no playing, coaching, or medical team experience versus current or former fan with experience). T-test results were based on an alpha level of .05 (5%). The group analyses were used to test for differences at the subsection level to understand differences between subgroups of the participants. All results will be reported in the aggregate.

CHAPTER V

RESULTS

Not all participants responded to every question, so the number of participants per question differed and did not always equate to the total number of participants.

Exclusion Criteria

Two-hundred and thirty-two participants ($M=35.81\pm 14.33$ years; 90 males, 124 females, 6 identified as “other”) initiated participation in the anonymous, online questionnaire. Of the total 232 participants, 26 participants were excluded bringing the total to 206 participants for analysis. Participants were excluded if they completed $\leq 37\%$ of the questionnaire or responded that they had a lack of familiarity with American tackle football or the NFL. The exclusion completion rate of $\leq 37\%$ was a data driven standard based on the overall results. All the participants excluded for completion rates of $\leq 37\%$ completed the demographic section but did not provide any answers for the perceptions or knowledge sections.

To ensure the statistical integrity of the overall data was unchanged after the exclusion process, differences between included participants ($n=206$) and excluded participants with sufficient data ($n=25$) were analyzed utilizing chi-square analyses and independent samples t-tests. Using chi-square analyses, there was no difference between the included and excluded participants with regard to sex, $\chi^2(3)=4.50$, $p>0.05$, race, $\chi^2(3)=4.63$, $p>0.05$, current state of residence, $\chi^2(31)=20.68$, $p>0.05$, highest degree earned,

$\chi^2(4)=13.80$, $p>0.05$, being a current or former tackle football player, $\chi^2(1)=0.07$, $p>0.05$, being a current or former tackle football coach or coaching staff member, $\chi^2(1)=0.57$, $p>0.05$, or being a parent of a current or former tackle football player, $\chi^2(1)=1.11$, $p>0.05$. Using independent samples t-tests, there was also no difference between included and excluded participants regarding birth year (i.e., age), $t(218)=0.-1.64$, $p>0.05$.

Participants

The 206 participants in this sample (sex: 79 male, 118 female, 6 others; race: 8 Asian, 6 Black or African American, 3 Native Hawaiian or Other Pacific Islander, 182 White) lived in 31 different states and 2 locations outside of the United States of America during the time of participation in the questionnaire per their self-reported answers. One participant (0.5%) had not earned a degree, 37 (18%) earned a high school or GED, 82 (39.8%) earned a Bachelor's degree, 52 (25.2%) earned a Master's degree, and 32 (15.5%) earned a Doctoral degree.

Fan with Experience Group versus Fan Only Group

Of the participants, 46 (22.3%) were current or former American tackle football players, coaches, or coaching staff members. These participants with current or former playing and/or coaching experience were grouped together into the Fan with Experience group. The remaining participants were grouped into the Fan Only group ($n=144$) and represented the general fan without any direct experience in American tackle football or the NFL. There were 34 males, 106 females, and 3 others (i.e., prefer not to answer,

prefer to self-describe) in the Fan Only group and 44 males, 0 females, and 2 others in the Fan with Experience group.

See Table 1 below for t-test results and descriptive statistics for the significant comparisons between the Fan with Experience group and the Fan Only group. See Table 2 below for t-test results and descriptive statistics for the non-significant comparisons between the Fan with Experience group and the Fan Only group.

| Table 1 | | | | | | | | |
|----------------------------------------------------------------------------------|---------------------------|-------|----------------|-------|--------|-------|---------|-----------|
| Statistically Significant Results of the Fan with Experience and Fan Only Groups | | | | | | | | |
| Question Topic | Fan with Experience Group | | Fan Only Group | | df | t | p value | Hedge's g |
| | M | SD | M | SD | | | | |
| Average percent current fan ¹ | 79.23 | 17.18 | 65.80 | 21.62 | 187.00 | -3.81 | <0.01 | 0.69 |
| Awareness of the rule to move up the kickoff line ¹ | 87.18 | 22.88 | 61.12 | 38.90 | 134.91 | -5.43 | <0.01 | 0.82 |

| | | | | | | | | |
|-----------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|--------|-------|-------|-------|
| Awareness of the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 96.28 | 7.84 | 81.36 | 30.50 | 178.26 | -5.28 | <0.01 | 0.67 |
| Awareness of the rule to allow remote officials to eject players for dangerous plays ¹ | 81.60 | 30.02 | 67.72 | 38.92 | 97.42 | -3.37 | <0.01 | 0.40 |
| Support for the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 77.24 | 25.23 | 87.52 | 22.58 | 185.00 | 2.59 | <0.05 | -0.43 |

| | | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|--------|------|-------|-------|
| Viewership change based on the rule to allow remote officials to eject players for dangerous plays ² | -0.48 | 2.35 | 0.73 | 2.55 | 183.00 | 2.85 | <0.05 | -0.49 |
| Choice to watch fewer or no NFL games related to news on concussions and CTE ⁴ | 2.00 | 1.08 | 2.40 | 1.13 | 187.00 | 2.11 | <0.05 | -0.36 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | | |

| Table 2 | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------|----------------|-------|--------|-------|---------|
| Statistically Non-significant Results of the Fan with Experience and Fan Only Groups | | | | | | | |
| | Fan with Experience Group | | Fan Only Group | | | | |
| Question Topic | M | SD | M | SD | df | t | p value |
| Viewership change based on news related to concussions or CTE ² | -0.57 | 1.60 | -0.96 | 2.34 | 111.33 | -1.28 | 0.20 |
| Support for the rule to move up the kickoff line ¹ | 73.67 | 30.05 | 76.34 | 30.41 | 182.00 | 0.51 | 0.61 |
| Support for the rule to allow remote officials eject players for dangerous plays ¹ | 72.05 | 30.43 | 79.67 | 29.81 | 183.00 | 1.47 | 0.14 |
| Viewership changes based on the rule to move up the kickoff line ² | -0.04 | 2.00 | 0.10 | 1.94 | 183.00 | 0.43 | 0.67 |
| Viewership changes based on the rule to penalize defensive players for lowering their head or shoulder prior to contact ² | -0.28 | 1.99 | 0.44 | 2.66 | 183.00 | 1.69 | 0.09 |
| Perceived understanding of concussions ³ | 1.22 | 0.42 | 1.33 | 0.47 | 85.04 | 1.52 | 0.13 |

| | | | | | | | |
|-------------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|------|
| Self-confidence in understanding of CTE ⁴ | 3.35 | 1.02 | 3.27 | 1.16 | 187.00 | -0.39 | 0.69 |
| Self-confidence in ability to recognize concussions ⁴ | 3.89 | 0.80 | 3.63 | 0.99 | 93.74 | -1.83 | 0.07 |
| Self-confidence in knowledge of concussion management ⁴ | 3.54 | 0.98 | 3.31 | 1.10 | 187.00 | -1.30 | 0.20 |
| Self-confidence in the ability to determine return to play ⁴ | 3.07 | 1.14 | 2.70 | 1.25 | 187.00 | -1.76 | 0.08 |
| Belief that a concussed player should stop playing and tell the coach or trainer ⁴ | 4.59 | 0.78 | 4.75 | 0.57 | 61.68 | 1.34 | 0.19 |
| Belief that the coach or coaching staff should be able to determine return to play ⁴ | 1.98 | 1.20 | 1.90 | 1.05 | 187.00 | -0.45 | 0.65 |
| Belief that the medical team should be able to determine return to play ⁴ | 4.63 | 0.80 | 4.59 | 0.73 | 187.00 | -0.34 | 0.74 |

| | | | | | | | |
|---------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|------|
| Belief that the player should be able to self-determine return to play ⁴ | 2.02 | 1.32 | 1.80 | 1.09 | 187.00 | -1.12 | 0.27 |
| Belief that concussions have a significant impact on the health of individuals ⁴ | 4.59 | 0.65 | 4.65 | 0.60 | 187.00 | 0.61 | 0.54 |
| Belief that concussions have a significant impact on the health of society ⁴ | 3.78 | 0.96 | 3.92 | 0.95 | 186.00 | 0.87 | 0.39 |
| Belief that CTE has a significant impact on the health of individuals ⁴ | 4.63 | 0.57 | 4.54 | 0.66 | 186.00 | -0.88 | 0.38 |
| Belief that CTE has a significant impact on the health of society ⁴ | 3.83 | 1.04 | 3.97 | 0.89 | 187.00 | 0.93 | 0.35 |
| Belief that the coach or coaching staff should be more involved in treatment ⁴ | 3.52 | 1.03 | 3.54 | 1.18 | 186.00 | 0.07 | 0.95 |

| | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|------|--------|-------|------|
| Belief that the medical team should be more involved in treatment ⁴ | 4.52 | 0.69 | 4.55 | 0.63 | 186.00 | 0.25 | 0.80 |
| Belief that the NFL adequately addresses concussion safety, rules, return to play, and CTE ⁴ | 2.91 | 1.07 | 2.66 | 1.04 | 187.00 | -1.44 | 0.15 |
| Perceived knowledge of CTE ⁴ | 3.28 | 0.93 | 3.42 | 0.98 | 187.00 | 0.83 | 0.41 |
| Knowledge total ⁵ | 12.39 | 1.27 | 12.13 | 2.05 | 188.00 | -0.81 | 0.42 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | |

Fan and Coach Group versus Fan and Player Group

There was one participant with current or former coaching experience only (i.e., never played American tackle football or in the NFL), 23 participants with current or former playing experience only (i.e., never coached American tackle football or in the NFL), and 7 participants with both current or former coaching and playing experience. These participants were then grouped into either the Fan and Coach (n=8) or Fan and Player (n=24) categories. It is important to note that the Fan and Coach group contains participants with both coaching and playing experience due to the small sample size (n=1) of the coach only category. There were 8 males in the Fan and Coach group and 23 males in the Fan and Player group. It is also important to note that these groups for comparison have small sample sizes which precluded the ability to run statistical analyses.

See Table 3 below for t-test results and descriptive statistics for the significant comparisons between the Fan and Coach group and the Fan and Player group. See Table 4 below for t-test results and descriptive statistics for the non-significant comparisons between the Fan and Coach group and the Fan and Player group.

| Table 3 | | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|----------------------|------|-------|------|---------|-----------|
| Statistically Significant Results of the Fan and Coach and Fan and Player Groups | | | | | | | | |
| | Fan and Coach Group | | Fan and Player Group | | | | | |
| Question Topic | M | SD | M | SD | df | t | p value | Hedge's g |
| Viewership change based on the rule to move up the kickoff line ² | 1.63 | 3.46 | -0.57 | 1.70 | 29.00 | 2.37 | <0.05 | 0.81 |
| Self-confidence in knowledge of concussion management ⁴ | 4.25 | 1.04 | 3.30 | 0.82 | 29.00 | 2.62 | <0.05 | 1.01 |
| Self-confidence in the ability to determine return to play ⁴ | 3.88 | 1.25 | 2.91 | 1.04 | 29.00 | 2.14 | <0.05 | 0.84 |
| Belief that concussions have a significant impact on the health of society ⁴ | 4.50 | 0.54 | 3.61 | 0.99 | 29.00 | 2.41 | <0.05 | 1.12 |
| Belief that CTE has a significant impact on the health of society ⁴ | 4.50 | 0.54 | 3.70 | 1.06 | 29.00 | 2.04 | <0.05 | 0.95 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | | |

| Question Topic | Fan and Coach Group | | Fan and Player Group | | df | t | p value |
|-----------------------------------------------------------------------------------------------------------------------|---------------------|-------|----------------------|-------|-------|-------|---------|
| | M | SD | M | SD | | | |
| Average percent current fan ¹ | 82.31 | 15.71 | 81.96 | 14.17 | 29.00 | 0.06 | 0.95 |
| Viewership change based on news related to concussions and CTE ² | -0.88 | 0.99 | -0.48 | 1.24 | 29.00 | -0.82 | 0.42 |
| Awareness of the rule to move up the kickoff line ¹ | 91.88 | 11.32 | 91.26 | 20.35 | 29.00 | 0.08 | 0.94 |
| Awareness of the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 96.88 | 5.84 | 96.87 | 7.97 | 29.00 | 0.00 | 0.99 |
| Awareness of the rule to allow remote officials to eject players for dangerous plays ¹ | 95.38 | 9.24 | 87.45 | 21.80 | 28.00 | 0.99 | 0.33 |
| Support for the rule to move up the kickoff line ¹ | 85.88 | 22.20 | 68.43 | 35.26 | 29.00 | 1.30 | 0.20 |

| | | | | | | | |
|-------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|------|
| Support for the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 72.13 | 23.34 | 72.61 | 29.87 | 29.00 | -0.04 | 0.97 |
| Support for the rule to allow remote officials to eject players for dangerous plays ¹ | 89.88 | 17.18 | 71.95 | 30.74 | 22.59 | 2.01 | 0.06 |
| Viewership change based on the rule to penalize defensive players for lowering their head or shoulder prior to contact ² | 1.00 | 3.89 | -0.74 | 1.45 | 7.69 | 1.24 | 0.25 |
| Viewership change based on the rule to allow remote officials to eject players for dangerous plays ² | 0.63 | 4.24 | -0.74 | 1.89 | 29.00 | 1.25 | 0.22 |
| Perceived understanding of concussions ³ | 1.13 | 0.35 | 1.30 | 0.47 | 16.31 | -1.13 | 0.28 |
| Self-confidence in the understanding of CTE ⁴ | 3.88 | 0.99 | 3.43 | 0.90 | 29.00 | 1.17 | 0.25 |
| Self-confidence in the ability to recognize concussions ⁴ | 4.13 | 0.99 | 3.83 | 0.78 | 29.00 | 0.87 | 0.39 |

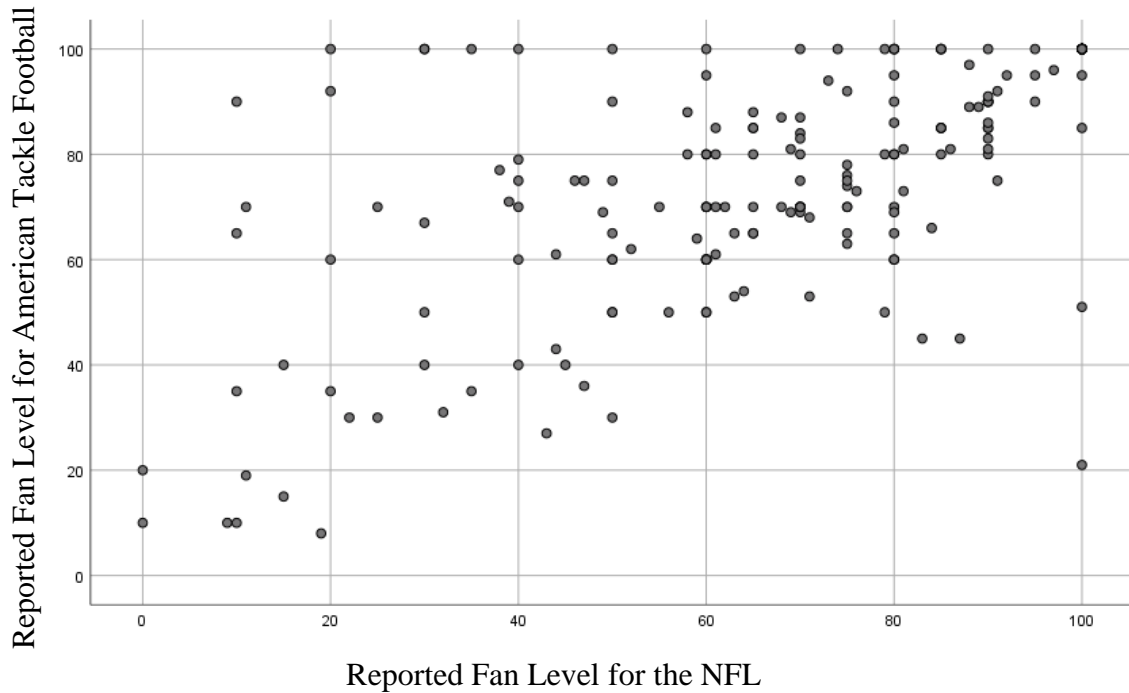
| | | | | | | | |
|-------------------------------------------------------------------------------------------------|------|------|------|------|-------|-------|------|
| Belief that a concussed player should stop playing and tell the coach or trainer ⁴ | 4.75 | 0.71 | 4.61 | 0.58 | 29.00 | 0.56 | 0.58 |
| Belief that the coach or coaching staff should be able to determine return to play ⁴ | 1.88 | 1.36 | 1.87 | 1.06 | 29.00 | 0.01 | 0.99 |
| Belief that the medical team should be able to determine return to play ⁴ | 4.25 | 1.39 | 4.65 | 0.71 | 29.00 | -1.01 | 0.30 |
| Belief that the concussed player should be able to self-determine return to play ⁴ | 1.63 | 1.06 | 2.00 | 1.28 | 29.00 | -0.74 | 0.46 |
| Belief that concussions have a significant impact on the health of individuals ⁴ | 4.75 | 0.46 | 4.65 | 0.49 | 29.00 | 0.50 | 0.62 |
| Belief that CTE has a significant impact on the health of individuals ⁴ | 4.63 | 0.52 | 4.70 | 0.56 | 29.00 | -0.31 | 0.76 |
| Belief that the coach or coaching staff should be more involved in treatment ⁴ | 3.63 | 0.92 | 3.30 | 1.18 | 29.00 | 0.69 | 0.49 |

| | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|------|-------|-------|------|
| Belief that the medical team should be more involved treatment ⁴ | 4.50 | 0.76 | 4.48 | 0.73 | 29.00 | 0.07 | 0.94 |
| Belief that the NFL adequately addresses concussion safety, rules, return to play, and CTE ⁴ | 2.88 | 1.46 | 2.78 | 0.74 | 8.28 | 0.17 | 0.87 |
| Choice to watch fewer or no NFL games based on news related to concussions or CTE ⁴ | 2.25 | 1.28 | 1.78 | 0.67 | 8.38 | 0.99 | 0.35 |
| Perceived knowledge of CTE ⁴ | 2.63 | 0.92 | 3.22 | 0.95 | 29.00 | -1.53 | 0.14 |
| Knowledge total ⁵ | 13.00 | 1.41 | 12.26 | 1.21 | 29.00 | 1.42 | 0.17 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | |

High Fan Group versus Low Fan Group

Participants were asked to respond on two slider scales (0-100) to select the number that best represented their perceived fan level for American tackle football and the NFL respectively. The attempt was made to encompass all fans of American tackle football by using both questions related to American tackle football and the NFL, because some avid football fans may not be avid fans of the NFL. Individuals who could be affected by this representation could be avid American tackle football fans who are not fans of the NFL because of the current concussion culture of the League. By combining these scores, participants were able to more thoroughly explain their different fan levels while still being included in the overall fan groups. A Pearson bivariate correlation coefficient was conducted to analyze the relationship between the slider scale question related to American tackle football fan level and the slider scale question related to NFL fan level (N=186). Figure 7 below shows a scatterplot of the scores for both slider scale questions. There was a strong, positive association between reported fan levels for American tackle football (M=72.88, SD=22.55) and reported fan levels for the NFL (M=65.29, SD=25.27), $r(185)=0.61$, $p<0.01$.

Figure 7. Scatterplot Correlation of the Reported Scores for Fan Level for American Tackle Football Question and the Fan Level for the NFL.



These scores were then averaged to get one score per participant representing the average fan level. In order to achieve the High Fan and Low Fan categories, the average fan level scores were split at 70.00 to have approximately half of the participants in the High Fan (70.00 and above) group and approximately half of the participants in the Low Fan (69.99 and below) group. There were 23 males, 57 females, and 5 others in the Low Fan group and 54 males and 49 females in the High Fan group. Because the recruitment efforts were focused on fans rather than non-fans, it is important to note that the participants in the Low Fan group are representative of low fans and not non-fans.

See Table 5 below for t-test results and descriptive statistics for the significant comparisons between the High Fan group and the Low Fan group. See Table 6 below for t-test results and descriptive statistics for the non-significant comparisons between the High Fan group and the Low Fan group.

| Table 5 | | | | | | | | |
|-----------------------------------------------------------------------------------------------------------------------|----------------|-------|---------------|-------|--------|--------|---------|-----------|
| Statistically Significant Results of the High Fan and Low Fan Groups | | | | | | | | |
| Question Topic | High Fan Group | | Low Fan Group | | df | t | p value | Hedge's g |
| | M | SD | M | SD | | | | |
| Average percent current fan ¹ | 84.16 | 10.09 | 50.84 | 16.65 | 134.63 | -16.24 | <0.01 | 2.42 |
| Viewership change based on news related to concussions or CTE ² | -0.27 | 1.47 | -1.55 | 2.66 | 127.22 | -3.96 | <0.01 | 0.60 |
| Awareness of the rule to move up the kickoff line ¹ | 79.01 | 32.37 | 52.84 | 38.37 | 138.43 | -4.74 | <0.01 | 0.74 |
| Awareness of the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 93.04 | 18.84 | 74.83 | 33.00 | 121.99 | -4.45 | <0.01 | 0.68 |

| | | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|--------|-------|-------|-------|
| Awareness of the rule to allow remote officials to eject players for dangerous plays ¹ | 74.87 | 36.38 | 58.57 | 37.19 | 176.00 | -2.93 | <0.01 | 0.44 |
| Choice to watch fewer or no NFL games related to news on concussions and CTE ⁴ | 1.89 | 0.91 | 2.77 | 1.17 | 159.55 | 5.66 | <0.05 | -0.84 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | | |

| Table 6 | | | | | | | |
|-------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|---------------|-------|--------|------|---------|
| Statistically Non-significant Results of the High Fan and Low Fan Groups | | | | | | | |
| Question Topic | High Fan Group | | Low Fan Group | | df | t | p value |
| | M | SD | M | SD | | | |
| Support for the rule to move up the kickoff line ¹ | 75.21 | 30.26 | 75.96 | 30.52 | 181.00 | 0.17 | 0.87 |
| Support for the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 82.18 | 26.24 | 88.63 | 19.63 | 182.41 | 1.92 | 0.57 |
| Support for the rule to allow remote officials to eject players for dangerous plays ¹ | 76.02 | 30.94 | 80.76 | 28.52 | 182.00 | 1.07 | 0.29 |
| Viewership change based on the rule to move up the kickoff line ² | 0.03 | 2.08 | 0.11 | 1.81 | 182.00 | 0.28 | 0.78 |
| Viewership change based on the rule to penalize defensive players for lowering their head or shoulder prior to contact ² | 0.17 | 2.63 | 0.38 | 2.41 | 182.00 | 0.56 | 0.57 |

| | | | | | | | |
|-----------------------------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|------|
| Viewership change based on the rule to allow remote officials to eject players for dangerous plays ² | 0.31 | 2.66 | 0.59 | 2.43 | 182.00 | 0.72 | 0.48 |
| Perceived understanding of concussions ³ | 1.30 | 0.46 | 1.30 | 0.46 | 186.00 | -0.02 | 0.98 |
| Self-confidence in the understanding of CTE ⁴ | 3.41 | 1.03 | 3.16 | 1.22 | 167.18 | -1.50 | 0.14 |
| Self-confidence in the ability to recognize concussions ⁴ | 3.70 | 0.93 | 3.67 | 0.98 | 186.00 | -0.16 | 0.88 |
| Self-confidence in the knowledge of concussion management ⁴ | 3.33 | 1.07 | 3.40 | 1.10 | 186.00 | 0.39 | 0.70 |
| Self-confidence in the ability to determine return to play ⁴ | 2.94 | 1.23 | 2.62 | 1.23 | 186.00 | -1.81 | 0.07 |
| Belief that a concussed player should stop playing and tell the coach or trainer ⁴ | 4.72 | 0.50 | 4.71 | 0.77 | 185.00 | -0.11 | 0.92 |
| Belief that the coach or coaching staff should be able to determine return to play ⁴ | 1.93 | 1.10 | 1.87 | 1.06 | 186.00 | -0.37 | 0.71 |

| | | | | | | | |
|-----------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|------|
| Belief that the medical team should be able to determine return to play ⁴ | 4.53 | 0.84 | 4.67 | 0.62 | 183.03 | 1.36 | 0.18 |
| Belief that the concussed player should be able to self-determine return to play ⁴ | 1.75 | 1.08 | 1.95 | 1.19 | 186.00 | 1.26 | 0.21 |
| Belief that concussions have a significant impact on the health of individuals ⁴ | 4.58 | 0.67 | 4.70 | 0.53 | 185.50 | 1.36 | 0.18 |
| Belief that concussions have significant impact on the health of society ⁴ | 3.83 | 1.01 | 3.95 | 0.89 | 185.00 | 0.86 | 0.39 |
| Belief that CTE has a significant impact on the health of individuals ⁴ | 4.56 | 0.68 | 4.55 | 0.59 | 185.00 | -0.06 | 0.95 |
| Belief that CTE has a significant impact on the health of society ⁴ | 3.91 | 0.96 | 3.99 | 0.87 | 186.00 | 0.57 | 0.57 |
| Belief that the coach or coaching staff should be more involved in treatment ⁴ | 3.51 | 1.09 | 3.55 | 1.21 | 185.00 | 0.26 | 0.80 |

| | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|------|--------|-------|------|
| Belief that the medical team should be more involved treatment ⁴ | 4.49 | 0.64 | 4.60 | 0.64 | 185.00 | 1.17 | 0.25 |
| Belief that the NFL adequately addresses concussion safety, rules, return to play, and CTE ⁴ | 2.80 | 1.02 | 2.59 | 1.06 | 186.00 | -1.39 | 0.17 |
| Perceived knowledge of CTE ⁴ | 3.41 | 0.89 | 3.35 | 1.06 | 166.96 | -0.44 | 0.66 |
| Knowledge Total ⁵ | 12.12 | 1.78 | 12.28 | 2.03 | 187.00 | 0.59 | 0.56 |
| <i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level. | | | | | | | |
| <i>Question Scale Type:</i> ¹ Slider scale (0-100); ² Slider scale (-10-10); ³ Likert scale (3-point); ⁴ Likert scale (5-point); ⁵ Score (0-15) | | | | | | | |

Recognizing that there was not a natural break in fan scores between the High Fan and Low Fan groups, the participants in the study were regrouped into thirds for additional comparisons. Instead of being grouped into two smaller groups, the participants were grouped by average fan score into three different groups: True High Fan, Moderate Fan, and True Low Fan. Participants with average fan scores of $x \leq 61.50$ were placed in the True Low Fan group ($n=61$, 32.3%), $61.51 \leq x \leq 76.99$ were placed in the Moderate Fan group ($n=60$, 31.7%), and $x \geq 77.00$ were placed in the True High Fan group ($n=68$, 36%). The purpose of the regrouping was to cope with the cluster of scores around the median in the original High Fan and Low Fan groups. To better analyze

associations between average fan level with the NFL, concussions, and CTE, the lowest third of the average fan scores, True Low Fan group, was compared to the highest third of the average fan scores, True High Fan group. This comparison resulted in 4 new statistically significant different results. Because the recruitment efforts were focused on fans rather than non-fans, it is important to note that the participants in the True Low Fan group are representative of low fans and not non-fans.

See Table 7 below for t-test results and descriptive statistics for the significant comparisons between the True High Fan group and the True Low Fan group. See Table 8 below for t-test results and descriptive statistics for the non-significant comparisons between the True High Fan group and the True Low Fan group.

| Table 7 | | | | | | | | |
|-----------------------------------------------------------------------------------------------------------------------|---------------------|-------|--------------------|-------|--------|--------|---------|-----------|
| Statistically Significant Results of the True High Fan and True Low Fan Groups | | | | | | | | |
| Question Topic | True High Fan Group | | True Low Fan Group | | df | t | p value | Hedge's g |
| | M | SD | M | SD | | | | |
| Average percent current fan ¹ | 89.93 | 7.26 | 44.72 | 16.11 | 81.42 | -20.16 | <0.01 | 3.62 |
| Viewership change based on news related to concussions or CTE ² | -0.10 | 1.43 | -1.92 | 2.92 | 84.99 | -4.41 | <0.01 | 0.79 |
| Awareness of the rule to move up the kickoff line ¹ | 86.34 | 27.01 | 47.48 | 38.76 | 86.82 | -6.16 | <0.01 | 1.16 |
| Awareness of the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 97.16 | 12.18 | 69.48 | 35.61 | 68.37 | -5.64 | <0.01 | 1.04 |
| Awareness of the rule to allow remote officials to eject players for dangerous plays ¹ | 82.60 | 31.67 | 54.76 | 37.94 | 105.11 | -4.35 | <0.01 | 0.80 |
| Self-confidence in the perceived understanding of CTE ⁴ | 3.52 | 0.99 | 3.10 | 1.26 | 113.70 | -2.10 | <0.05 | 0.37 |

| | | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|-------|-------|
| Self-confidence in the ability to determine return to play ⁴ | 3.18 | 1.19 | 2.59 | 1.24 | 126.00 | -2.74 | <0.01 | 0.49 |
| Belief that the concussed player should be able to self-determine return to play ⁴ | 1.55 | 0.91 | 1.98 | 1.19 | 126.00 | 2.32 | <0.05 | -0.41 |
| Belief that the NFL adequately addresses concussion safety, rules, return to play, CTE ⁴ | 2.90 | 1.09 | 2.43 | 1.02 | 126.00 | -2.51 | <0.05 | 0.45 |
| Choice to watch fewer or no NFL games related to news on concussions and CTE ⁴ | 1.85 | 0.93 | 2.93 | 1.18 | 126.00 | 5.80 | <0.01 | -1.02 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the p≤0.05 level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | | |

| Table 8 | | | | | | | |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------|--------------------|-------|--------|-------|---------|
| Statistically Non-significant Results of the True High Fan and True Low Fan Groups | | | | | | | |
| Question Topic | True High Fan Group | | True Low Fan Group | | df | t | p value |
| | M | SD | M | SD | | | |
| Support for the rule to move up the kickoff line ¹ | 77.74 | 29.35 | 77.82 | 28.38 | 123.00 | 0.02 | 0.99 |
| Support for the rule to penalize defensive players for lowering their head or shoulder prior to contact ¹ | 84.70 | 21.56 | 89.93 | 19.91 | 125.00 | 1.42 | 0.16 |
| Support for the rule to allow remote officials to eject players for dangerous plays ¹ | 81.91 | 27.84 | 83.17 | 28.74 | 124.00 | 0.25 | 0.80 |
| Viewership change based on the rule to move up the kickoff line ² | 0.03 | 2.49 | -0.09 | 1.51 | 123.00 | -0.31 | 0.76 |
| Viewership change based on the rule to penalize defensive players for lowering their head or shoulder prior to contact ² | 0.40 | 2.92 | -0.04 | 2.07 | 118.36 | -0.97 | 0.33 |
| Viewership change based on the rule to allow remote officials to eject players for dangerous plays ² | 0.63 | 2.91 | 0.18 | 2.02 | 122.00 | -0.99 | 0.33 |

| | | | | | | | |
|-------------------------------------------------------------------------------------------------|------|------|------|------|--------|-------|------|
| Perceived understanding of concussions ³ | 1.25 | 0.44 | 1.33 | 0.47 | 126.00 | 0.92 | 0.36 |
| Self-confidence in the ability to recognize concussions ⁴ | 3.84 | 0.93 | 3.72 | 0.97 | 126.00 | -0.68 | 0.50 |
| Self-confidence in the knowledge of concussion management ⁴ | 3.42 | 1.09 | 3.38 | 1.13 | 126.00 | -0.21 | 0.84 |
| Belief that a concussed player should stop playing and tell the coach or trainer ⁴ | 4.72 | 0.52 | 4.82 | 0.50 | 125.00 | 1.10 | 0.27 |
| Belief that the coach or coaching staff should be able to determine return to play ⁴ | 1.82 | 1.09 | 1.82 | 1.01 | 126.00 | -0.01 | 0.99 |
| Belief that the medical team should be able to determine return to play ⁴ | 4.51 | 0.91 | 4.69 | 0.50 | 104.51 | 1.41 | 0.16 |
| Belief that concussions have a significant impact on the health of individuals ⁴ | 4.63 | 0.69 | 4.74 | 0.44 | 113.50 | 1.09 | 0.28 |
| Belief that concussions have significant impact on the health of society ⁴ | 3.90 | 0.97 | 4.00 | 0.78 | 125.00 | 0.66 | 0.51 |

| | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-------|------|--------|-------|------|
| Belief that CTE has a significant impact on the health of individuals ⁴ | 4.61 | 0.67 | 4.54 | 0.56 | 126.00 | -0.64 | 0.52 |
| Belief that CTE has a significant impact on the health of society ⁴ | 3.99 | 0.95 | 4.03 | 0.82 | 126.00 | 0.30 | 0.76 |
| Belief that the coach or coaching staff should be more involved in treatment ⁴ | 3.49 | 1.11 | 3.48 | 1.25 | 126.00 | -0.08 | 0.93 |
| Belief that the medical team should be more involved treatment ⁴ | 4.54 | 0.59 | 4.61 | 0.61 | 126.00 | 0.65 | 0.51 |
| Perceived knowledge of CTE ⁴ | 3.22 | 0.92 | 3.30 | 1.12 | 126.00 | 0.40 | 0.69 |
| Knowledge Total ⁵ | 12.13 | 1.94 | 12.03 | 2.24 | 127.00 | -0.27 | 0.79 |
| <p><i>Note:</i> All t-tests were conducted with a 95% confidence level. p value: significant at the $p \leq 0.05$ level.</p> <p><i>Question Scale Type:</i> ¹Slider scale (0-100); ²Slider scale (-10-10); ³Likert scale (3-point); ⁴Likert scale (5-point); ⁵Score (0-15)</p> | | | | | | | |

CHAPTER VI

DISCUSSION

The purpose of this study was to investigate the relationship between fans, the NFL, concussions, and CTE specifically to describe fans' perceptions, understanding, and opinions of the topics. It was hypothesized that participants with direct current or former experience (Fan with Experience) would score higher on the concussion knowledge portion of the questionnaire as compared to participants with fan experience only (Fan Only). It was also hypothesized that coaches would score lower on the perceptions section regarding concussions and CTE than current or former players.

Contrary to the primary hypothesis that Fans with Experience would score higher on the knowledge portion compared to the Fan Only participants, there was no statistical difference between the groups with knowledge total score in this study. There were 15 points possible for the maximum knowledge total score. Participants were awarded a single point per correct question. The Fan Only knowledge total mean score was 12.13 (SD=2.05) and the Fan with Experience knowledge total mean score was 12.39 (SD=1.27) indicating that both groups answered most of the questions correctly. This result shows that direct experience in American tackle football and the NFL may have a stronger influence on perceptions than understanding of the NFL, concussions, and CTE.

Participants in the Fan with Experience group had higher average fan scores compared to participants in the Fan Only group. Participants in the Fan with Experience group were also significantly more aware of the three featured rule changes (i.e., rule change to move up the kickoff line, rule change to penalize defensive players for lowering their head or shoulder prior to contact, rule change to allow remote officials to eject players for dangerous plays) than the Fan Only group. However, participants in the Fan with Experience group reported a greater viewership decrease based on the rule to allow remote officials to eject players for dangerous plays while participants in the Fan Only group reported a viewership increase based on the rule. This could indicate that direct experience with American tackle football can result in Fans with Experience being hesitant to change due to older rules and the American tackle football culture being ingrained in their perspective of American tackle football. In contrast, having no direct experience with American tackle football and no subsequent sentimental attachment to older rules may result in people who are Fans Only being more open to changes in NFL rules and protocol. By general fans being more likely to increase viewership related to the acceptance of rule changes, the NFL may have the viewership support needed to continue improving rules and protocols for concussions despite fans with experience being hesitant to change. Most NFL fans do not have the opportunity to interact with American tackle football on a direct level, so the majority of NFL fans will presumably be more likely to have similar responses to those found with the Fan Only group in this study.

Participants in the Fan Only group, while less aware of the three featured rules, were more supportive of the rule to penalize defensive players for lowering their head or shoulder prior to contact. This, in conjunction with results from the viewership change, reinforces the likelihood of fans without direct experience in American tackle football being more willing to accept changes to the sport while fans with direct experience in American tackle football are more hesitant to changes to the sport. Coghlan (1993) explains that change inherently includes losing something familiar in replacement of something new or altered. Using this perspective, participants in the Fan with Experience group may have been less supportive of the rule to penalize defensive players for lowering their head or shoulder prior to contact due to an unwillingness to change, such as a distrust of the unknown as explained by Coghlan (1993). However, the statistical difference in support for the rules did not present regarding the rule to move up the kickoff line or allow remote officials to eject players for dangerous plays. There was also no statistical difference between the Fan with Experience group and the Fan Only group with the perceived understanding of concussions and CTE, ability to recognize concussions, knowledge of concussion management, and ability to determine return to play.

It was hypothesized that participants with current or former coaching experience (i.e., Fan and Coach) would have more negative views toward improving concussion and CTE issues than participants with current or former playing experience (i.e., Fan and Player). This means that it was expected that participants in the Fan and Coach group would be less likely to support rule and protocol changes to better treat concussions, less

likely to encourage concussed players from discontinuing play to seek treatment, and less likely to believe that concussions and CTE have a negative impact on the health of individuals and society. Despite this expectation, participants in the Fan and Coach group believed more strongly that concussions and CTE have a significant impact on the health of society than participants in the Fan and Player group. The average age of participants in the Fan and Coach group was approximately 38 years of age ($M=38.25$, $SD=6.71$), and the average age of participants in the Fan and Player group was 31 years of age ($M=31.00$, $SD=5.91$). The range of dates of playing American tackle football was 1962-2015 for the Fan and Coach group and 1968-2015 for the Fan and Player group. These findings, while opposite to the secondary hypothesis, may show a potential improvement in coaches' perception and knowledge on concussions and CTE due to the increased resources provided by football organizations for coaches and coaching staff members. While American tackle football players are also provided educational resources by their organizations, the Fan and Player group results on the impact of concussions and CTE may reflect the interaction of masculinity in football. Masculinity in American tackle football, such as the NFL, creates a risk culture which can influence players to have acceptance and tolerance toward pain and injury as a sign of extreme commitment to sport, and concussions are often interpreted as a sign of weakness in football players (McGannon, Cunningham, & Schinke, 2013). Previous research has highlighted the sociological effect of American tackle football being strongly associated with inevitable injury and concussion (Furness, 2016) and lack of weakness (Anderson & Kian, 2012) which, when combined, can create a perception of heroism (Trujillo, 1991).

This may mean that NFL players have the assumption that they are an exception to injuries and do not need to pay as much attention to the educational resources on concussions and CTE as other players. The sample of current or former football players in this study, while small, may be representative of the population of football players based on these assumptions of the influence of masculinity.

Participants in the Fan and Coach group also reported experiencing a viewership increase based on the rule to move up the kickoff line whereas participants in the Fan and Player group reported a decrease in viewership related to the rule. Reflecting on the idea that fans with direct current or former experience in American tackle football may be more hesitant to change as seen in the comparison between the Fan with Experience and Fan Only groups, it is reasonable to assume that the players in this study were more likely to decrease viewership related to rule changes to move up the kickoff line due to unfamiliarity with the new rules (Coghlan, 1993). Current or former American tackle football players may have a stronger, negative reaction (i.e., decrease in viewership) related to rule changes based on not wanting to see the sport they are familiar with be changed or altered into something new and different (Coghlan, 1993) and due to a strongly ingrained masculinity perspective of the sport in which players want to maintain the appearance of strong, unharmed, celebrated heroes (Anderson & Kian, 2012; Trujillo, 1991). Players may be more likely to still believe that NFL players must exemplify strength and masculinity to achieve success (Tjonndal, 2016) and that all NFL players understand and accept risks associated with being an NFL player (Furness, 2016) which decreases the need to change rules for concussion safety. While the secondary hypothesis

of this study would have led to the assumption that current or former coaches would also respond negatively to rule changes, the opposite result shown in this study may also reflect on the improved educational resources provided to coaches. Participants in the Fan and Coach group were also more confident in their knowledge of concussion management and ability to determine return to play compared to participants in the Fan and Player group. These results may be yet another reflection on the effect of educational resources provided to coaches and coaching staff members regarding concussions and CTE. However, it is also possible that players are less confident regarding concussion management and return to play because of lack of responsibility regarding these decisions. It is more likely that the coach or a member of the coaching staff would be choosing how to manage a concussed player's care and return to play eligibility than another player on the team. Often, the coach is determining return to play eligibility based on the interaction between the concussed player's health and the team's needs while the concussed player considers the return to play issue through the lens of their desire to play, teammate norms, and team cohesion. This could represent either a practice effect of repeated situations where coaches must make these decisions, or it may reflect a knowledge difference between coaches and players based on the differences seen between these two sample groups in this study.

The hypothesis for the comparison between Fan and Coach and Fan and Player groups was based on previous reports from current or former players who emphasized pressure from coaches to play with a concussion or return to play too soon. Based on the results of this study, this hypothesis may have not been supported due to flawed

background research selection in which more reports and research from players' perspectives than coaches' perspectives were included in the literature review. This may have accidentally inhibited a complete and representative understanding of the interactions between coaches, players, and the NFL which limited the scope of knowledge associated with the creation of the secondary hypothesis. It may also reflect a potential improvement in coaches' knowledge and perceptions of concussions and CTE due to improved education. Both the NFL and NFLPA have taken initiative in providing educational support for NFL coaches and many other organizations have done the same (i.e., primary and secondary education football teams). Because participants in the Fan and Coach group were more confident in their knowledge of concussion management and return to play, had increased viewership based on one of the three featured rule changes, and believed that concussions and CTE have a significant impact on the health of society, this may highlight a potential lack of education retention from players' education materials on concussions and CTE as compared to participants in the Fan and Coach group.

It is also important to note that both groups in this comparison had small sample sizes and that participants in the Fan and Coach group were not exclusively fans and coaches. Of the 206 participants included for data analysis in this study, only one participant had current or former coaching experience without current or former playing experience, indicating that this participant had never played American tackle football but did have experience coaching American tackle football; all other participants with current or former coaching experience also had current or former playing experience. While it is

likely more common for coaches to have playing experience than no playing experience, only 25% of the participants in the Fan and Coach and Fan and Player groups combined had current or former coaching experiences. Assuming there are more people in the United States of American with playing experiences than with coaching experiences, this percentage (75% current or former player, 25% current or former coach) may be an accurate representation of the general population.

The comparison of the High Fan and Low Fan groups was utilized to test how the direction of association with the NFL and tackle football compared to the direction of perceptions and understanding of the NFL, concussions, and CTE. The aim was to determine if level of tackle football and NFL association (i.e., High Fan or Low Fan) was related to level of knowledge, support for rule changes, and perception of concussion and CTE. The participants in the High Fan group were statistically more aware of the three featured rules regarding changes to reduce concussions. Participants in the Low Fan group reported a greater decrease in viewership and were also more likely to watch fewer or no NFL games due to news on concussions or CTE. This may relate to participants in the High Fan group, who self-describe as more avid fans, being more invested in the sport of American tackle football and the NFL which makes them more likely to be aware of rule changes and less likely to change viewership habits. Participants in the Low Fan group, who self-describe as less avid fans, in contrast, may be less aware of specific rule changes and more likely to change viewership habits to reduce cognitive dissonance. High Fans may likely be more aware of specific changes in the NFL related to concussions and CTE, such as new rules, due to being more invested in the sport and

therefore, having more consistent NFL viewership. Low Fans may be less aware of specific changes in the NFL but have a general idea related to concussions and CTE in the NFL. In contrast to the results from the Fan with Experience and the Fan and Player group, these results show that High Fans may be less likely to change viewership habits regardless of rule changes due to dedication to the sport as a fan and investment in the NFL for entertainment. Low Fans, however, may be more likely to decrease in viewership due primarily to the weak association likely related to inconsistent viewing habits prior to any concussion rule changes.

Just like with the pilot study, the two groups were found by taking the average percent current fan, acquired by averaging the self-reported scores from the two slider scales regarding fan level for American tackle football and the NFL, and splitting it to attempt to have 50% of the participants in the High Fan group and 50% of the participants in the Low Fan group. In this study, there were many participants clustered around the median for the 50% split. This led to imbalance in the distribution of participants in the groups. The split that was utilized for the groups in this study was determined to be the best option for representation of an even split containing all of the included participants in the study. Due to the difficulties attaining a true, even split, more participants were in the High Fan group than in the Low Fan group. This may have influenced the results of the analyses and more statistical significance between the two groups may be found in samples where an even split can be achieved. To compensate for the clustered participants at the median, an additional analysis was conducted to compare the two more extreme groups which were called the True High Fan and True Low Fan

groups. The analyses with the new groups resulted in 4 statistically significant differences between the True High Fan and True Low Fan groups in addition to the 6 statistically significant differences between the original High Fan and Low Fan groups. The new statistically significant results from the True High Fan and True Low Fan groups indicate that the participants clustered around the median score may have influenced the original High Fan and Low Fan group to have more moderate comparisons that are not accurate of the general population of more and less avid fans.

These results may highlight an increase in concussion and CTE knowledge related to increased level of fan association with American tackle football and the NFL. Because participants in the True Low Fan group were more likely to watch fewer or no NFL games related to news on concussions and CTE, this result may be more related to NFL fans with low fan association levels having lower general NFL viewership levels than NFL fans with high association levels. It is likely that less avid NFL fans (i.e., True Low Fans) are less aware and knowledgeable on rules, protocols, and information related to concussions and CTE due to habitual low viewership levels and that continuing to decrease viewership levels may be based less on news related to concussions and CTE and more related to a lack of interest. This can also explain why more avid NFL fans (i.e., True High Fans) may be more aware and knowledgeable on these subjects and less likely to decrease viewership levels based on habitual high viewership and association levels related to the NFL. If this is the case, the NFL should consider that part of the overall decrease in viewership may be caused from less avid fans who may be looking for an excuse to discontinue watching altogether, although the effect from this population

may be small. If the NFL wants to increase viewership and improve overall fan perspectives, the focus should be on the moderate fans; the clustering of the participant in the Moderate Fan group in this study may indicate that there are many moderate NFL fans who could become more avid fans with better understanding of concussions, CTE, and the NFL.

Despite 26 participants being excluded, there was no statistical difference in demographics for the included and excluded participants in this study. The participants in this sample were predominantly white (88.25%) but did have participants from four of the five racial categories recognized by the U.S. government (i.e., Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White). There was also a normal distribution of highest degree earned at time of completion of the study with the most common degree earned being a bachelor's degree. Participants were from 62% of the states and 2 locations outside of the United States of America at the time of completion of the study. Because the recruitment methods were heavily and primarily based on online methods through social media, more locations were represented in this study than in the pilot study. This improves the reach of the study to a wider audience more representative of the general population of NFL fans. Future research should explore more online recruitment methods, including promoting social media posts to further expand the reach of the study.

In both the overall sample before exclusion and the utilized participants for analysis, there were more female participants than male participants in the study. After exclusion, the sample was 57.28% female, 38.35% male, and 4.37% other (i.e., prefer not

to answer, prefer to self-describe, no response). In the subgroups for analysis, the Fan Only group was 74.13% female, 23.78% male, and 2.10% other; the Fan with Experience group was 95.65% male and 4.35% other; the Low Fan group was 67.06% female, 27.06% male, and 5.88% other; and the High Fan group was 47.57% female and 52.43% male. There were no female participants in the Fan and Coach and Fan and Player groups. Chi-square analyses were conducted to test for potential sex differences per each group. Only the male and female sexes were included in the analysis as there were not enough participants in the “other” category for analysis. There was a statistical difference between the Fan with Experience group and the Fan Only group regarding sex, $\chi^2(1)=80.84$, $p<0.05$. There were 39 males and 111 females in the Fan Only group and 48 males in the Fan with Experience group. There was also a statistical difference between the High Fan and Low Fan group regarding sex, $\chi^2(1)=6.29$, $p<0.05$. There were 33 males and 65 females in the Low Fan group and 48 males and 45 females in the High Fan group.

Overall, this study showed different interactions between NFL fans the NFL, concussions, and CTE through sub-group comparisons. These analyses were done in an attempt to understand the influences (i.e., direct current or former experience, fan experience only, current or former coaching experience, current or former playing experience, fan level) on fan perception and understanding of the NFL, concussions, and CTE. The focus of NFL fans as a sample was based on two reasons: 1) studies on the perceptions and understanding of the NFL, concussions, and CTE have previously not explored the topics as they relate to the general public or fans, and 2) using the idea that

fans can influence the NFL, the assumption was that participants in this study would be motivated to influence change in the NFL for better treatment of concussions and CTE. The results of this study, specifically related to overall perceptions of concussions and CTE having negative effects on health, support for rule changes, and viewership decreases related to concussions and CTE, show that the participants in this study reported making changes related to their NFL fan roles to better support an improvement in the treatment of concussions and CTE. There were still participants who reported negative reactions (low support, decrease in viewership) related to rule changes for concussions and CTE. This could be from lack of understanding of concussions, CTE, and the NFL's role in attempting to reduce these occurrences in their players. However, due to the inherent limitations of this study being a thesis study, there were not enough resources to implement educational interventions or provide educational resources to the participants. Therefore, it is unknown whether the fans in this study would be more active in influencing NFL changes for better treatment of concussions and CTE after an educational intervention. If these participants were able to have an educational intervention, it is likely that they would use their knowledge about the dangers of concussions and CTE to influence positive changes (i.e., concussion rule and protocol improvements, increased value on concussion reporting) in the NFL based on the reported results of participants already adjusting their fan behavior to reduce cognitive dissonance. It is important to note that the questionnaire did not ask broadly about rule changes. However, the results showed support for the three rule changes featured in the questionnaire which may be suggestive of support for future rule changes in the NFL. As

more rule changes are discussed, such as the potential to eliminate Thursday night football, it is important for researchers to ask for perceptions and support regarding new and future rule changes to continue to understand potentially changing opinions toward the NFL regarding concussions and CTE.

Limitations

This study had several limitations. While 232 people initiated participation in the study, only 206 participants could be used for analysis. This small sample size resulted in even smaller sample sizes in sub-groups that were not analyzed in this study due to unreliable results. In larger sample sizes, it may be beneficial to look at these proposed analyses with other topics in the study (i.e., Fan and Parent compared to Fan and Player; influence of trainings or education on perception and understanding of concussions and CTE; influence of viewership of the Concussion movie or League of Denial on perception and understanding of concussions and CTE; number of diagnosed or undiagnosed concussions on perception and understanding of concussions and CTE).

As previously mentioned, the sample also did not have many participants with current or former coaching experiences compared to the total 206 participants which may have affected the Fan and Coach and Fan and Player analyses. Finally, the sample was predominantly white with more females overall. This might not be truly representative of the population of NFL fans in America. However, there were more female participants in the pilot study as well, so this may relate to a bias for females to be more likely to complete online questionnaires for research or potentially being more involved in the concussion and CTE issue.

Recommendations and Future Directions

This study covered many topics related to the NFL, concussions, and CTE to help with future studies on the topic including tailoring educational interventions for specific groups. Future research should build upon this study, and other related research, to provide more participants with effective educational interventions to improve the overall understanding of concussions and CTE. Educational interventions should be based on the lens of the population being studied. For example, educational interventions for players may include information regarding masculinity associated with tackle football and the implications of concussions. The results of this study highlight that both masculinity and the dangers of concussions may influence players' perceptions on concussions and CTE as they relate to professional tackle football, such as the NFL. Educational sessions in this manner should focus more on the implication of concussions, because the results of this study reflect that players understand concussions but not the specific dangers associated with concussions. Another important factor to consider for future educational interventions with players is the effect of team cohesion and commitment to sport and teammates. In a study on concussion symptom underreporting, Kroshus et al. (2015) explained that psychosocial factors, such as norms accepted by teammates, can influence concussion reporting behavior. Failing to report concussion symptoms as a method to continue playing can be viewed as an asset in a teammate when players are highly connected to their athletic role and teammate's opinions (Kroshus et al., 2015). In addition, teammate norms and team cohesion are also more strongly correlated with higher levels of athletic competition (Kroshus et al., 2015). This may

mean that the players in this study minimized the dangers of concussions and CTE based on the influence of their commitment to American tackle football and to their teammates. Because this can alter player perception, future research with players should include questions related to participants' predictions about fellow teammates' thoughts and behaviors related to concussions and CTE as well as accepted norms among teammates.

Researchers should utilize the findings, while limited by a small sample size, to focus on specific topic areas within the questionnaire in order to have a more focused and effective study. This study attempted to cover many different areas in order to serve as a starting point for future research. If future research studies do not anticipate having a substantially large sample size in order to thoroughly analyze the topics covered in this study, select topics should be utilized with participants. Future research should also consider the focus of this study being the NFL instead of other tackle football leagues such as the Canadian Football League (CFL), college tackle football, or high school tackle football. If researchers choose to extrapolate the findings from this study to other football organizations, it is important to examine potential effects of exposure and popularity on participants' perception and understanding of concussions and CTE. The results of this study may not translate to other football leagues that have less media presence or fewer fans overall.

In addition, it would be beneficial for future research to tailor the research study and questionnaire to the specific population being studied (i.e., Fan Only, Fan with Experience, Fan and Coach, Fan and Player, High Fan, Low Fan). By improving the recruitment methods, a more meaningful sample may be obtained to improve the analysis

of future studies. It is also necessary to remember that the questionnaire utilized in this study and pilot study was developed using a few general questions from previous questionnaires on the perceptions and understanding of the NFL, concussions, and CTE, but this questionnaire still has room for improvement since many of the questions were created for this study. It would behoove future researchers to attempt to edit and improve the questionnaires used in this study in order to reduce any leading questions which may influence participant answers, eliminate unnecessary questions, and add essential topics.

Because two different primary recruitment methods were utilized as part of this thesis project (i.e., UNCG-based recruitment for the pilot study and online recruitment for the thesis study), it is recommended that future researchers consider the sample population they wish to study and adjust recruitment methods to better reach these participants. More participants were accrued in a timelier manner, relative to the goal number of participants, during the thesis study when the primary recruitment method was online through social media. This may show potential for better recruitment methods through popular communication methods. It is important to note that the online recruitment for this study included using tag phrases (i.e., hashtags on Instagram, Facebook, and Twitter; common short phrases on Twitter) to increase the likelihood of the recruitment post populating on potential participants' screens if they searched one of the tag phrases. Potential participants did not have to search the tag phrases in order to find the posts, however, searching one, or more, of the tag phrases (i.e., "football") would increase the likelihood of finding the post since the word "football" was already tagged in the recruitment post. These tag phrases should be used selectively based on who the

desired participants are for the study. It is also important to consider that tag phrases can increase the chance of recruiting participants who are already interested in the topic more than the general public which may affect the overall findings. However, online questionnaires tend to have this risk potential associated with the format of the study as people who are either extremely for or extremely against the topic will likely be more motivated to participate anyway. Using the tag phrases, while potentially still accruing the extreme participants, increases the chances that the recruitment posts will be seen by a wider audience which may result in more moderate participants. In addition, two of the most popularly used tag phrases in the study were “football” and “NFL” which potentially increased the chances of accruing eligible participants who viewed themselves as fans of American tackle football, thus decreasing the number of participants excluded from the study for lack of familiarity with the NFL. However, this recruiting method may not be the best method for all studies or participant samples. For example, future researchers should not use online recruitment methods primarily if the desired sample for the study is representative of people who do not use social media or is meant to include the general population rather than being focused on people with some interest in football.

It is also recommended that improvements be made to the knowledge portion of the questionnaire for future studies. The pilot study questionnaire did not have any unrelated questions in the knowledge section in order to verify that participants were not just selecting the most obvious choice instead of actually knowing the answer. Adjustments were made, recognizing how the lack of unrelated questions could be an issue, to the thesis questionnaire to include a few unrelated questions. These were

created in the symptomology portion of the knowledge section and included symptoms unrelated to concussions or CTE, such as symptoms related to mononucleosis or influenza. However, there were only a few unrelated questions added to the thesis questionnaire and they were only located in the symptomology portion of the questionnaire which may have resulted in inflated total knowledge scores. Future researchers should make a point to add more unrelated questions to better understand participants' actual knowledge on the subject.

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APPENDIX A

DEVELOPMENT OF THE QUESTIONNAIRE

The questionnaire(s) used during this study were developed using the following information:

1. Items #1, 2, 4, 28-29, 33, 37, 39-43, 50, from Yorke, Littleton, & Alsalaheen (2016) were used in this survey¹.
2. Items #5-8, 30-31 34, 51, from Yorke et al. (2016) were modified slightly to focus on fans of football as opposed to physical therapists (as was the focus of the original questionnaire).
3. Items #3, 9-27, 32, 35-36, 38, 44-49, 52-55 from Yorke et al. (2016) were excluded.

In addition, the following items were added:

1. I voluntarily consent to participate in this research study.
 - a. Yes
 - b. No
2. What is your race?
 - a. American Indian or Alaska Native
 - b. Asian
 - c. Black or African American
 - d. Native Hawaiian or Other Pacific Islander
 - e. White

¹ While these questions were utilized in the entirety from Yorke, Littleton, & Alsalaheen (2015), some additional answer options were added to a few questions. For example, the options “Prefer to self-describe as” and “Prefer not to answer” were added as answer options to the question regarding sex. For the pilot study questionnaire, question #2 from Yorke et al. (2015) was used with the original open-ended answer blank. However, this was modified to include selection options for birth years 1900-2018 for the thesis study questionnaire after there were issues with participants writing unrelated answers in the blank during the pilot study. Also, question #4 from Yorke et al. (2015) was modified to include different degree options (i.e., “I have not earned a degree,” “High School or GED,” “Bachelor’s degree,” “Master’s degree,” “Doctoral degree”) in order to be more representative of the general fan population.

3. Where do you currently live? If you live outside of the United States of America (USA), please select "Outside of the USA."
- a. Alabama
 - b. Alaska
 - c. Arizona
 - d. Arkansas
 - e. California
 - f. Colorado
 - g. Connecticut
 - h. Delaware
 - i. Florida
 - j. Georgia
 - k. Hawaii
 - l. Idaho
 - m. Illinois
 - n. Indiana
 - o. Iowa
 - p. Kansas
 - q. Kentucky
 - r. Louisiana
 - s. Maine
 - t. Maryland
 - u. Massachusetts
 - v. Michigan
 - w. Minnesota
 - x. Mississippi
 - y. Missouri
 - z. Montana
 - aa. Nebraska
 - bb. Nevada
 - cc. New Hampshire
 - dd. New Jersey
 - ee. New Mexico
 - ff. New York
 - gg. North Carolina
 - hh. North Dakota
 - ii. Ohio
 - jj. Oklahoma

- kk. Oregon
- ll. Pennsylvania
- mm. Rhode Island
- nn. South Carolina
- oo. South Dakota
- pp. Tennessee
- qq. Texas
- rr. Utah
- ss. Vermont
- tt. Virginia
- uu. Washington
- vv. West Virginia
- ww. Wisconsin
- xx. Wyoming
- yy. Outside of USA

4. Are you familiar with American tackle football?
 - a. Yes
 - b. No
5. Are you a current or former player of American tackle football?
 - a. Yes
 - b. No
6. Please expand on your history as a current or former American tackle football player.
 - a. Please list the number of years spent in this role in numerical format

 - b. Please list your ages when you played American tackle football

 - c. Please list the calendar years when you played American tackle football (for example: 1988-1990)

 - d. Please list the levels you spent in this role (i.e., youth, high school, college, professional)

7. Are you a current or former coach or coaching staff member of American tackle football?
 - a. Yes
 - b. No

8. Please expand on your history as a current or former American tackle football coach or coaching staff member.
- a. Please list the number of years spent in this role

 - b. Please list your ages when you coached or were a member of the coaching staff _____
 - c. Please list the calendar years when you coached or were a member of the coaching staff (for example: 1988-1990)

 - d. Please list the levels you spent in this role (i.e., youth, high school, college, professional)

9. Are you a parent of a current or former American tackle football player(s)?
- a. Yes
 - b. No
10. Please expand on your history as a parent of a current or former American tackle football player(s).
- a. Please list the number of years spent in this role

 - b. Please list the ages your child (children) played football

 - c. Please list the calendar years your child (children) played football (for example: 1988-1990, 1992-1993)

 - d. Please list the levels your child (children) played football

11. Are you a current or former fan of American tackle football?
- a. Yes
 - b. No

12. Please mark on the scale below the spot on the line that best reflects the extent to which you view yourself as a current fan of American tackle football (in general, including youth, high school, college, professional).

0 = Not a fan at all 100 = Avid fan

0 10 20 30 40 50 60 70 80 90 100



13. Please mark on the scale below the spot on the line that best reflects the extent to which you view yourself as a current fan of the National Football League (NFL).

0 = Not a fan at all 100 = Avid fan

0 10 20 30 40 50 60 70 80 90 100



14. Do you consistently watch part or all of National Football League (NFL) games?

- a. Yes
- b. No

15. Which of the following days do you watch National Football League (NFL) games?

- a. Sunday
- b. Monday
- c. Thursday

16. To what extent has your NFL viewership changed based on news related to concussions or chronic traumatic encephalopathy (CTE)? If your viewership has not changed, you must touch the slider option on "0" to record your answer.

Decreased viewership No change Increased viewership

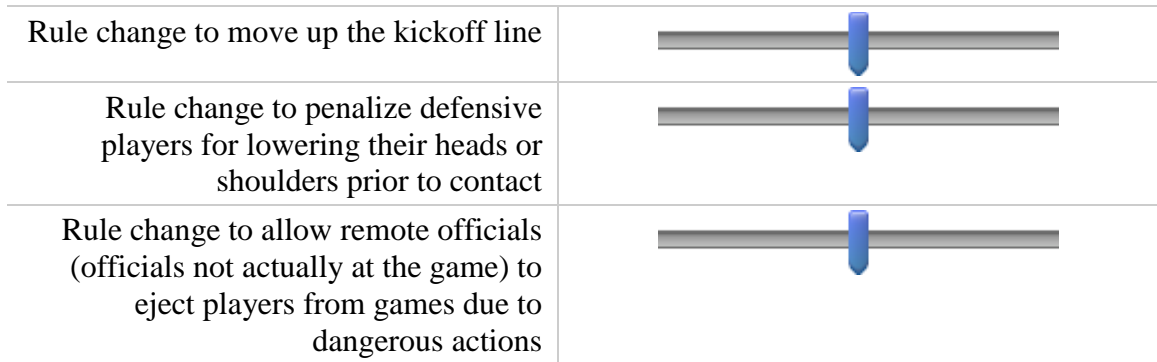
-10 -8 -6 -4 -2 0 2 4 6 8 10



17. To what extent are you aware of rule changes related to concussions and chronic traumatic encephalopathy (CTE)?

0 = Not aware 100 = Completely aware

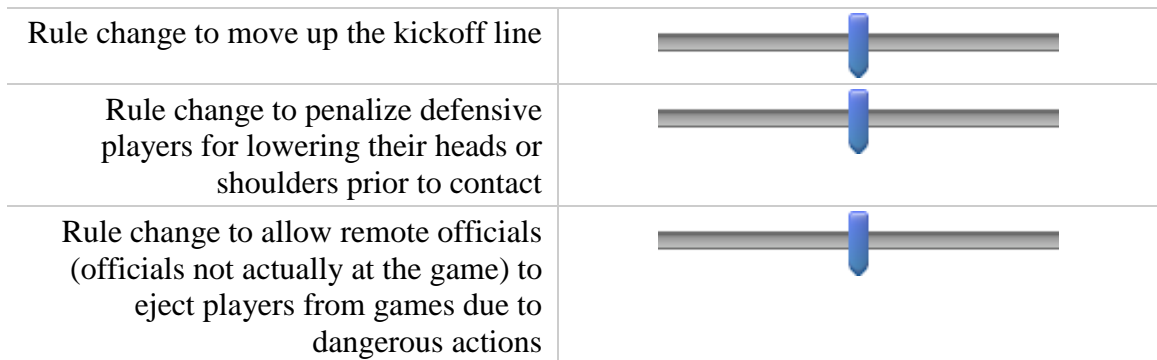
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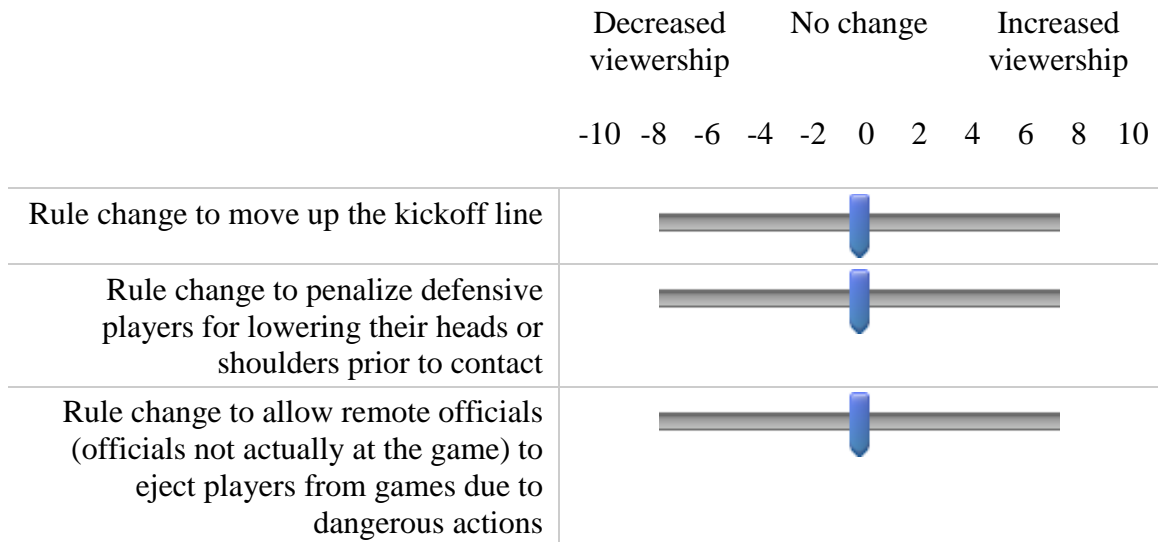
18. To what extent do you support the rule changes related to concussions and chronic traumatic encephalopathy (CTE)?

0 = Do not support at all 100 = Fully support

0 10 20 30 40 50 60 70 80 90 100



19. To what extent have the rule changes related to concussions and chronic traumatic encephalopathy (CTE) changed your viewership of the NFL?



20. What is your perceived understanding of concussions?

- a. Fully understand what a concussion is
- b. Moderately understand what a concussion is
- c. No understanding of what a concussion is

21. Have you ever watched the 2015 movie Concussion in full?

- a. Yes
- b. No

22. How many diagnosed concussions have you received in your life? Please respond in numerical format.

a. _____

23. How many undiagnosed concussions do you believe you have you received in your life? Please respond in numerical format.

a. _____

24. Have you ever received any formal training or education on chronic traumatic encephalopathy (CTE)?

- a. Yes
- b. No

25. What type of formal training or education have you received on chronic traumatic encephalopathy (CTE)? Please respond to all that apply.
- Education as part of a degree program
 - Online certification
 - Seminar
 - Other (please specify)
-
26. I am confident in my understanding of chronic traumatic encephalopathy (CTE).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
27. If a player sustains a concussion during a game, that player should stop playing and tell the coach or trainer
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
28. I believe the coach or coaching staff should be allowed to determine whether a player who has sustained a concussion is able to return to play in the National Football League (NFL).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
29. I believe a member of the medical team should be allowed to determine whether a player who has sustained a concussion is able to return to play in the National Football League (NFL).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

30. I believe the concussed player should be allowed to self-determine their ability to return to play in the National Football League (NFL).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
31. I believe that chronic traumatic encephalopathy (CTE) has a significant impact on the health of individuals.
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
32. I believe that chronic traumatic encephalopathy (CTE) has a significant impact on the health of society.
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
33. I believe that the National Football League (NFL) coach or coaching staff should be more involved in the treatment of players with concussion(s).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
34. I believe that the National Football League (NFL) medical team should be more involved in the treatment of players with concussion(s).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

35. I believe that the National Football League (NFL) adequately addresses concussion safety, concussion rules, return to play, and chronic traumatic encephalopathy (CTE).
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
36. I have chosen to watch fewer or no National Football League (NFL) games due to the concussion and chronic traumatic encephalopathy (CTE) culture within the NFL.
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
37. Has your knowledge or perceptions of concussions, CTE, or the NFL impacted your view of your child participating in football?
- It has negatively impacted my view of participation in football
 - It has not impacted my view of participation in football
 - It has positively impacted my view of participation in football
38. How much do you know about chronic traumatic encephalopathy (CTE)?
- Extremely knowledgeable
 - Very knowledgeable
 - Moderately knowledgeable
 - Slightly knowledgeable
 - Not knowledgeable at all
39. Please tell me everything you know about chronic traumatic encephalopathy (CTE). If you prefer not to answer or do not know anything about CTE, please type "prefer not to respond."
- _____
40. A concussion is:
- An injury to the spinal cord
 - An injury to the brain
 - Unsure

41. A helmet prevents a player from getting a concussion
- Yes, it completely protects a player
 - No, it does not protect a player
 - It helps, but it doesn't completely prevent one
 - Unsure
42. A concussion is treated by:
- Taking medication from a doctor
 - Therapy with a team trainer
 - Resting completely
 - Unsure
43. A player can return to play after a concussion when the player:
- Feels 90% better
 - Feels completely better
 - Only has a mild headache
 - Unsure
44. When a player is feeling the effects of a concussion, it is okay to play as long as the player is careful or when it is an important game.
- True
 - False
 - Unsure
45. Symptoms related to dry mouth
- True
 - False
 - Unsure
46. Nasal congestion symptoms
- True
 - False
 - Unsure
47. Is there anything else you would like to tell me about your experience with or knowledge about concussions, chronic traumatic encephalopathy (CTE), and the National Football League (NFL)?
- _____