BLACK AMERICANS AND TRAUMATIC HEAD INJURIES

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Bachelor of Science in Systems Engineering

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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CHANGE LEADING TO NEW SCHOOLS OF THOUGHT

According to John Meyer (2019) of *The Denver Post Online*, there are twenty-four million golfers, both recreational and professional, in the United States, and, golf has not changed much in the past hundred years. These two facts have made golf an oft-cited example of a sport with vast potential for growth for data analysts (Dusek, 2019). Companies have already begun to take advantage of this gold mine of revenue possibilities. GameForge is the leader in this new space, with roughly two thousand rounds of golf entered into their database every month. Additionally, the Professional Golfers' Association (PGA) Tour has used ShotLink software to gather data on every stroke taken in tournaments since 2003 (Burke, 2012). Therefore, we can conclude that the data is there, it just is not being used in any meaningful way. In the technical capstone project, GameForge called upon the capstone group to design and implement, into the GameForge product, a training recommendation system which considers round scoring data, training drill performance data, and golf course trait data to provide both a general training regimen as well as a tournament-specific regimen. The end product will suggest how an athlete can modify, and adapt to change, both mentally and physically.

Another recent trend in sports research is the seemingly sudden outbreak of a particular brain injury, chronic traumatic encephalopathy (CTE), in retired athletes. This disease overwhelmingly affects professional football players, and as such former National Football League (NFL) players have been suing the league in recent years. This outbreak was so widespread that in 2018 the NFL paid former players who suffered traumatic brain injuries over a billion dollars (Garcia-Roberts & Murphy). Currently, there is no cure for CTE, and symptoms take years to appear in patients (Bailes, Fitzsimmons, Hammers, & Omalu, 2010). Additionally, a recent survey of 50,000 middle and high school-aged children done by Monitoring The Future

(Hoyle, 2019) found that tackle football is mainly played by black children. This fact creates a troubling societal issue; one which a particular racial group is more prone to a traumatic injury than other racial groups.

Even though both of these topics deal with sports, the STS topic does not deal directly with the technical topic and therefore the topics are loosely coupled. They both involve sports industries that have undergone change recently and are ripe for more research to be done: either golf training analytics or studying head injuries and their effects. This paper will draw mainly from sociological journals concerning the overrepresentation of minorities in the NFL and the adverse effects CTE has on specific racial groups, as well as journal articles concerning the systematic nature of oppression that minorities have faced for years in the United States.

LACK OF CURRENT RESEARCH

There is plenty of research done in the concussions space, and plenty of research done in the racial inequality and sociology spaces, but the intersection of the two has been mostly vacant in recent years. The paucity of discussion of these connections provided an opportunity to do new STS research in an interesting field. The effects of concussions are not seen as a priority among sociologists who would rather look at more pressing issues in race or sport. This unfortunate fact is outlined in detail in the second volume of the *Sports Medicine – Open* journal, published in 2016. In this journal, researchers Laurens Holmes, Jr, Joshua Tworig, and others demonstrate this reality in their article "Implication of Socio-Demographics on Cognitive-Related Symptoms in Sports Concussion Among Children". Holmes, et al. explain that even though there are millions of cases of concussion a year, the risk factors and long term effects of repeated concussion still are not fully understood (2016). Even in the years that have followed the publishing of this article, much more research has not been done to try and enumerate the

risks a little more and figure out just how these risks vary depending on age, race, sex, and other factors that the party who suffers the concussion can not control.

What is known is that any athlete who decides to play, or continues to play, a sport in the face of concussion risk has to consider many elements. The elements an athlete must consider when deciding whether to continue playing football in particular can be displayed using a model adapted from W. Bernard Carlson's System in Context model, shown below in Figure 1. As shown in this figure, there are multiple agents in play who have a direct benefit to a player continuing to play football. The boundary object here is the act of playing football itself, as that is the action creating this controversy in the first place and the ensuing decisions have to be made. The decision has to be made in the context of evaluating the risk of sustaining a concussion while participating in football. The agents themselves are where the model becomes non-trivial.

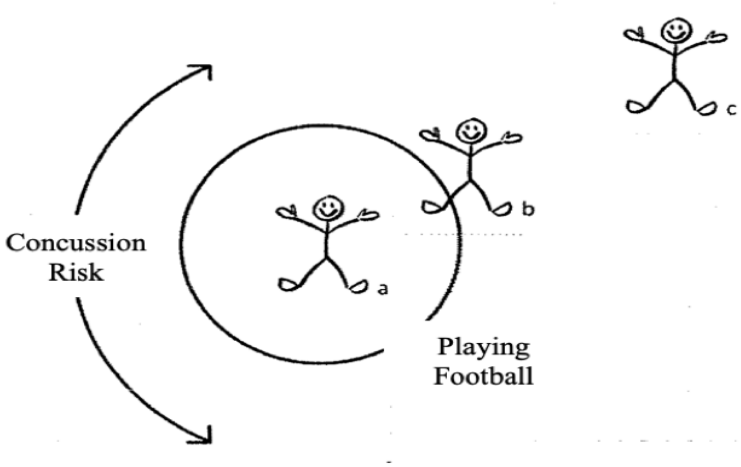

Figure 1: Weighing the Risks of Concussions While Playing Football: Shows how many agents are involved in a decision to continue playing football in the face of concussion risk. Agent (a) is the player himself, agents (b) are peers who play football, and agents (c) are family and coaches who have say in whether an athlete continue to play football even after acknowledging the risks. Similar to Carlson's System in Context model (Ziller, adapted from Carlson, 2020).

Any athlete, regardless of race, which will be discussed in detail in a later section of this paper, would be in the center of this model, as they are the ones who in some way or another are

involved in every consequence of their decision. On the boundary are peers who play football with the player in question. They face identical risks as the athlete, but are also able to relate to him more due to them having this context that agents on the outside, such as parents, coaches, and other family and friends who do not play football, simply do not have. These variables are important to consider as the framework throughout this paper, as certain characteristics about individual players will change, such as race or age, but these basic considerations of risk. But, no matter who the subject is, the consequences will remain constant.

In terms of the technical project, the culture of golf is more old-fashioned and less focused on improving technology. As noted, the sport has not changed much at all since the first Masters tournament almost a century ago. Lack of change is a large reason why the current data analysis infrastructure in golf is not robust, however this research paper will focus more so on the STS topic of the differing racial effects of concussions rather than the golf training recommendation system project undergone this year, submitted as a separate paper to a Systems Engineering conference this spring.

CONCUSSION EFFECTS ON VARIOUS RACES?

The STS research question starts by first analyzing the current situation of the concussion research industry as one that is in a good position for further research. Due to the NFL's poor treatment of former athletes outlined in the introduction, there is not much research being done in this space, but this paper will begin to investigate this situation. The logical question to begin with, and the one that will be discussed in this paper, is: How do concussions affect black families differently than families of other races?

This research aims to shed light on the importance of such a topic in the sports sociology industry and should result in better handling of CTE cases in the future as well as understanding

the underlying causes of why certain groups feel the need to take risks other groups do not. Of paramount importance in today's culture, are almost four million concussions diagnosed in the United States each year, and almost fifty percent of concussions go undiagnosed (Brain Injury Research Institute, 2020). Therefore, there could be close to eight million concussions each year in the United States, with any repeated cases being possibly the beginning stages of CTE. Any mechanism a society as advanced as the United States uses to improve its handling of said cases is important, and this research paper aims to provide ways of improvement.

DIFFERING OPPORTUNITIES IN BLACK COMMUNITIES

Among all CTE sufferers, there is a preponderance of former pro football players, of which seventy percent are black (Sonnad, 2018). Figure 2, on the following page, provides a breakdown, by race, of the NFL, but it is clear that black men over index in pro football, as only six percent of the United States is made up of black males (Moore, 2015), while almost seventy percent of the NFL is made up of black males.

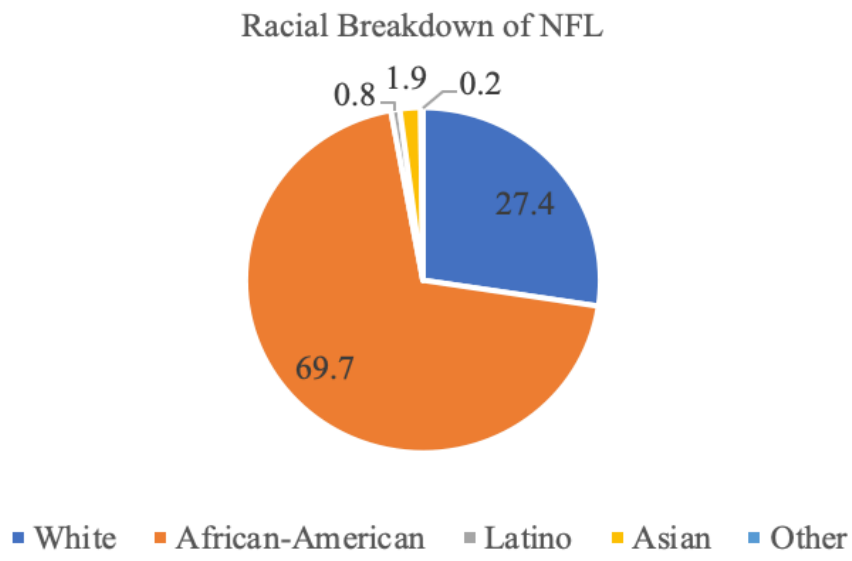

Figure 2: Racial Breakdown of NFL: This chart shows the stark black overrepresentation in the NFL. (Ziller, 2019).

Black men are overrepresented in the NFL, and by extension overrepresented in CTE cases, for a number of reasons. First, low-income parents use sports, namely football, as an outlet to prevent their children from joining gangs while growing up (Hoyle, 2019). According to the United States Census Bureau (2019), race and low-income status are correlated, with blacks earning significantly lower median household incomes. Therefore, black parents participate in this activity at a higher rate than parents of other races. Also, in her 2019 article "The White Flight From Football", Alana Semuels shows that for many low-income families, football can be the only way to be admitted into a college. It is clear that depending on where a child grows up, susceptibility to CTE can vary dramatically (Semuels, 2019) based on the extenuating circumstances a child faces in his or her neighborhood.

Even among football-playing children, those in low income cities are often not fortunate enough to own helmets with the latest technology, much of it designed to prevent concussions and by extension CTE. Without such technology, hits that would be safe for some players are devastating for lower-income players. Figure 3 shows the positive trickle-down effects for all le agues, mostly the low-income leagues, of the affluent leagues getting new helmet technology.

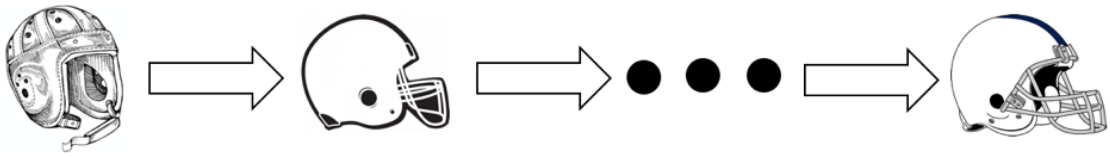

Figure 3: Effect of Helmet Technology Improvement on All Leagues: An improvement in helmet technology in the most affluent league leads to all leagues receiving better quality helmets down the line. Similar to Carlson's Handoff model (Ziller, adapted from Carlson, 2020).

The top leagues in an area will get the newest helmets and donate the helmets they used to use to the leagues that are less fortunate and create a society in which every league becomes much safer. As long as there continues to be technological improvement in the helmet industry, everyone will be better off, even the leagues who can not afford to get the newest technology.

There is even evidence that within football there is a race problem, though. Certain positions, such as running back, wide receiver, tight end, linebacker, and defensive back require a more versitile skillset than other positions. An athlete playing these positions must be mobile enough while, at the same time, big enough to withstand the greater than average number of hits they will sustain during any given game. Skill positions also happen to be played overwhelmingly by black athletes (Moore, 2015), a fact which can be used to draw a good

causation to the reason black football players are concussed more than players of other races (Moore, 2015). All of these facts together reinforce a narrative that black men put their whole life into a game that does not give them anything in return (Moore, 2015).

This problem needs to be explored more because of the sheer number of parties that have stock in a child's future. While it may not seem like it at the time, every decision a person makes effects multiple other people down the line. Figure 4 shows a few of the parties who would take interest in an athlete making the choice either to play or not to play football. This graphic is similar to a common STS framework, W. Bernard Carlson's Social Relationships model. The relationships are two-way, meaning that the athlete has an influence on each of those parties, but each of those parties has an influence on the athlete as well. For example, a relative of an athlete growing up at a lower socioeconomic level, such as a parent, may try to push an athlete to choose football in order to dissuade them from joining gangs, as Hoyle (2019) pointed out. On the other side, though, the athlete may want to pursue football so they can provide for their family on the rare case that they make the NFL. Each of these relationships has a two-way nature to it, which adds a level of complexity to the problem. For this reason, this problem of the sociological impact of head injuries is an interesting one for an STS topic.

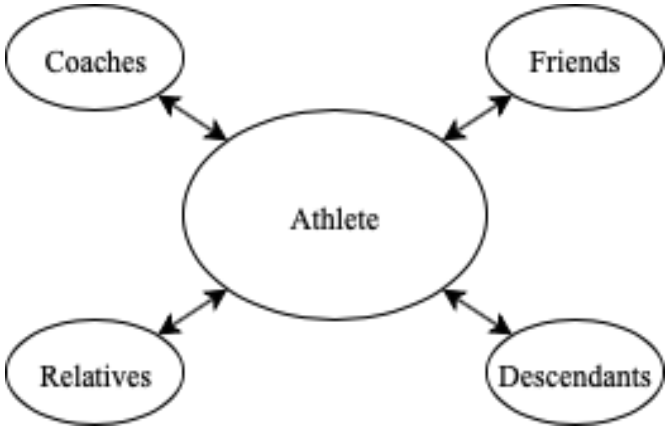

Figure 4: Effect of an Athlete's Decisions on Others: An athlete's decision to continue playing a sport that causes harm to his or her brain has a trickle-down effect on many other parties. Similar to Carlson's Social Relationships model (Ziller, adapted from Carlson, 2019).

Adding to the importance of this topic is that experts in this field do not agree on how to gather data to support a hypothesis. An example of this is how to represent socioeconomic status in an experiment. In their 2017 experiment, researchers Thomas Aicher, Trevor Bopp, Robert Turick, and Joshua Vadeboncoeur examine, through a survey of 451 college students, fourteen sports and the differences in racial makeup of youth participation in each sport. They assume that race is a fine proxy for socioeconomic status. Just a year before, researchers Asken, et al. (2016) wrote about what makes one athlete more susceptible to CTE than another. In contrast to Aicher, et al., these authors caution against using simply race to mean socioeconomic status. Rather, they argue that the developmental environment a youth is in matters much more than the race they belong to (Asken, et al., 2016). All of these researchers are credible and affiliated with universities, they just have differing opinions on this topic.

A logical follow up to all this research is, what can to be expected as a result of growing awareness of risks associated with concussions? Some swift change is already starting to happen across the United States. In his book *Social Issues in Sport*, Ron Woods (2016) outlines the steady decline in participation that football experienced in relation to other sports popular among youths. Interestingly, it seems that head injuries are a chief reason for this, as shown by youth leagues cutting down on the amount of tackling allowed in practice in response to the declined participation rates (Woods, 2016). All of these facts explain that, while football is still popular among children, especially those who grow up in low-income households and those who are black, there have been enough negative stories written about football in the past few years that participation will continue to decline if nothing is done to combat the recent outbreak of head injuries.

Even though awareness of concussions has never been higher, there remain serious limitations to performing a study to determine linkages between socio-economical factors and concussion incidence, as shown by Holmes, et al. from their previously-cited article "Implication of Socio-Demographics on Cognitive-Related Symptoms in Sports Concussion Among Children" (2016). There is a real problem in lower-income areas with medical record keeping and data acquisition that prevents high-level research to be done without significant restructuring of the hospital systems in these towns (Holmes, et al., 2016). Also, it is tough to compare concussion case frequency now versus back in the day when it was commonplace to have a concussion and not report it and "stick it out" and go back in the game (Holmes, et al., 2016). This piece outlines many of the reason that the research on this topic has been lean, as has been the topic throughout this paper, and why it is important that many more researchers begin to look into this. Therefore, not enough data being available in certain areas or in certain eras to do a thorough regression analysis without confounding biases skews results considerably.

As long the cultures of different races remain distinct due to a combination of academic, social, and technological factors, football participation rates for black Americans are likely to continue to fall at a slower pace than the rates for other outlets (Woods, 2016) and there will be this disparity between races and concussion incidence. It is imperative that the United States as a whole works to help these lower-income areas become safer and more abound with opportunity other than this dangerous sport to participate in non-violent activity growing up. Recent legislation and negative press surrounding football has begun to start a wave of popularity shifting, but there is still work to be done in this space. In terms of this research paper, a logical next step would be to continue to look into the diffusion of new sports technologies and examining how the technology differs between leagues in affluent areas and leagues in low-

income areas. Additionally, the next iteration of this paper would include looking into empirical studies more to put more numbers behind the story rather than anecdotal evidence such as the Semuels and Hoyle articles. There are always risks involved in any study, and for this one the risk is that people draw too much of a causal link between race and concussion effects. It is important to note that just because a certain person is less likely to stop playing football even in the face of concussion concerns, that does not make them any less responsible.

WORKS CITED

Aicher, T., Bopp, T., Turick, R., & Vadeboncoeur, J. (2017). Are you welcomed? A racial and ethnic comparison of perceived welcomeness in sport participation. *International Journal of Exercise Science*, *10*(6), 833-844.

Asken, B., Sullan, M., Snyder, A., Houck, Z., Bryant, V., Hizel, L., … Bauer, R. (2016). Factors influencing clinical correlates of chronic traumatic encephalopathy (CTE): a review. *Neuropsychology Review I, 26*(4), 340-363.

Bailes, J., Fitzsimmons, R., Hammers, J., Omalu, B. (2010). Chronic traumatic encephalopathy, suicides and parasuicides in professional american athletes: the role of the forensic pathologist. *The American Journal of Forensic Medicine and Pathology*, *31*(2), 130-132.

Brain Injury Research Institute. (2020). What is a concussion?. In *Protect the brain.* Retrieved from http://www.protectthebrain.org/Brain-Injury-Research/What-is-a-Concussion-.aspx

Burke, M. (2012, April 5). ShotLink is making golf easier for hacks and harder for pros. *Forbes.* Retrieved from https://www.forbes.com/

Dusek, D. (2018, March 4). By the numbers: analytics become an increasingly important part of golf. *Golfweek Digital Edition*. Retrieved from https://golfweek.com/

Garcia-Roberts, G., Murphy, B. (2018, October 23). NFL players with brain trauma receive notice of settlements stripped to nothing. *USA Today*. Retrieved from https://www.usatoday.com/

Holmes, L., Jr, Tworig, J., Casini, J., Morgan, I., O'Brien, K., Oceanic, P., & Dabney, K. (2016). Implication of socio-demographics on cognitive-related symptoms in sports concussion among children. *Sports medicine - open*, *2*, 38. doi.org/10.1186/s40798-016-0058-8

Hoyle, B. (2019, February 6). *American football and CTE: is a racial divide inevitable?.* Retrieved from https://www.mdedge.com/psychiatry/article/194020/mixed-topics/american-football-and-cte-racial-divide-inevitable

Meyer, J. (2019, April 12). The state of golf in 2019 by the numbers. *The Denver Post*. Retrieved from https://www.denverpost.com/

Moore, A. (2015, December 24). *Football's war on the minds of black men*. Retrieved from https://www.vice.com/en_us/article/eze4gj/footballs-war-on-the-minds-of-black-men

Semuels, A. (2019, February 1). The white flight from football. *The Atlantic*. Retrieved from https://www.theatlantic.com/

Sonnad, N. (2018, May 24). The NFL's racial divide, in one chart. *Quartz*. Retrieved from https://www.qz.com

United States Census. (2019) *Current Population Survey.* Retrieved from https://www.census.gov/programs-surveys/cps.html

Woods, R. (2016). *Social Issues In Sport* (3rd ed.). Champaign, Illinois: Human Kinetics.

Ziller, J., Carlson, W.B. (2020). *Weighing the risks of concussions while playing football.* [Figure 1]. School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.

Ziller, J. (2019). *Racial breakdown of NFL.* [Figure 2]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Ziller, J., Carlson, W.B. (2019). *Effect of an athlete's decision on others.* [Figure 4]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.

Ziller, J., Carlson, W.B. (2020). *Effect of helmet technology improvement on all leagues.* [Figure 3]. (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.

BIBLIOGRAPHY

Aicher, T., Bopp, T., Turick, R., & Vadeboncoeur, J. (2017). Are you welcomed? A racial and ethnic comparison of perceived welcomeness in sport participation. *International Journal of Exercise Science*, *10*(6), 833-844.

Asken, B., Sullan, M., Snyder, A., Houck, Z., Bryant, V., Hizel, L., … Bauer, R. (2016). Factors influencing clinical correlates of chronic traumatic encephalopathy (CTE): a review. *Neuropsychology Review I, 26*(4), 340-363.

Bailes, J., Fitzsimmons, R., Hammers, J., Omalu, B. (2010). Chronic traumatic encephalopathy, suicides and parasuicides in professional american athletes: the role of the forensic pathologist. *The American Journal of Forensic Medicine and Pathology*, *31*(2), 130-132.

Broadie, M. (2018, October 16). Mark Broadie – the godfather of golf analytics [Interview by Walter Lis]. *Chicago Golf Report*. Retrieved from https://www.chicagogolfreport.com/

Brain Injury Research Institute. (2020). What is a concussion?. In *Protect the brain.* Retrieved from http://www.protectthebrain.org/Brain-Injury-Research/What-is-a-Concussion-.aspx

Burke, M. (2012, April 5). ShotLink is making golf easier for hacks and harder for pros. *Forbes.* Retrieved from https://www.forbes.com/

Buteau, M. (2016, January 27). The solution to golf's stalled participation might be found in a lesson. *Forbes.* Retrieved from https://www.forbes.com/

Dusek, D. (2018, March 4). By the numbers: analytics become an increasingly important part of golf. *Golfweek Digital Edition*. Retrieved from https://golfweek.com/

Fry, M. & Ohlmann, J. (2012, April 1). Introduction to the special issue on analytics in sports, part I: general sports applications. *Informs Journal on Applied Analytics*, *42*(2), 105-228

Garcia-Roberts, G., Murphy, B. (2018, October 23). NFL players with brain trauma receive notice of settlements stripped to nothing. *USA Today*. Retrieved from https://www.usatoday.com/

Holmes, L., Jr, Tworig, J., Casini, J., Morgan, I., O'Brien, K., Oceanic, P., & Dabney, K. (2016). Implication of socio-demographics on cognitive-related symptoms in sports concussion among children. *Sports medicine - open*, *2*, 38. doi.org/10.1186/s40798-016-0058-8

Hoyle, B. (2019, February 6). *American football and CTE: is a racial divide inevitable?*. Retrieved from https://www.mdedge.com/psychiatry/article/194020/mixed-topics/american-football-and-cte-racial-divide-inevitable

Meyer, J. (2019, April 12). The state of golf in 2019 by the numbers. *The Denver Post*. Retrieved from https://www.denverpost.com/

Moore, A. (2015, December 24). *Football's war on the minds of black men*. Retrieved from https://www.vice.com/en_us/article/eze4gj/footballs-war-on-the-minds-of-black-men

Semuels, A. (2019, February 1). The white flight from football. *The Atlantic*. Retrieved from https://www.theatlantic.com/

Sonnad, N. (2018, May 24). The NFL's racial divide, in one chart. *Quartz*. Retrieved from https://www.qz.com

United States Census. (2019) *Current Population Survey.* Retrieved from https://www.census.gov/programs-surveys/cps.html

Woods, R. (2016). *Social Issues In Sport* (3rd ed.). Champaign, Illinois: Human Kinetics.

Ziller, J. (2019). *Par 5 scoring vs. round scoring.* [Figure 1]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Ziller, J. (2019). *Racial breakdown of NFL.* [Figure 2]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Ziller, J., Carlson, W.B. (2019). *Effect of an athlete's decision on others.* [Figure 4]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.

Ziller, J., Carlson, W.B. (2020). *Weighing the risks of concussions while playing football.* [Figure 1]. School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.

Ziller, J., Carlson, W.B. (2020). *Effect of helmet technology improvement on all leagues.* [Figure 3]. (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA. Adapted from Carlson.