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Impact of NFL Team Intelligence on Overall Team Performance



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By

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.

Thomas Michael Bober

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Abstract

The goal of this paper is to investigate the impact that and NFL team's intelligence has on their teams performance. It will first look at how the NFL measures intelligence and what previous works have done with the relationship of intelligence and performance. From the theory aspect, this paper will focus on two area, signaling, and human capital. A regression will be run to see how average college rank affects the winning percentage of a team. Other performance based statistics were added to make a more accurate model. The regression showed that as the average college ranking decreased, the winning percentage increased with statistical significance.

I. Introduction

When a college football athlete finishes their college career, there is quite the process for them to go through if they believe they are good enough to play in the National Football League (NFL). To get a better idea of the athleticism and performance potential of the players, the NFL holds a combine. The NFL Combine is a showcase where athletes perform various athletic drills and tests so they can be assessed by the different NFL coaches and general managers. Unknown to some, NFL prospects are not only tested in their physical capabilities, but also in their mental capabilities. As of now the NFL uses what is called the Wonderlic Personnel Test (WPT), which is a 12-minute, 50-question cognitive ability test that is used to measure intelligence. It is obvious that physical capabilities play a major role in how a player will perform in the NFL, but it is not so obvious how intelligence affects a player's future success. The final days of the process comes down to what is called the NFL Draft. This is the few days that NFL teams get to choose which college athletes they want on their team. The draft is done in an order that is determined by the performance in the previous NFL season.

The goal of this paper is to investigate the impact of the average intelligence level of an NFL team on the team's overall performance, measured by win percentage; whereas previous works have only looked at individual player performance. It will need to look at what makes a team successful and try to find what aspects and characteristics contributed to the performance, with a focus on intelligence. The measurement of intelligence will be measured by looking at the academic caliber of the college that each player attended.

When it comes to the relationship between intelligence and NFL performance, there are two economic theories that can be applied, the first being signaling. An NFL coach cannot tell exactly how well their team, or their players, will do, so they have to look at different signals that

are both performance and intellectually based to determine the possible performance. A major factor of signaling is the psychic costs that go into the choice of college for an athlete. Next, the theory of human capital can be looked at with the general relationship between player performance and intelligence. By examining a basic supply and demand function, there is a visible relationship between a player's added value and their level of intelligence.

II. Literature Review

As this paper studies the effect of intelligence on NFL team performance, the most common way that NFL teams still gauge intelligence is through the Wonderlic test. As such, it is important to investigate the validity of the Wonderlic test and how well it measures intelligence. Another area is what previous work has found on the topic of Wonderlic scores and its correlation to NFL performance. The first two articles compare the Wonderlic to other IQ and intelligence testing and the last three look at different specific areas of NFL performance, but all look at individual player performance, not team performance.

Matthews and Lassiter (2007) examined the validity of the Wonderlic Personnel Test and Woodcock-Johnson-Revised Tests of Cognitive Ability. According to the authors, there are plenty of studies that show the Wonderlic's reliability and validity, but there is little evidence linking performance on the Wonderlic to current theories of intelligence. One theory that has been tested is the Cattell-Horn-Carroll Gf-Gc theory of intelligence. This theory states that IQ score is composed of several components, the two most important being fluid and crystallized abilities. Fluid intelligence (Gf) is the ability to solve novel problems quickly and efficiently. This is less experience-based and is related more to the person's own innate ability to process information. Crystallized intelligence (Gc) is related more to cognitive abilities based on experience that require the integration of past information and its application to current tasks (Matthews and Lassiter, 2007).

Before this work, there has only been one study the last ten years prior to Bell, Matthews, Lassiter and Leverett (2002) that tested the validity of the Wonderlic using a broad theoretically based test of intelligence. This test compared the Wonderlic to the Kaufman Adolescent and Adult Intelligence Test, which is based on the Cattell-Horn-Carroll Gf-Gc theory of intelligence.

The test showed a significant correlation between the Wonderlic and all indexes of intelligence measured by the Kaufman Adolescent and Adult Intelligence Test (Matthews and Lassiter, 2007). The results supported the validity of the Wonderlic.

The method of this study was to replace the Kaufman Adolescent and Adult Intelligence Test with the Woodcock-Johnson-Revised Tests of Cognitive Ability. Based on the previous research, the authors hypothesize that the Wonderlic would strongly correlate with fluid and crystallized intellectual abilities as measured by the Woodcock-Johnson-Revised Test of Cognitive Ability (Matthews and Lassiter, 2007).

Thirty-seven graduate and undergraduate students from psychology courses were selected to participate in this study. Both of these tests were administered in counterbalance order in accord with standardized procedures outlined in the test manuals (Matthews and Lassiter, 2007).The results indicate that the Wonderlic scores were significantly associated with the WL-R Standard Battery IQ score and Comprehension-Knowledge scores, while scores on the Wonderlic and WJ-R Fluid Reasoning Composite were not strongly associated. So these results only partially support the hypothesis of the Wonderlic Personnel Test is related to acquired knowledge (Matthews and Lassiter, 2007).

Some problems may have occurred from the sample size being so small and most likely would not reflect the population as a whole. After this study, there is still a need for more research to assess whether the Wonderlic is a good overall estimate of intellectual functioning that measures both Gf-Gc constructs or whether the test is more closely related to crystallized intelligence or fluid intelligence (Matthews and Lassiter, 2007). Overall, the test presented shows promise that the Wonderlic can measure broad cognitive abilities and be a brief screening device.

For this topic, Dodrill and Warner (1988) evaluated the relationship between the Wonderlic and the Wechsler Adult Intelligence Scale. The study used subject groups of psychiatric, neurological, psychiatric/neurological, and normal subjects. Previous studies have found positive relationship for the Wonderlic being a brief measure of intelligence, but those studies did not include the different subject groups (Dodrill and Warner, 1988).

The data consisted of four different subject groups which are as listed: 34 psychiatric hospitalized patients, 43 nonpsychiatric hospitalized patients, 34 psychiatric epileptic patients, and 50 normal control subjects. All of the subjects were administered both tests in counterbalance order (Dodrill and Warner, 1988).

In the results, the hospitalized psychiatric, nonpsychiatric epileptic and control samples all had average WAIS Full Scale IQ scores and Wonderlic scores that were within 1.3 points of each other. The psychiatric epileptic group had a difference of 3.2 points. Furthermore, correlations between the tests were uniform across the groups and there was a general consistency in the number of cases where the WAIS and the Wonderlic scores were within 10 IQ points (81% to 94%) (Dodrill and Warner, 1988). These results agree with most other literature, expect for Edinger et al.'s (1985). One reason the studies did not match was Edinger's reliance on the Wechsler classification of intelligence, which is not effective according to Dodrill. Second, Dodrill believes and error was made in the construction of the conversion table used by Edinger. Finally, it was also stated that the difference in the test subjects of each study could of lead to a discrepancy (Dodrill and Warner, 1988). After discussing the limitations of Edinger et al.'s work, it is believed that Dodrill and Warner's research is still valid.

Now that there is some evidence of validity with the Wonderlic as a measure of intelligence, looking into what previous works have shown about the relationship between the

Wonderlic scores and NFL performance would be the next step. Adams and Kuzmits (2008) conducted a study to examine the relationship between the Wonderlic and subsequent NFL success. As stated earlier, the Wonderlic is a well-known cognitive ability test that is used by the NFL in their annual combine, a pre-draft assessment of player mental and physical skills.

The area of sports psychology has grown markedly in the past two decades, and the discoveries of certain psychological constructs help athletes achieve peak performance. This has been defined as "superior use of human potential", which has led to advancements in the understanding of success in a wide variety of athletic endeavors. A previous work involving peak performance and successful athletes showed that the psychological profile of peak performing athletes included high self-confidence, energy, feelings of control, concentration, positive attitudes, determination, and commitment (Adams and Kuzmits, 2008).

In spite of the NFL's continued use of the Wonderlic as a measure of cognitive ability, no scientific support of the Wonderlic as a predictor of NFL success has been provided by either the NFL or the Wonderlic organization (Adams and Kuzmits, 2008). The authors reviewed previous literatures and uncovered only two studies that have examined the ability of the Wonderlic to predict professional football success. In the first study, the Wonderlic results of 261 NFL players selected in the 2002 draft were correlated with NFL performance for 2002 and 2003, where the performance data was specific to each position (Adams and Kuzmits, 2008). The results failed to show a statistical relationship between the Wonderlic and NFL performance for either year, or both years combined. The Wonderlic also failed to predict overall draft order for 2002 and 2003. The second study looked at the relationship between Wonderlic scores and NFL performance was examined for 82 quarterbacks drafted in the years 1989-2004. Wonderlic scores predicted

neither first-year NFL performance (passing efficiency) nor first-year salary (Adams and Kuzmits, 2008).

The purpose of Adam and Kuzmits' (2008) research is to further investigate whether the Wonderlic has the ability to predict NFL performance. Multiple measures of success will be investigated for three different offensive positions (quarterback, running back, and wide receiver) over a multi-year period, 1999 through 2004. The research may also encourage greater interest in the use of psychological construct testing, whether it is the Wonderlic, or other types of cognitive ability tests.

Correlation analysis was used to determine if the Wonderlic Personnel Test is linearly related to any one of several possible measures of performance of drafted players. Treating the professional player prospect's Wonderlic score as the independent variable with the following dependent variables: draft order, salary, on-field performance measures (quarterback rating, average yards per carry, and average yards per reception), and games played (Adams and Kuzmits, 2008).

The results looked at two areas of summary, correlations by position and drafted versus undrafted players. For correlations by position, only two of the 30 correlations generated a p-value less than .05, which were wide receiver year two salary (-.259) and average yards per carry of year one (.282) (Adams and Kuzmits, 2008). Looking at drafted versus undrafted players, the Wonderlic of drafted quarterbacks was 2.15 points higher that undrafted quarterbacks, but the p-value showed that the relationship was not statistically significant. The scores between drafted and undrafted RBs and WRs were almost identical and were also not statistically significant. Therefore for these three "skill" positions the study failed to find that drafted players have significantly higher Wonderlic scores than players who were not drafted. The final conclusion is

that Wonderlic scores are unrelated to a player's draft order, salary, games played in, and on-field position-specific success measures (Adams and Kuzmits, 2008).

The authors discussed several shortcomings, with the first being that the data for Wonderlic Personnel Test scores and performance data were collected from secondary sources: nfldraftscout.com, usatoday.com, and nfl.com. These are considered secondary sources, but they are nonetheless still usable sources for profession football statistics. Second, the research only looked at six draft classes, and it is questionable whether or not the results are generalizable to other draft classes. Expanding the research over a greater time period might add some insight into the ability to generalize the predictability of the Wonderlic. Third, the performance data was over a three-year period and a player may not "blossom" until after several years of experience, but the average NFL career lasts less than four years (NFL Players Association, 2007). The fourth limitation relates to the level of competition a player has for getting playing time. A great new player might have limited playing time because an experienced, superior player is currently performing for the team; conversely, a less quality recently drafted player may see considerable less playing time for another team because he is the best available from a weaker roster of current players (Adams and Kuzmits, 2008). This study did not show and conclusive evidence that there is a strong relationship between intelligence and NFL performance, but with all of its limitations, there is still much further research that can be done.

Lyons, Hoffman and Michel (2009) looked to determine the efficiency and equity of general mental ability in a nontraditional employment setting – professional football. This study also uses the Wonderlic to measure general mental ability.

From the authors' findings, there is plenty of empirical research that supports the validity of general mental ability as a predictor of job performance (e.g., Schmidt and Hunter, 1998;

Viswesvaran and Ones, 2002). The NFL administers the Wonderlic with the research to support of its validity in a more traditional job setting. The incorporation of the Wonderlic in this context is likely predicted on the assumption that more intelligent players will acquire position-related knowledge more quickly and be able to use this knowledge to perform better during a game. General mental ability is assumed to be a valid predictor in this context. The problem is that it is unclear the extent to which these findings can be generalized to a less traditional employment setting such as the NFL (Lyons, Hoffman and Michel, 2009). This study does not recognize any previous works on this same subject, but as shown earlier, a piece was done by Adams and Kuzmits (2008). With the topic of efficiency, Murphy (2002) stated, it is stated that general mental ability is "likely to be correlated with performance in virtually any job, in part because all jobs call for some learning, judgment, and active information processing" (p. 176). This relationship between decision making (Gully, Payne, Koles, & Whiteman, 2002), problem solving (Stevens & Campion, 1999), and acquisition of job knowledge (Schmidt, 2002) has been empirically demonstrated in a previous literature. This leads to the first hypothesis of the study which is that general mental ability will be positively related to NFL performance (Lyons, Hoffman and Michel, 2009).

Schmidt and Hunter (1998) demonstrated that although general mental ability is related to performance across levels of job complexity, the relationship is stronger in more complex jobs characterized by greater cognitive demands. With this study, it would seem that certain positions may require more problem-solving and decision-making ability, like quarterbacks, as opposed to other positions that primarily rely on physical attributes and instinct, like running backs. This idea leads to the next hypothesis question which states: position type will moderate the

relationship between general mental ability and NFL performance, such that the relationship will be stronger for quarterbacks than other positions (Lyons, Hoffman and Michel, 2009).

Along with the two hypotheses, there are two other research questions that are examined in this study. For the first question, many NFL teams disagree on the validity of the Wonderlic, so not all NFL teams consider scores of players in the NFL Draft (Mulligan, 2004). On the other side, some teams take it as a vital part of evaluation of players (Merron, 2002). With no hard evidence supporting either side, this study examined the question; does general mental ability affect selection in the NFL Draft (Lyons, Hoffman and Michel, 2009)? Next, Wonderlic, Inc. released a press release in 2005 that suggested a positive relationship exists between the Wonderlic and the number of games a prospect will start during an NFL season. The problem was that no empirical evidence was able to be located. There are many factors that could attribute to the number of games played in by a prospect, and given what general mental ability shows; it is believed to have an effect on playing time. Conversely, there are plenty of physical-based aspects that could also attribute the amount of playing time a prospect receives. Given this information, the authors seek the empirical evidence of the question; does general mental ability influence the number of games started in the NFL (Lyons, Hoffman and Michel, 2009).

The data used in this empirical analysis was the 762 players selected in the 2002 through 2004 NFL Drafts. Due to the low sample sizes, kickers and punters were excluded from the study (Lyons, Hoffman and Michel, 2009). As stated earlier, general mental ability was measured by the Wonderlic. For NFL performance, statistical data was collected for the first three years of performance. The performance data is specific to each position but the study does not list which stats exactly are used for each of those positions. This data was collected from nfl.com and stats.com (Lyons, Hoffman and Michel, 2009). Three years of performance data closely

approximates a player's average tenure in the NFL, which is about three and a half years. Also, using multiple years allows for a depiction of the general mental ability-performance relationship longitudinally and applies relevant general mental ability-performance theories. Two restrictions had to be made to the performance data to make for a more efficient model. First, offensive linemen were excluded from the data because there is no efficient way to measure the performance of an offensive lineman. Next, the study avoided including redundant statistics, for example, only including total tackles instead of including solo and assisted tackles (Lyons, Hoffman and Michel, 2009).

In order to compare the relationship between Wonderlic and performance across positions, all performance criteria within a position were standardized. In general, each player received a z* score the represented a player's performance relative to other players at the same position. To create averaged performances across all three years, the z* score totals for each year were summed and this value was divided by the total number of performance criteria (Lyons, Hoffman and Michel, 2009).

The authors used bivariate correlations to determine the general mental ability-NFL performance relationship. Based on the calculations, it was shown that Wonderlic was unrelated to any of the NFL performance criteria, causing the first hypothesis to not be supported. The study also examined the relationship over time with varying levels of Wonderlic scores. NFL performance was regressed on three levels of Wonderlic scores: at the group mean, one standard deviation above the mean, and one standard deviation below the mean. The results were found to also not be significantly related to performance (Lyons, Hoffman and Michel, 2009). For the second hypothesis, which stated that position type will moderate the relationship between general mental ability and NFL performance, such that the relationship will be stronger for

quarterbacks than other positions, two statistical analyses were conducted. Bivariate correlations between Wonderlic Personnel Test scores and NFL performance were conducted by position type and performance year. This test showed no significant positive correlations between the Wonderlic Personnel Test and NFL performance for any position. In particular, there was no relationship found within the quarterback position. Next, a moderated regression was conducted using the quarterback position as the referent group, with dependent variables of Wonderlic score, performance variables, draft selection, games started and salary. This lead to the similar conclusion that the quarterback position did not engender a significantly different result than the other positions. Therefore, the second hypothesis was also not supported. (Lyons, Hoffman and Michel, 2009)

To review the research questions, the first question which examined the relationship between general mental ability and selection in the NFL Draft. The bivariate correlation between Wonderlic scores and draft selection was not significant. This suggests that there is no relationship between how well a prospect scores on the Wonderlic and where he is selected in the NFL Draft (Lyons, Hoffman and Michel, 2009). The second research question examined if Wonderlic scores were related to the number of games started in the NFL. Once again, the bivariate correlation showed that there was no relationship between the two. (Lyons, Hoffman and Michel, 2009)

To summarize the results, all four of the tested questions were shown to not be significant. This may be a result of the amount of physical ability that is required to perform well in the NFL. General mental ability has been shown to be a good indicator of job performance in a traditional job setting, but the physical aspect of the NFL may outweigh the mental

requirements. The final conclusion is that the use of the Wonderlic Personnel Test in the NFL Combine is questionable in nature (Lyons, Hoffman and Michel, 2009).

There are several limitations that should be noted. First, all of the data that was examined was gathered from recognized secondary data sources – cbs.sportsline.com, nfl.com, and nfldraftscout.com, but all three are believed to be reliable sources for NFL data. Second, there are other factors that attribute to player performance that is outside that player's control, like degree of depth chart quality, opponent quality, and overall talent of entire team. The draft is organized in such a way that the best players in the draft are going to go to the worst teams in the league, based on the previous year's record. This means that a very talented player may be drafted by a poor quality team, which limits his performance. A final limitation is the sample size within positions. Some positions, like quarterbacks, had less statistical power than others, which most likely affected the results negatively (Lyons, Hoffman and Michel, 2009).

Gill and Brajer (2012) use the Wonderlic to test one implication of a simple Phelps model of statistical discrimination in the NFL draft. The focus of the test is to examine if the Wonderlic is a noisy signal that provides more information for White players than it does for Black players (Gill and Brajer, 2012).

Berri and Simmons (2011) showed a detailed examination of the NFL Draft for quarterbacks, highlighting the difficulties involved in making these complex assessments. One intriguing finding from this study was that physical and psychological player assessments from the NFL Combine were more important than collegiate on-field performance. This is believed to be true because the NFL Combine setting eliminates the factor of performance being contaminated by the performance of other players on the field. The goal of this study is to

improve this previous work and inspect the importance of the psychological or mental agility assessments from the Combine (Gill and Brajer, 2012).

The study applies a simple Phelps model (1972) to the NFL Draft and it is assumed that players possess potential adaptability to the NFL game. The Wonderlic is the main focus for measure of adaptability because it has the most potential to be differentially informative by race. The basic model is as follow:

$$\text{Draft Position}_i = \beta X_i + \alpha_1 \text{Wonderlic}_i + \alpha_2 \text{Black}_i + \delta_1 \text{Black}_i \times \text{Wonderlic}_i + E_i$$

These control variables are determining draft position by the Wonderlic score, an indicator variable whether a player is black and a Wonderlic-black interaction term to determine how Wonderlic scores affect draft position by race. The X vector includes a player's 40-yard dash, a predraft grade, indictor variables for player's position, and college-team rank. It is expected that α_1 will be greater than zero if teams believe that higher levels of cognitive ability predict greater success in the NFL. The estimate for black players is $(\alpha_1 + \delta_1)$, which gives the sum of the main effect for Wonderlic scores and the coefficient for Wonderlic scores interacted with Black. If, as suggested by the simple Phelps model, teams believe that Wonderlic scores are less reliable for blacks than whites, they will put less weight on Wonderlic scores for blacks when assuming potential success in the NFL. That is, it is assumed that the findings $(\alpha 1 + \delta 1) < \alpha_1$ is consistent with a model of statistical discrimination in the NFL (Gill and Brajer, 2012).

The data used was from 496 drafted players for 2004 to 2008. The source of the data was from a few different places. The player's draft position was obtained from *Pro Football Weekly* (*PFW*) magazine. There are to keys to construct the explanatory variables, the first being speed

which is measured by the 40-yard dash. The second is predraft ranking, or grading of each player (*Pfwscore*), based on *PFW*'s assessment of a player's chances for success in the NFL. For the college team rank, the team's record and strength of schedule was collected for the previous year. Player's position was also collected from *PFW,* where race was collected from various websites. The indicator variables were created for eight position categories: quarterback, running back, wide receiver, offensive lineman, tight end, defensive lineman, linebacker, and defensive back. For players of other ethnicities, like Latino or Hawaiian descent, they were excluded from the analysis for the lack of sufficient observations. The Wonderlic scores were collected from various sources, including *PFW* (Gill and Brajer, 2012).

The results yielded three major conclusions. First, a faster 40-yard dash moves a player up in the draft. Second, a higher predraft grade, an ordinal measure, is associated with a better draft position. The last conclusion demonstrates racial differences in the marginal effect of Wonderlic scores on draft position. The results show that the magnitudes of the coefficients for Wonderlic scores are consistent with statistical discrimination model, though the statistical evidence is somewhat weak. The conclusion for this model is that teams discount Wonderlic scores for black players who are in positions where the Wonderlic score is unimportant (Gill and Brajer, 2012). The model is refined to investigate this conclusion. First, the model is estimated again where the only interaction term included is for Wonderlic scores with player position. The key to the result of this iteration is that Wonderlic scores are important in explaining draft selection only for the offensive positions of quarterback, offensive lineman, and tight end. The second result is that Wonderlic scores are quantitatively more important for quarterbacks than any other position. The next adjustment to the model is to incorporate what has been learned about the importance of player position to the analysis of the effect of Wonderlic scores on race.

This is done by adding three variables: an interaction between player position and Black, an interaction between player position and Wonderlic score, and an interaction between player position and the Wonderlic-Black interaction term (Gill and Brajer, 2012). Three conclusions can be drawn from the results of the quarterbacks. First, Wonderlic scores are important in determining relative draft position from white quarterbacks but not for black quarterbacks. Second, the impact of a one-point increase for both white and black are well within the range of estimates from a previous study. Third, there is no evidence to support a statistical discrimination story (Gill and Brajer, 2012).

The underling conclusion from this study the discrimination model leads us to believe that NFL teams may view the signal they receive from Wonderlic scores as less reliable markers of adaptability to the NFL game for black players than for white players. However, little evidence was found to support a hypothesis of statistical discrimination based on the analysis of Wonderlic scores (Gill and Brajer, 2012). Some possible limitations to consider are first that the dependent variable in the baseline model is an ordinal ranking, which can skew the results. Second was the use of predraft grading as a control variable. Lastly, the effects of Wonderlic scores for whites and blacks at the intensive margin were considered. It seems likely that the extensive margin may also be relative (Gill and Brajer, 2012).

It is collectively seen from these studies that there does not seem to be much correlation between intelligence and NFL performance. Instinctively, this does not seem correct for anyone who has experience playing football. To play at such a high level, there has to be some level of intelligence to understand the game. In looking at the intelligence level of an entire team, there might be different results than what these previous works have shown. It is shown that the

Wonderlic can be a measure of intelligence; now the matter is to see how that measure can be effectively shown in the NFL.

III. Theoretical Framework

Looking into the theory aspect of this paper, two different economic theories that can be applied to this topic of the impact of NFL team intelligence on overall team performance. These two theories are performance signaling and human capital. NFL teams obtaining players is similar to the hiring process in a normal work market, but with more of a focus on physical performance.

Michael Spence (1973) first states the difficulty in defining the term of "market signaling", but in his article describes it the best to his ability. Spence (1973) states that "My aim is to outline a conceptual apparatus within which the signaling power of education, job experience, race, sex, and a host of other observations, personal characteristics can be determined" (p.356). The question investigated is what the interactive structure of a market accounts the information content of these potential signals. The primary emphasis was placed on the definition and properties of signaling equilibria, the interaction of potential signals, and the allocative efficiency of the market.

In most job markets, the employer is not sure of the productive capabilities of an individual at time he hires him and that information may not become available to the employer immediately after hiring. This means that hiring is an investment decision that takes time to learn an individual's capabilities. Since these things are not known beforehand, the hiring decision is made with uncertainty (Spence 1973).

As an employer, they are able to observe the copious amounts of personal data observed in the form of observable characteristic attributes. The image of the individual includes education, previous work, race, sex, criminal and service records, and a host of other data. There are some attributes that are fixed and others that can be altered. For example, education is

something that individual can invest in with more time and money. On the other hand, race and sex are not generally thought to be alterable. The observed unalterable attributes will be looked at as indices and the term signals will be reserved for the attributes that can be altered by the individual (Spence 1973).

Sometime after hiring an individual, the employer will learn the individual's production capabilities, based off of previous experience in the market. This information will give the employer conditional probability assessments over productive capacity given various combinations of signals and indices. The signals and indices are regarded as parameters in shifting conditional probability distributions that define an employer's beliefs (Spence 1973).

The acquisition of players in the NFL is similar to this process described by Spence. A difference is that an employer does not have the same ability to test their applicants like the NFL can. The NFL has the combine that can help asses those attributes. There are many different attributes, both physical and intellectual, that act as signals for NFL prospects. Some of those signals include strength, speed, agility, awareness, and intelligence. NFL general managers use these signals to determine if a prospect will be successful with their team. Like in the job market, there is no guarantee how well someone will do before they are actually playing. One thing to note is that different teams look at different signals to be more important than others. There are many different ways and styles to play the game, some teams may play stronger and others may play faster. This means that there is no one right way to interpret these signals.

In terms of making adjustments to a signal, one might incur a certain cost. For example, a cost for education is a psychic cost, or in other words, school is difficult, especially at a more prestigious school. If someone is intelligent, the psychic cost of studying at a prestigious school is lower. It is lower because it is not that hard for an intelligent person to do well there. Now if

there was a less intelligent individual that wanted to attend a prestigious school, the psychic costs for that student would be high because it would be extremely difficult for them to succeed there. That less intelligent student might then attend a less prestigious academic school to lower their psychic cost. With this idea of psychic costs, the college an athlete attends could be a general signal of intelligence for NFL general managers. If two players are equal in the physical aspect, could the college they attended be a deciding factor. This idea is what this paper focuses around in that does attending a more prestigious school indicates a more intelligent player?

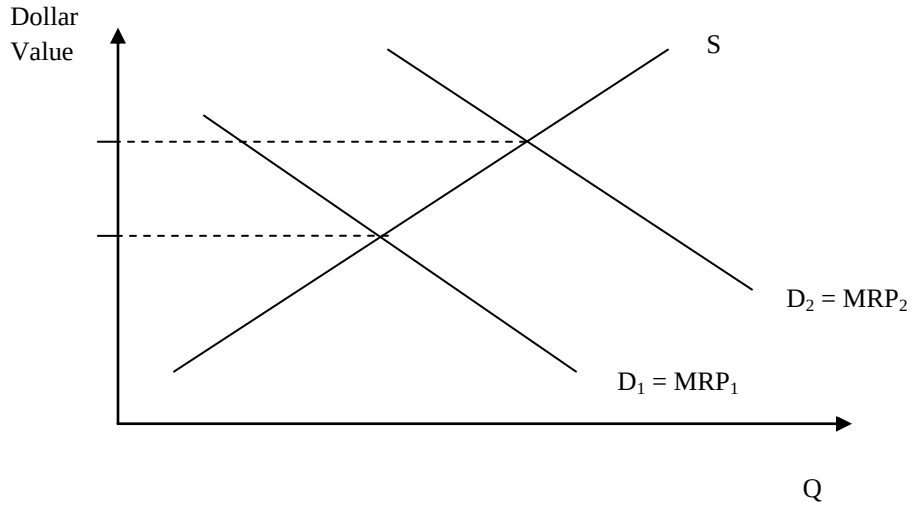
Adam Smith was the first economist to really theorize about the idea of human capital, but his insight was not recognized by all economists. In the late 1950s, economists Jacob Mincer, Theodore Schultz and Gary Becker used his insight and developed the theory of human capital. Human capital is defined in this work as any activity that entails a cost in the current period and raises productivity in the future can be analyzed within the framework of investment theory (Kaufman and Hotchkiss, 2006).

The type of human capital investment that relates to this topic is based on the cost benefit analysis of bringing in different players of different school qualities. Schooling can sometimes be considered consumption good, where as some may pursue an education for pleasure, it is also treated as an investment in the future for most individuals. Most people are aware of the costs of a college education, both direct and indirect. Some direct costs include actual incurred costs like tuition, books and other living expenses. There is also the indirect cost of forgoing current earnings in the form of a job to attend school. To counterbalance that indirect cost, a college education has anticipated benefits of increased earnings, more attractive employment opportunities, and higher status and social prestige (Kaufman and Hotchkiss, 2006). In terms of the NFL, a higher education can be seen as a means to increase the overall performance of a

single player. A higher intelligence level will lead to a better understanding of the game and hopefully that will become better performance.

Another important concept to understand pertains to the market of human capital. The model for this topic can be shown by Figure 3.1.

Figure 3.1



This model shows a basic demand function with two different demand curves. D_1 represents the demand for less intelligent players and D_2 represents the demand for more intelligent. The dollar value represents the total value that a player will bring to a team, measured in dollars. MRP, which stands for marginal revenue product, can be calculated by multiplying the marginal product of labor with marginal revenue (Kaufman and Hotchkiss, 2006). It basically shows how much extra revenue, or in this case, value, does a team get from acquiring a new player. A higher MRP means that a team will get more value back with each additional player that is added. Given the figure above, it is shown that a higher MRP comes from the more intelligent players, so teams will invest in the more intelligent players. This means that there is a higher demand for more intelligent players because they will produce a higher MRP. This means that the added intelligence increases the total value of the team.

From these two theories, there seems to be a relationship between intelligence and performance. It is shown that there can be a relationship between the college a player attends and that player's intelligence level. This could be an important signal for an NFL general manager in determining how successful a player will be on their team. Also, it can be seen that more intelligent players will bring more value to a team as opposed to a less intelligent player. In conclusion, these theories point in the direction that a more intelligent team will result in a more successful team.

IV. Empirical Analysis

Unfortunately, Wonderlic data for NFL players was unattainable due to unexpected and recent restrictions set by the NFL. Another measure that could be used would be the college rankings of each player. The rosters were collected from pro-football-reference.com and the rosters for the last five seasons (2010-2014) were combined. The college rankings came from forbes.com's most recent list of America's Top 650 Schools. Forbes.com used five criteria in determining their list which were; student satisfaction, post-graduate success, student debt, graduation rate, and academic success (Howard 2014). Each player's college was then replaced by that college's ranking according to Forbes. If the school was not on the list, then that entry was left blank. Once all of the entries were changed, an average was taken for every team's roster for each year. This produced the variable *averageschoolrank.* This variable is the main dependent variable in the model which needs to be compare with each teams winning percentage indicated by *win.* A team's winning percentage is ratio between the number of games won and the total number of games played.

In order to build a more accurate model, there are other variables that can have an effect on winning percentage. Those variables are as follows;

Yardsgained – the total number of yards gained by one team's offense in a season
Yardsallowed – the total number of yards given up by one team's defense in a season
Turnovers – the total number of turnovers lost in a season
Takeaways – the total number of takeaways by the defense in a season
Cmp – completion percentage, the ratio between the number of passes completed and total passes thrown
Defensetds – the total number of defensive touchdowns scored in a season

To discuss why these variables were chosen, yards gained and yards given up are good indicators of performance on both offense and defense. Turnovers and takeaways are also seen as important factors and can make a major difference in a games momentum and ultimately the outcome of

the game. With completion percentage, the performance of a team's quarterback is viewed as more important than all other positions. This variable is used to measure a quarterback's performance and how it affects the winning percentage. Lastly, there need to be another uncommon variable that accounted for defensive performance. Since defensive touchdowns are so uncommon, they might have a big impact on the winning percentage. Table 4.2 summarizes the data that has been collected.

Table 4.1

Variable	**Obs**	**Mean***	**Standard Deviation***	**Min**	**Max**
Year	160	2012	1.42	2010	2014
Average school rank	160	239.05	24.98	178	297.24
Win	160	.50	.19	.125	.9375
Yards gained	160	5525.46	623.66	4135	7474
Yards given up	160	5525.46	498.51	4274	7042
Turnovers	160	25.24	6.57	10	44
Takeaways	160	25.24	6.15	11	44
Completion Percentage	160	61.00	4.05	50.6	71.3
Defensive TDs	160	3.46	2.14	0	10

*****Values were rounded to two decimal places

There are some interesting points to make about the table above. The first is the relationship between some pairings of variables. When it comes to points scored and points allowed, yards gained and yards given up, and turnovers and takeaways, each group has a matching mean. This is caused by the fact that in order for a team to gain points, another team must lose points. This relationship is the same for the other two pairings.

For this model, there are going to be two different regressions to run. The first is a simple model that looks into the effect that *averageschoolrank* only has on the *win* variable. This model will look like;

$$Win = \beta_0 + \beta_1 averageschoolrank.$$

Given that there are many other variables that can have an effect on winning percentage, it is expected that *averageschoolrank* will not be a statistically significant variable in this model. This simple model is not necessary for this research, but it may help get a better understanding of the variable. In order to account for this, a second model will be analyzed that will include the other dependent variables that were collected. The goal of this model is to try to include as many factors that are believed to also have an effect on winning percentage in order to make *averageschoolrank* more significant. This new model will look as follows;

$$Win = \beta_0 + \beta_1 averageschoolrank + \beta_2 yardsgained + \beta_3 yardsgivenup + \beta_4 turnovers + \beta_5 takeaways + \beta_6 cmp + \beta_7 defensetds.$$

The first model analyzed was the simple model that only included the *averageschoolrank* against *win.* Those results can be seen in Table 4.2 below.

Table 4.2

Variable	**P-value**	**Coefficient**
Averageschoolrank	.291	-.0006487
Constant	0.00	.6538956

Although the coefficient is not statically significant, the sign of the coefficient is the expected sign. With a negative sign, it means that if the average college ranking for one team rises, then the winning percentage would decrease. Inversely, if the average college ranking decreases, then the winning percentage would increase. This means that having a "smarter" team will lead to a higher winning percentage.

Next, the addition of the other dependent variables should change the outcome and make it a more accurate model. The results of the new model can be seen in Table 4.3.

Table 4.3

Variable	P-value	Coefficient
Averageschoolrank	.092	-.0005727*
Yardsgained	0.00	.0001252*
Yardsgivenup	0.00	-.0001104*
Turnovers	0.00	-.0068092*
Takeaways	0.00	.0089965*
Cmp	.111	.0045093
Defensetds	0.00	-.0184707*
Cons	.150	.2874927

**Indicates statistically significant with 90% confidence*

The first thing seen from this model is that the *averageschoolrank* is now statistically significant at a 90% confidence level. The coefficient shows that if the average college ranking of one team increases by one, then the win percentage will decrease by about .057%. It may not seem like much of a difference, but what matters is that the variables act in the way that was expected with statistical significance. As for yards gained, yards given up, turnovers, and takeaways, they all have significance and have the expected sign. Completion percentage came out to be not significant and this may be because there is a lot more that goes into a quarterback's performance other than just completion percentage. With defensive touchdowns, the data is saying that having more defensive touchdowns would decrease winning percentage, which is not expected. This may be caused by there not being very many defensive touchdowns in a year, making their statistical power weak.

V. Conclusion

The goal of this research was to further investigate the impact of intelligence on NFL team performance. The initial objective was to use the Wonderlic scores of NFL players in order to get an estimate on a team's average intelligence level. Given the restrictions, the focus was shifted toward general intelligence, measured by average college ranking. To start, the validity of the Wonderlic was investigated and it was shown that it could be an effective measure of intelligence. This research was different in that all other works focused on individual player Wonderlic scores and how it affects their respective draft position. Those other articles came to the conclusion that the Wonderlic score did not have an effect on the draft positioning of an incoming player, so this paper investigated the idea of the intelligence level of an entire team and how that affected winning percentage.

There were two economic theories that also applied to this topic and they were signaling and the theory of human capital. Signaling was based on the fact that a NFL general managers have no way of telling exactly how well a player will do in the NFL, so they have to use different signals, both physical and mental, to predict their future performance. The most important part of this theory was the idea of psychic costs and how that was a signal for intelligence. The theory of human capital, related to this topic stated that the more intelligent players are going to give a marginal revenue product, meaning that it would be more profitable to invest in players with higher intelligence.

This research concluded with a regression model that tested different NFL performance statistics along with a created variable that represented the average college ranking of each team. These performance variables were tested against the winning percentage of each team. This regression showed that the average college ranking coefficient was in fact statistically significant

and with the expected sign that indicated a lower college ranking average lead to a higher winning percentage.

The overarching connection from this research is that there is in fact a relationship between the intelligence level and performance in that a more intelligent team can lead to a higher winning percentage, which is not what was explicitly expected from the previous literature and economic theories. The previous literature showed that intelligence was on important for certain situations and certain positions. It was not anything definitive but it showed that a relationship could be made. The theories showed that more of a connection could exist and it also showed a positive relationship between intelligence and added value. They all showed that there was some relationship between intelligence and performance, but not the significance of that relationship.

For future research, the best thing would be to try to obtain the Wonderlic data to give a more accurate measure of intelligence. Also, there are more factors that go into winning a football game that could be analyzed like the experience of the head coach, whether or not it was a conference game, and even the weather. For what was available, it was still an acceptable regression model.

References

Adams, A., and Kuzmits, F. (2008). Testing the Relationship Between a Cognitive Ability Test and Player Success: The National Football League Case. The Online Journal of Sports Psychology, 10(1), 1-14.

Bell, N. L., Matthews, T. D., Lassiter, K. S., and I.Everett, J. P. (2002) Validity of the Wonderlic Personnel Test as a measure of fluid or crystallized intelligence: implications for career assessment. North American Journal ofl-'sychology, 4, 113-120.

Berri, D. J., & Simmons, R. (2011). Catching a draft: On the process of selecting quarterbacks in the National Football League amateur draft. Journal of Productivity Analysis, 35, 37-49.

Dodrill, C., and Warner, M. (1988). Further studies of the Wonderlic Personnel Test as a brief measure of intelligence. Journal of Consulting and Clinical Psychology, 56(1), 145-147.

Gill, A., and Brajer, V. (2012). Wonderlic, Race, and the NFL Draft. Journal of Sports Economics, 13(6), 642-653.

Gully, S. M., Payne, S. C., Koles, K. L. K., & Whiteman, J. A. K. (2002). The impact of error training and individual differencesontrainingoutcomes:Anattribute-treatmentinteractionperspective. JournalofAppliedPsychology,87,143–155

Howard, C. (2014, June 30). Ranking America's Top Colleges 2014. Retrieved March 24, 2015, from http://www.forbes.com/sites/carolinehoward/2014/07/30/ranking-americas-top-colleges-2014/

Kaufman, B., & Hotchkiss, J. (2006). *The economics of labor markets* (7e [ed.]. ed., pp. 328-340). Mason, OH: Thomson/South-Western.

Lyons, B., Hoffman, B., and Michel, J. (2009). Not Much More Than g? An Examination of the Impact of Intelligence on NFL Performance. Human Performance, 22, 225-245.

Matthews, T., and Lassiter, K. (2007). What Does The Wonderlic Personnel Test Measure? Psychological Reports, 707-712.

Merron, J. (2002, February 28). Taking your Wonderlics. Retrieved May 6, 2007, from http://espn.go.com/page2/s/closer/020228.html

Mulligan, M. (2004, April 22). Wonderlic scores have NFL teams wondering. The Chicago Sun-Times, p. S4.

Murphy, K. R. (2002). Can conflicting perspectives on the role of g in personnel selection be resolved? Human Performance, 15, 173–186.

National Center for Education Statistics, *Digest of Educational Statistics,* 2000 (Washington, D.C.: Government Printing Office, 2001), Table 313 http://nces.gov/pubs2001/digest/dt313.html.

NFL Players Association. (2007). FAQs: NFL hopefuls FAQ. Retrieved June 5, 2007, from http://www.nflpa.org/Faqs/NFL_HopefulsFaq.aspx

Phelps, E. (1972). The statistical theory of racism and sexism. American Economic Review, 62, 659-661.

Schmidt, F. L. (2002). The role of general cognitive ability and job performance: Why there cannot be a debate. Human Performance, 15, 187–210.

Schmidt, F. L., & Hunter, J. E. (1998). The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. Psychological Bulletin, 124, 262–274.

See Bureau of the Census, "More Education Means Higher Career Earnings" *Statistical Brief* (August 1994), for a discussion of the simple statistical technique used to obtain these estimates and the caveats associated with it.

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics, 87*(3), 355-374.

Stevens, M. J., & Campion, M. A. (1999). Staffing work teams: Development and validation of a selection test for teamwork settings. Journal of Management, 25, 207–228.

Viswesvaran, C., & Ones, D. S. (2002). Agreements and disagreements on the role of general mental ability (GMA) in industrial, work, and organizational psychology. Human Performance, 15, 211–231.

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