

Analytics and Free Throw Shooting: Perception vs. Reality

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by

Bryson Johnson  
Bachelor of Science  
Bucknell University, 2013

Director: Robert Baker, Professor  
School of Recreation, Health and Tourism  
College of Education and Human Development

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George Mason University  
Fairfax, VA

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## **DEDICATION**

This work is dedicated to my mother, Peggy MacLean.

## **ACKNOWLEDGEMENTS**

I would like to thank my friends, family, and my professors at George Mason University for allowing this to happen. Specifically, I offer my gratitude to the George Mason men's basketball team for allowing me access to data and individual players. Drs. Baker, Atwater, and Wiggins were beyond helpful throughout this whole process.

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**LIST OF ABBREVIATIONS**

Player Efficiency Rating ..... PER  
Visuo-Motor Behavioral Rehearsal ..... VMBR  
Quiet Eye ..... QE



## **ABSTRACT**

### **ANALYTICS AND FREE THROW SHOOTING: PERCEPTION VS. REALITY**

Bryson Johnson, M.S

George Mason University, 2017

Thesis Director: Dr. Robert Baker

Free throw shooting is one of the simplest skills in basketball and yet one of the most complex and overlooked aspects of the game. Crucial free throws have resulted in a team winning a championship but also a team losing at the highest level. In fact, players at all levels have experienced the harsh reality of missing these crucial free throw attempts. This study focuses on developing a uniform method of improving free throw shooting that can be taught to all genders and ages. Using techniques that help reduce anxiety, establish physical and mental routine, as well as monitor sleep and hydration coaches can assist in helping players become better free throw shooters. The men's basketball team at George Mason University participated in the study and saw their free throw shooting rise from the 2015/16 season to the 2016/17 season. It appears that there is a correlation between this uniform methodology and improved free throw shooting. However, other variables may have contributed to this improvement as well.

## **CHAPTER ONE: INTRODUCTION AND REVIEW OF RELATED LITERATURE**

Basketball is a game of instinct and reaction; players must experience the various situations the game presents to truly develop a comfort level. Establishing a comfort level in game speed and physicality is important; but establishing comfort at the free throw line may have the strongest correlation to success. Free throws require focus, comfort and relaxation, all characteristics that are difficult to master in the midst of chaotic competition. Free throws are an integral part of the game of basketball and can alter eventual outcomes positively or negatively. Understanding the complete process is crucial and analyzing the shot mentally, physically and analytically will allow greater understanding of this crucial skill.

### **Section One – History of Analytics**

The use of analytics in sports has drawn increased attention in recent years as analytics have proven to be a beneficial tool to aid decision-making. Finding a competitive edge is crucial in the ultra competitive sport industry. Many professional and collegiate coaches lose their jobs based on decisions made throughout the season. Analytics uses data to help make more informed decisions and therefore is crucial in providing coaches and front office personnel with accurate, evidence based data to help inform future decisions. Ultimately, it is a coach's job to lead and make the decisions

that are best for the team and organization. If the coaches do not have all the data, then it becomes increasingly difficult to make the decisions in the best interest of the team.

Analytics have been used in the business community for decades as algorithms, derived from analytic analysis, often influence basic economic decisions. In 1956, John McCarthy created the term “artificial intelligence,” eventually contributing to what we now understand as analytics today (Cooper, 2012).<sup>1</sup> There is a tendency to believe that analytics began with the technological revolution, although this is not the case. Advances in technology have expanded the variety of analytics, but is not essential for analytics to be practiced. Before technology assisted analytics, data was often limited, compared to the abundance of information available at one’s fingertips today.

The role of analytics in sports has continued to increase in prominence over the last few decades. Basketball in particular has seen a drastic rise in the use of analytics. The function of analytics is to assist by providing added information in decision-making. Numbers/statistics provide unbiased data, as many outside factors such as previous experience; prejudices and personal preferences can influence human decisions. This is most evident in the draft process, when scouts and coaches are extremely “high” on a certain player although their statistics may not support their enthusiasm (and vice versa). This misinterpreting or ignoring of information can cause coaches to lose their jobs, as well as the drafted basketball players to be labeled a “bust” (for not living up to their perceived potential). Using analytics in team sports can be complex because of the numerous variables that can contribute to an athletes successes or failures (Salador,

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<sup>1</sup> Cooper, A. (2012). A Brief History of Analytics, JISC CETIS Analytics Series 1 (9). *University of Bolton*.

2011).<sup>2</sup> That is why analytics are a great tool to reference; but making decisions solely based on analytics, or excluded analytics all together is irresponsible.

In a team sport, understanding that numbers do not always tell the complete story is important when trying to assemble the best possible combination of players to win games. For example, 2014/15 NBA season, Gordon Hayward of the Utah Jazz averaged 19.3 ppg, 4.1apg and 4.9rpg<sup>3</sup>, while Kawhi Leonard averaged 16.5 ppg, 2.5apg and 7.2 rpg.<sup>4</sup> Their stat lines are comparable, but very few basketball analysts (if any) would say Gordon Hayward is a better basketball player than Kawhi Leonard; yet their statistics may prove otherwise. This is why outside variables are so important. Gordon Hayward plays for the Utah Jazz which is an inferior team compared to Kawhi Leonard's San Antonio Spurs. The players each individual plays along side can play a huge role in affecting individual statistics. Kawhi Leonard plays with better players in San Antonio and therefore his statistics may reflect a lesser role, although experts of the game understand his true value that may not be reflected in statistics. This disconnect with analytics often is not addressed when evaluating individual players in a team setting. Often when players change teams, their effectiveness fluctuates positively or negatively because of the style of play and adjusting to the new players supporting them. It is very difficult to predict how players will perform in a new environment because of the numerous variables that must be accounted for by performing in a new environment.

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<sup>2</sup> Salador, K. (2011). Forecasting performance of international players in the NBA. In *Proceedings of the MIT Sloan Sports Analytics Conference*.

<sup>3</sup> Gordon Hayward. (n.d.). Retrieved October 18, 2015. <http://www.basketball-reference.com/players/h/haywago01.html>

<sup>4</sup> Kawhi Leonard. (n.d.). Retrieved October 18, 2015. <http://www.basketball-reference.com/players/l/leonaka01.html>

Analytics do help us assess a value on players the basic statistics may not address. This is the relatively new concept of advanced analytics in basketball that is essentially more in depth statistical analysis. PER or player efficiency rating is an advanced analytic stat that essentially sums the value of a player's positive plays, subtracts the negative plays and then offers a numerical value on the player's performance. Sounds simple enough, although it is a complex algorithm. Using the two players from above in this example, we now discover that Kawhi Leonard possesses a higher PER than Gordon Hayward, which supports many expert's claims that he is in fact that better player. PER and other advanced statistics are helping to fill in gaps that traditional statistics (points, rebounds, assists) may miss. The complexity of the sport of basketball allows players to add tremendous value to a team, while maintaining relatively low statistical output. Plays like charges, deflections, defensive pressure and hustle are valuable assets to a team and yet quantifying the value these characteristics bring to basketball game is extremely difficult.

Offensive performance has always been far easier to quantify than defensive performance, but with the use of advanced analytics, improved ways of quantifying play on the defensive end of the floor is emerging. Often the only stats that relate to defense in basketball are steals, rebounds and blocked shots. These three categories are often weighted heavily when considering an award such as Defensive Player of the Year. With the availability of advanced analytics, this is how many experts began to vote for a prestigious award such as Defensive Player of the Year in the NBA. In 2013, Marc Gasol won Defensive Player of the Year, although he did not lead the league in any of the

traditional defensive statistics. Advanced analytics supported Gasol's defensive prowess as he was second among centers with a +5.4 score differential, and his team had a score differential of +7.5 when Gasol was on the floor and a poor -3.9 with him on the bench (Goldsberry & Weiss, 2013).<sup>5</sup> This speaks the influence analytics is now having on the game of basketball. Many onlookers were shocked to see Gasol get the award because his traditional statistics were not the best in the defensive categories. However, analytics provided a clearer picture of how valuable Gasol was on the defensive end and measured his impact based on far more than individual statistics. Moving forward, analytics will continue to play a key role in decision-making in the basketball community and as the practice continues to be developed it will be able to place a concrete numerical value of a player's value that cannot be disputed. This is important to produce the most informed decisions because, to quote Jay-Z, "men lie, women lie, numbers don't."

Free throw shooting in recent years has drawn more attention from an analytic perspective because of the "Hack-a-Shaq" phenomenon. This unique style of play originated when opposing teams would play Shaquille O'Neal, who is widely regarded as the most dominant basketball player ever. Shaquille or "Shaq" was the most physically imposing player in the league as he stood 7'1 and weighed roughly 340 lbs. His athleticism defied his physical stature, as he was extremely mobile and strong. However, all great players have deficiencies and Shaq's Achilles heel was his inability to make free throws. For his career, Shaq shot 52% from the free line and because of his physical dominance he frequented the free throw line often. He shot just over 9 free throws per

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<sup>5</sup> Goldsberry, K., & Weiss, E. (2013). The Dwight effect: A new ensemble of interior defense analytics for the NBA. *Sports Aptitude, LLC. Web.*

game throughout his 19 year NBA career.<sup>6</sup> At his peak, opposing teams began to employ a new strategy to combat Shaquille's dominance; this is when "Hack-a-Shaq" was created. Rather than try to stop Shaq the traditional way and hope he missed shots during the flow of a game, opposing teams began fouling Shaq on purpose, forcing Shaq to make free throws. This Hack-a-Shaq strategy works in many different ways affecting a game by slowing down tempo (if a team has a tendency to play fast paced). Players that are not being fouled may lose rhythm and finally analytically points per possession decline when analyzing the opposing teams field goal percentage (Skinner, 2011).<sup>7</sup> This basketball tactic, although famously coined after Shaquille O'Neal, has since been employed on other poor free throw shooters such as DeAndre Jordan (Los Angeles Clippers) and even Tim Duncan (San Antonio Spurs).

Using the Hack-a-Shaq tactic is unique because as analytics are continuing to become more prevalent in basketball, there is an argument for teams to use the strategy not only when trailing an opponent but also when in the lead. Inferior teams, when trailing their opponent, have commonly used the Hack-a-Shaq practice. The team Shaquille O'Neal played on often experienced Hack-a-Shaq when they were operating offensively at an extremely efficient level (Skinner, 2011).<sup>8</sup> Basketball is a game of chemistry and rhythm. By intentionally fouling a poor free throw shooter, it not only disrupts rhythm and chemistry but analytically it can increase the odds of lowering points

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<sup>6</sup> Shaquille O'Neal. (n.d.). Retrieved October 18, 2015, from <http://www.basketball-reference.com/players/o/onealsh01.html>

<sup>7</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).

<sup>8</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).

per possession of the opposing team. For example, if a team is in a great rhythm and playing efficiently they may be shooting 55-60% from the floor. Assuming that all field goal attempts are two-point shots it analytically it makes most sense to foul a free throw shooter like Shaquille O'Neal (career 52% free throws) as not only will it yield a decrease in points per possession but also as previously mentioned disrupts rhythm and chemistry (Skinner, 2011).<sup>9</sup>

\*Analyzing the math over a small sample size of 10 possessions lets examine both scenarios: 1) The team is shooting 60% from the floor, which means they make 6/10 field goal attempts, resulting in 12 points. 2) Implementing Hack-a-Shaq on those 10 possessions and assuming an approximate free throw percentage of 50% then that results in 1/2 free throws made a possession, or 10 points (Skinner, 2011).<sup>10</sup>

Not only did the team save 2 points over the 10 possessions, but also with further analytical analysis one can predict the impact of game flow and tempo after implementing Hack-a-Shaq.

Analytically, the Hack-a-Shaq tactic may also be useful for teams with a lead, although this scenario is rarely experienced. The reasoning may be slightly different for the winning team to employ this method of strategy. The team in the lead wants to reduce risk and account for any unpredictable behaviors possible. An opposing team can score in various ways and can score as many as 4 points on a play. In an effort to reduce risk, the team in the lead should foul a 50% free throw shooter essentially conceding 1

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<sup>9</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).

<sup>10</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).



point per possession (over an extended period of time). Therefore this would reduce the risk of the team with the lead, as they account for variability that could occur by traditionally playing defensive possessions to conclusion (Skinner, 2011).<sup>11</sup> There is a chance the trailing team could hit 3,4 or maybe 5 shots in a row, which would reduce the lead in far fewer possessions. Again this tactic is still relatively new considering this scenario.

The prevalence of this technique often raises questions from fans, players and coaches, why do so many players struggle with this relatively easy aspect of the game? Free throws are the one time in a basketball game where variability is limited and players can take their time and focus on their shot, at their own pace. Yet many phenomenal basketball players struggle with free throws. Shaquille O’Neal was the most prominent example as he could have been the NBA’s all-time leading scorer if only he had shot free throws at 70% (an average free throw percentage for professional basketball players). With increased data and availability of analytics, this tactic could affect great players impact on the game because of their inability to perform at the free throw line. Any way to improve a player’s free throw percentage would be extremely valuable to coaches as games are often won and lost at the free throw line. Winning and losing is the difference between accolades and coaches possibly looking for a new job.

The goal of this study is to accumulate and analyze different studies concerning free throw shooting and determine what is the best template to follow in order to improve player percentages. Using analytics as concrete data, it is possible to track improvement

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<sup>11</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).

or regression from athletes when focusing on the many different variables basketball players encounter at the free throw line. Free throw shooting is the one semi-controlled play in basketball because the athlete essentially has a free shot at the basket. Obviously, crowd noise and distractions may occur; but it is the only time in a basketball game where the defense cannot attempt to contest a shot. The simplicity of the shot is why it is so puzzling that many athletes struggle with free throws, and why in order to correct possible issues, one must completely understand the variables associated to free throws. Understanding the many facets of the free throw shot and supplying a generic approach to teach athletes to improve free throw shooting would be a valuable piece of information. The higher the level of basketball, the more competitive the games become, which decreases the margin for error. With minimal room for mistakes, controlling the outcomes that are in the individual player's ability to control is crucial to consistent positive outcomes. Free throws are appropriately named, as they are literally "free" shot attempts at the basket and by not doing everything possible to yield the highest percentage throwing away those "free" points.

What issues do players encounter at the free throw line? What physical skills can increase free throw shooting percentage? What mental skills can increase free throw percentage shooting? What are characteristics of great free throw shooters? What are characteristics of poor free throw shooters? All of these questions are valid and players at the highest level have never had to answer these questions because free throw shooting is often taken for granted. Often coaches label players as "bad" or "good" free throw shooters when what should be happening is how do we take a "bad" free throw shooter

and turn him into a “good” free throw shooter, and then a “good” to “great.” Capability is rarely the issue when analyzing free throw issues, which is why we will not discuss shooting technique because the free throw template should work for every basketball player regardless of form and improve their percentages. Every player will have a unique starting point, but with analysis and the use of analytics, there should be a list of the most important physical and mental players must do to improve their percentages.

## **Section Two - Routine**

One of the most overlooked aspects in the game of basketball is free throw shooting. Regarded as a relatively easy skill, often youth participants all the way to professionals, take the technique for granted. Free throws influence basketball games now more than ever with the increased emphasis on analytics in today’s game. If many individuals agree on the importance of free throw shooting, why is it not taught as thoroughly as other aspects of the game of basketball, such as shooting, footwork or defensive positioning? Examining how a player can improve free throw shooting without necessarily adjusting shooting form is valuable information that can be applied to every individual playing the game today. There are many controllable variables that can be addressed at the free throw line for basketball players, and the key to optimizing one’s success rate may lie in the individuals to control these variables.

The most basic and common advice athletes receive regarding free throws is “establish a routine.” Routines among basketball players vary in length, content, meaning and function. Pre-shot routines are effective for concentration and are used in various sports such as baseball, golf and track and field. A routine (in this context) is

essentially a pattern of actions that is repeated before a performance. Not to be confused with superstition, routines are intended to put the athlete in a specific mental state to perform a task to the best of their ability (Czech, Ploszay, & Burke, 2004).<sup>12</sup> To master any skill, it takes tremendous focus and extensive repetition. By establishing a pre-shot routine, basketball players can address both the mental and physical component of a free throw. The goal of an individual's routine is essentially to reduce variability, which should increase the success rate, which in turn will have a positive effect on the athlete's confidence. A study performed among 16 Division 1 basketball players (9 men and 7 women) analyzed the statistical variability of those players that maintained their routine and those who deviated (inconsistent pre-shot activity) from their routine. The study concluded, players that maintained their free throw routine (74%) statistically shot a higher percentage than those that deviated (68%) (Czech, Ploszay, & Burke, 2004).<sup>13</sup> Outside factors can always influence a study such as this, such as game situation, pressure and playing time for example. Although the statistical difference is not overwhelming, it is still significant in a basketball setting. There are many variables that remain unaddressed that may also affect free throw shooting, but it is important to know that establishing a routine and not deviating from it is the foundation to improving free throw percentage.

Establishing a routine for at the free throw line is commonly practiced and it is comforting to know that there is value in this practice. Another crucial finding in the

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<sup>12</sup> Czech, D. R., Ploszay, A. J., & Burke, K. L. (2004). An examination of the maintenance of pre-shot routines in basketball free throw shooting. *Journal of Sport Behavior*, 27(4), 323.

<sup>13</sup> Czech, D. R., Ploszay, A. J., & Burke, K. L. (2004). An examination of the maintenance of pre-shot routines in basketball free throw shooting. *Journal of Sport Behavior*, 27(4), 323.

study was the disparity of shot success between the first and second free throw (only 2 shot free throw situations were recorded, excluding “And 1’s”/3 point plays and technical foul shots). The individuals that maintained their routine show a much higher percentage on the second free throw (83%) as opposed to the first (65%) and vice versa for the group that did not maintain a consistent free throw routine (first – 70%, second 65%) (Czech, Ploszay, & Burke, 2004).<sup>14</sup> Again basketball is an unpredictable game and it is impossible to duplicate certain situations for different individuals because game situations tend to be unique based on time, personnel and opponent. This study proves the benefits of establishing a consistent routine and the positive affect it can have on a player’s free throw percentage.

### **Section Three – Self-Talk**

Clearly establishing a routine at the free throw line is beneficial in the process of mastering the skill. Analyzing various routines, it is essential to break down the practice further and now examine individual components of routines that may improve success rate. A component of many great free throw shooters’ routine is the use of self-talk. The practice of self-talk has been examined for years in various sports, producing positive correlations between self-talk and athletic performance. It is important to note that self-talk can often be classified in two categories, positive self-talk and negative self-talk. Positive self-talk helps athletes perform with increased confidence and concentration, while also combating anxiety they may encounter. On the other hand, negative self-talk

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<sup>14</sup> Czech, D. R., Ploszay, A. J., & Burke, K. L. (2004). An examination of the maintenance of pre-shot routines in basketball free throw shooting. *Journal of Sport Behavior*, 27(4), 323.

can debilitate athletic performance by decreasing an athlete's confidence and concentration while promoting anxiety. Random self-talk is not proven to aid performance and outcomes (Theodorakis et al., 2001).<sup>15</sup> Instead, self-talk must be appropriate to the task and contribute to the positive outcome the athlete seeks. By introducing the benefits of self-talk to basketball players it is important that athletes understand it is not enough to just use the technique, but use appropriate and related language to the task at hand.

The use of positive self-talk has shown to have a positive correlation on shooting percentage in the game of basketball. A study was conducted with 60 participants that performed 3 minutes of shooting at 5 spots on the floor from 4.5 meters away from the basket. There was a control group that performed the shooting exercise not using self-talk and two other groups used two words associated with the characteristics of shooting, speed and accuracy. Balancing these two characteristics is crucial when shooting a basketball because when one is over emphasized the other tends to suffer. Therefore, one group was given the instructions to say "fast" while shooting, to emphasis the speed characteristic of the shot. The other group was instructed to say, "relax" to address the accuracy characteristic. All groups performed 3 trials, and it is important to note the first 2 trials produced similar results in the categories of total shots taken and successful shots. However, the third trial proved that the "relax" group experienced a significantly higher accuracy rate as opposed to both the control group and the group instructed to say, "fast."

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<sup>15</sup> Theodorakis, Y., Chroni, S., Laparidis, K., Bebetos, V., & DOUMA, F. (2001). Self-talk in a basketball-shooting task. *Perceptual and Motor Skills*, 92(1), 309-315.

The discrepancy in success is quite significant as the “relax” group shot 12% better than the “fast” group and 9% better than the control group (Theodorakis et al., 2001).<sup>16</sup>

Although this study did not have the participants shoot free throws specifically, it is still useful when examining the effects of positive self-talk. Free throws are a unique aspect of basketball and emphasizing accuracy by using a key word such as “relax” is more realistic because the variable of defense and live action is removed from the task. Speed of the shot is also essentially a non-factor because an individual has 10 seconds to perform the routine of their choice and shoot the ball (this rule is rarely enforced). Therefore, the only concern of the free throw shooter should be accuracy as ample time is provided, negating the speed of the shot as an essential characteristic. Random self-talk will not guarantee improved success rate, but the self-talk must be appropriate and related to the task at hand. Therefore, self-talk should promote concentration and confidence, while reducing anxiety or fear.

It is crucial to use any practice or technique in moderation, because if done in excess, it can yield negative results. Self-talk therefore must be balanced and used appropriately. Negative self-talk such as “don’t miss” or “I can’t let my teammates down,” although the intension is to produce the right outcome, it can cause a decline in athletic performance. The mental aspect of sports is often overlooked as athletes are often evaluated on their physical gifts. This causes confusion for onlookers when extraordinary physical gifts do not always result in extraordinary results. This is often where the mental aspect of athletics is taken for granted. An extreme example of

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<sup>16</sup> Theodorakis, Y., Chroni, S., Laparidis, K., Bebetos, V., & Douma, F. (2001). Self-talk in a basketball-shooting task. *Perceptual and Motor Skills*, 92(1), 309-315.

negative self-talk or overthinking is when athletes experience the “yips.” The term “yips” can be described as an unexplained loss of a motor skill previously performed by an athlete. This is common in sports such as golf, baseball and free throw shooting in basketball (Smith et al., 2000).<sup>17</sup> Golfers often miss short putts by putting extra pressure on themselves by using negative self-talk. In basketball players, they often experience performance anxiety from the setting of practice to games. Shaquille O’Neal is the most famous case, as when focused in practice he consistently could shoot roughly 80% from the free throw line. By his own admission, he used negative self-talk that often caused his free throw percentage to plummet in a game setting. Rather than focusing on positive outcomes, individual athletes often struggle to perform relatively simple tasks because of their inability to use positive self-talk as opposed to negative self-talk.

An interesting study on cognitive-behavioral reinforces the benefits of using practices such as self-talk, related to free throw shooting. Basketball is a game of instincts and reactions, yet free throw shooting is a unique aspect of the game, as it does not emphasize instinct or reaction nearly as much. The mental approach to free throw shooting cannot be understated and that combined with appropriate repetition and practice provides a strong foundation. The study was performed on three male collegiate basketball players. A baseline was established for all three athletes’ free throw percentage in both practice and game situations. The players then underwent a cognitive-behavioral training program consisting of four segments:

1. Deep muscle relaxation

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<sup>17</sup> Smith, A. M., Malo, S. A., Laskowski, E. R., Sabick, M., Cooney III, W. P., Finnie, S. B., ... & Kaufman, K. (2000). A multidisciplinary study of the ‘yips’ phenomenon in golf. *Sports Medicine*, 30(6), 423-437.



2. Identification of negative self-statements
3. Development of positive self-statements
4. In vivo rehearsal during team practice (Hamilton & Fremouw, 1985)<sup>18</sup>

Cognitive measures were taken before and after a 4-week training period. The three subjects supplied the necessary data about cognitive-behavior by reconstructing thoughts while watching videotape. The subjects categorized their thoughts into three categories; positive statements, negative statements and interfering statements (statements unrelated to performance).

The results from after the training drew correlations between the cognitive-behavioral training program and athletic performance. Before the training all subjects were relatively poor free throw shooters; and the poor free throw shooting showed a correlation with negative statements. After the training, the three subjects saw a positive increase in their free throw percentage and positive statements. Obviously the data cannot necessarily be taken at face value, as identifying these statements is dependent on the reflection of the same individual athlete after video review. The study concluded by showing that the three collegiate athletes showed tremendous improvement (32%, 30.5% and 25% increase in game free throw percentage) (Hamilton & Fremouw, 1985).<sup>19</sup>

Results from this study are crucial because it reinforces the importance of establishing a routine and implemented positive self-talk. It also advocates for evaluating past performances and methods off the court that can contribute to enhance performance.

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<sup>18</sup> Hamilton, S. A., & Fremouw, W. J. (1985). Cognitive-behavioral training for college basketball free-throw performance. *Cognitive Therapy and Research*, 9(4), 479-483.

<sup>19</sup> Hamilton, S. A., & Fremouw, W. J. (1985). Cognitive-behavioral training for college basketball free-throw performance. *Cognitive Therapy and Research*, 9(4), 479-483.

The use of deep muscle relaxation is interesting because relaxation methods are extremely common. The specifics of the deep tissue relaxation methods were not elaborated on however its contribution is consistent with the necessary use of relaxation methods and improved free throw shooting.

#### **Section Four – Reducing Anxiety and Visuo-motor (VM)**

The use of Visuo-motor behavioral rehearsal (VMBR) contains similar intent to cognitive-behavioral training, with the purpose of VMBR being to reduce anxiety. Reducing anxiety is a common theme when attempting to increase free throw percentage. This practice is easier said than done as performance anxiety can be intensified at the free throw line, as the game stops and focus zeroes in on an individual player. Another emphasis of the study was the use of Videotaped Modeling. The study was performed using 48 male athletes. Interestingly this study only used four basketball players for the study out of the 48 participants. The study stated that professional basketball players were not included in the study because mental training has a greater correlation with professional athletes as opposed to “occasional” players. A majority of the subjects had at junior high level basketball experience (the rest had high school varsity or higher) and therefore possessed basic skills and were familiar with the game. There were three groups of 16 participants separated and introduced to specific training. One group would use VMBR, another would use VMBR and videotaped modeling; and the final group would only use videotaped modeling.

Feedback from the subjects is crucial as 50% believed felt mental imagery was most useful, 31% believed relaxation was most beneficial and 19% thought the video

modeling component had the most significant impact on their improvements. The results also showed a correlation between initial ability and improvement, as mentioned earlier in the study, when professional basketball players were not considered for the experiment. The subjects that had a relatively low-ability of basketball skills showed more significant improvement than those who are considered to have a high-ability level. Overall, 35 of the 48 participants showed improvement after the testing was completed (Onestak, 1997).<sup>20</sup>

The key to this study as outlined in the “Discussion” section is establishing participant confidence in the training practices performed in the study. As individuals have faith in the practices they are performing, the chances of improved performance is most probable. Confidence is essential when performing an athletic task and confidence can be fostered by perceived improvement. The subjects believed VMBR and videotaped modeling was beneficial and therefore increased confidence, which in turn improved athletic performance. Mental training has proven to yield consistent positive results with athletic performance. Genetics play far too large a role in physical gifts athletes may possess, but using mental training techniques can access untapped athletic performance potential. Basketball is a game that caters to the physically gifted, and players that are not as athletic must find other ways to assert their value on a game. Mental training techniques are ways in which an athletically challenged individual can maximize their functionality on the basketball court and close the gap in athleticism as much as possible.

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<sup>20</sup> Onestak, D. M. (1997). The effect of Visuo-Motor Behavioral Rehearsal (VMBR) and Videotaped Modeling (VM) on the free-throw performance of intercollegiate athletes. *Journal of Sport Behavior*, 20(2), 185.

## Section Five – Arousal and Mindfulness

There have been numerous studies surrounding the relationship between routine and basketball free throw percentage. There is consensus in the basketball community that establishing a free throw routine is essential to improving free throw accuracy. The individuals that advocate for the benefits of establishing a free throw routine often do not know the studies and why it is successful. Routines have proven to increase free throw shooting accuracy by 7% in games and as much as 23% in game settings (Lobmeyer & Wasserman, 1986, as cited in Gooding & Gardner, 2009).<sup>21</sup> In the following study, three components of free throw shooting were evaluated and they were pre-performance routine, arousal and mindfulness. The benefits of routines are mentioned above, but it is also important to note that length and consistency of routine also is related to performance. When individuals were asked to shorten their preferred routines, their free throw percentage declined. Duration of an individual's routine is a personal preference and there is no optimal routine length as it depends on the comfort level of the athlete. There also is a correlation between routine consistency and free throw accuracy, as the individuals with the most consistent routines often yielding the higher free throw percentage.

Arousal, stress and anxiety can improve or hinder performance depending on the individual. Routines are used to reduce anxiety, stress and arousal because those emotions are often associated with other memories and feelings, which can impede

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<sup>21</sup> Gooding, A., & Gardner, F. L. (2009). An investigation of the relationship between mindfulness, pre-shot routine, and basketball free throw percentage. *Journal of Clinical Sport Psychology*, 25(4), 303.

performance (Wilson et al., 2009).<sup>22</sup> Controlling these emotions is crucial, as it is not realistic to suppress the emotions completely but rather focus them to enhance performance as opposed to impair performance. Many experts have studied the relationship between arousal and performance. One theory insists that every athlete has an optimal level of arousal that results in optimal athletic performance and it is to be determined individually the level of arousal required to obtain this athletic peak. Obviously because optimal arousal levels are unique to every individual, it is extremely difficult to determine a general process for athletes to approach their desired arousal levels for athletic performance. This causes data to be inconsistent compared to other components of free throw shooting that establish direct correlations. Mindfulness is another variable that can have drastic effects on free throw shooting. With an abundance of distractions, players can deal with in a game setting such as, crowd noise, opposing team, pressurized game situations and timing of game. Mindfulness is examining individuals who can focus on the task at hand efficiently tend to produce better results from the free throw line. This skill lies in the player's ability to focus on task-relevant cues as opposed to task-irrelevant cues (Gooding & Gardner, 2009).<sup>23</sup>

In this study, 43 Division I basketball players initially participated. The subjects had to complete Sport Competition Anxiety Testing (SCAT) and Mindful Attention Awareness Scale (MAAS). All of the testing and practice free throw shooting were completed before the start of the regular season. During the season, athletes had to shoot

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<sup>22</sup> Wilson, M. R., Vine, S. J., & Wood, G. (2009). The influence of anxiety on visual attentional control in basketball free throw shooting. *Journal of Sport and Exercise Psychology*, 31(2), 152-168.

<sup>23</sup> Gooding, A., & Gardner, F. L. (2009). An investigation of the relationship between mindfulness, preshot routine, and basketball free throw percentage. *Journal of Clinical Sport Psychology*, 25(4), 303.

a total of 30 free throws during competition to be considered for the study; only 17 individuals met all of the criteria. By using the SCAT and MAAS tests, concrete correlations could be established based on test scores and in-game free throw percentage. The study concluded that mindfulness can significantly predict game free throw percentage, as well as practice free throw percentage. Interestingly, the study also discovered that year in school/experience significantly predicted game free throw percentage (Gooding & Gardner, 2009).<sup>24</sup> This can also be viewed as experience is related to mindfulness and with increased experience, mindfulness improves therefore contributing to increased free throw percentage.

The study on routine, mindfulness and arousal clearly shows how many working components contribute to improving free throw percentage. There are individual components that are important and may have a stronger relationship to free throw accuracy; but if one component must suffer for the benefit of another, then the improvement will be minimal, if at all. Understanding all of the working parts contributing to free throw shooting is important and improving depends on focusing on one component while not hindering another component. This obviously takes an enormous amount of practice and discipline, which happen to be common characteristics of great free throw shooters.

## **Section Six - Perceptual Training**

Perceptual skills are often overlooked, as many basketball coaches do not have access or expertise to use perceptual training. Perceptual training can be sport-specific

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<sup>24</sup> Gooding, A., & Gardner, F. L. (2009). An investigation of the relationship between mindfulness, pre-shot routine, and basketball free throw percentage. *Journal of Clinical Sport Psychology*, 25(4), 303.

and is essentially the recognition and interpretation of visual information. Visual perception consists of static and dynamic acuity, depth perception, color vision and peripheral vision. Previously examined studies mentioned the many distractions from crowd activity to opposing player movements and noise; perceptual training, again, focuses eyes on the target or task. This eliminates distractions and can lead to increased accuracy from shooting in different basketball situations, including free throw shooting. Perceptual learning consists of two specific processes: education of attention and calibration of action. Education of attention is described in the study as “narrowing down from a vast manifold of information to the minimal, optimal information that specifies the affordance of an event, object or layout” (Oudejans et al., 2005).<sup>25</sup> Essentially it is training an individual to only process the information that is related to the task at hand. Many athletes process an abundance of information and very little is related to the athletic performance they are attempting to accomplish. Calibration of action in the most general sense is described as the ability to identify specific/useful variables to the desired task. Again, this information reinforces the ability of individuals to focus on the task, and this ability should yield positive athletic results.

Perceptual training specific to free throw shooting is the use of a concept called quiet eye (QE). This is when a player is fixated on the target for what seems like a long time (time varies depending on the individual) before initiating final movements to perform the task. This is also used in rifle shooting, darts and billiards. Previous studies

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<sup>25</sup> Oudejans, R. R., Koedijker, J. M., Bleijendaal, I., & Bakker, F. C. (2005). The education of attention in aiming at a far target: Training visual control in basketball jump shooting. *International Journal of Sport and Exercise Psychology*, 3(2), 197-221.

have shown that fixating on the intended target before initiating final movements produces optimal outcomes. The time spent fixating on the desired target and using QE is when other cognitive processes are occurring such as self-talk, anxiety reduction, confidence building and positive statements (Oudejans et al., 2005).<sup>26</sup> Many of the original testing on this subject was completed in a laboratory setting and establishing an on-court environment for testing may prove to be more reliable. One on-court study proved that increasing QE time improved the free throw percentage among female collegiate basketball players.

The study in this experiment examined perceptual training on jump shooting. The skills required for jump shooting can obviously still be easily translated to free throw shooting. The biggest difference is speed, time and opposing player's defense. Perceptual training for jump shooting requires an individual to find their target quickly, as free throw shooting allows for the player to remain in quiet eye for an extended period of time, until ready to shoot. After perceptual training, the subjects experienced improvements in shooting percentage from the 3-point line. The study was performed using sheets that only allowed players to see the basket, as well as special glasses that narrow vision. The subjects of this study were collegiate basketball players that did not have shooting technique changed at all. This was on purpose in order to truly discover the effects of perceptual training on shooting outcomes (Oudejans et al., 2005).<sup>27</sup>

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<sup>26</sup> Oudejans, R. R., Koedijker, J. M., Bleijendaal, I., & Bakker, F. C. (2005). The education of attention in aiming at a far target: Training visual control in basketball jump shooting. *International Journal of Sport and Exercise Psychology*, 3(2), 197-221.

<sup>27</sup> Oudejans, R. R., Koedijker, J. M., Bleijendaal, I., & Bakker, F. C. (2005). The education of attention in aiming at a far target: Training visual control in basketball jump shooting. *International Journal of Sport and Exercise Psychology*, 3(2), 197-221.



Although this study was not specifically focused on free throw shooting it still provided beneficial techniques that could be applied to free throw shooting.

Understanding the importance of the time spent focusing on your target before initiating shooting mechanics is also known as quiet eye (QE). Many collegiate athletes play in arenas, which can be difficult to adjust to the depth perception without appropriate practice time and repetition. Perceptual training can help an athlete locate their target quickly and maintain the focus while blocking out distractions that do not contribute to final outcome. A common theme in the studies examined is that those who have the ability to focus on the task and ignore distractions tend to be better free throw shooters.

### **Section Seven – Hydration**

Thorough analysis of physical and mental aspects of free throw shooting has been explored and all of this takes place during the shooting the process. However, the complexity of basketball and a specific skill can still be influenced by numerous variables. Hydration, for example, is essential to maintaining high athletic performance; but what are the effects of an athlete that experiences dehydration? Free throw percentage often tends to decline in the final moments of a game, this can obviously be a product of pressure, but also players may not be experiencing varying levels of dehydration. Exploring this issue and educating athletes of the effects of dehydration can help performance throughout strenuous activity.

A study was conducted on athletes between the ages 12 and 15 years old. The subjects would perform baseline testing on vertical leap, blood analysis and maximum oxygen consumption (VO2 max). All subjects performed athletic testing and basketball

skills training while being properly hydrated. Then they performed the same athletic tests and basketball skills training while being dehydrated by 2%. The subjects experienced a decline in basketball skill testing from the hydration to dehydration phase. Subjects reported feelings of fatigue and lightheadedness when dehydrated. The experiment showed that as little as 2% dehydration causes impaired shooting, sprinting and lateral movements. All of these skills are essential to the game of basketball; and although basketball has numerous opportunities for athletes to hydrate, many still experience dehydration at various parts of competition. The study also showed that consuming a 6% carbohydrate solution as opposed to water has a positive correlation with basketball performance (Dougherty et al., 2006).<sup>28</sup> Water may not replenish all of the vital nutrients and vitamins that are lost from physical exercise.

Finding a competitive edge in basketball is essential at the collegiate and professional levels as basketball can be a very profitable sport for many institutions. With that being said, often coaches seek new technology and philosophies while disregarding proven practices that are proven to work. Rather than using a high altitude mask to simulate working out in the mountains, which is a costly gadget, it may be just as beneficial to educate athletes on the benefits of staying hydrated. The great thing about hydration is that it is a variable that we can control by having fluids ready for the athletes. Every timeout and stoppage in play (when appropriate) attempts to build the habit in young athletes to hydrate themselves and replenish their fluids. It is proven that

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<sup>28</sup> Dougherty, K. A., Baker, L. B., Chow, M., & Kenney, W. L. (2006). Two percent dehydration impairs and six percent carbohydrate drink improves boys basketball skills. *Medicine and Science in Sports and Exercise*, 38(9), 1650-1658.

dehydration can cause drastic impairments on motor skills; therefore, education on the subject is important. Building this habit does not require special sport specific knowledge and yet coaches do not emphasize its importance nearly to the degree that is required.

## **Section Eight – Effects of Pressure**

Many of the variables that have been examined are variables that can be controlled by the athlete shooting the free throw, by proper preparation and practice. Basketball is a multifaceted sport that provides variables that the athletes cannot control. One of these variables is pressure and the environment in the gymnasium (home vs. away and crowd noise). The effects of pressure on free throw shooting are evident in many games throughout a basketball season. One of the more infamous examples in collegiate competition is Darius Washington Jr. of the University of Memphis, missing two of three attempts at the free throw line, resulting in a one-point loss. Washington, a 72% free throw shooter, famously collapsed after missing his final two free throw attempts. The variable of pressure is present in this example as the game was going to be decided by Darius Washington's free throws and the game just happened to be for a conference championship (which if won, gives the victors an automatic bid into the NCAA Tournament or March Madness). The impact of pressure can be exacerbated by self-talk or self-focus, although both are essential to improving free throw shooting as well.

Previous studies have shown that self-talk and self-focus have been identified as a key factor in the decline of performance in pressurized situations. Therefore, this speaks to the essential need to not waver from one's routine while at the free throw line.

Moderation is key in athletics as too much training or exercise can often be detrimental even though the intention is to foster improvement. Pressure situations cause increased self-focus which commonly is referred to as “over thinking” when completing a skill such as free throw shooting. Self-talk can also transform from positive to negative, as athletes in pressure situations often begin to let thoughts of the consequences of missing creep in to their mind as opposed to positive confidence enhancing thoughts. Pressure magnifies anxiety among athletes because of the negative self-talk and increased self-focus is not consistent with their routine and therefore anxiety reducing cues are not met during the free throw shooting process.

The most interesting discovery in the study was the effect of home vs. away crowd’s role in relation to pressure experienced at the free throw line. Contrary to common belief, the study concluded that “home free throw shooters do significantly worse in clutch situations, with effect being larger for poor shooters. Road players show no change in behavior under pressure, indicating distraction plays a limited role in this task” (Goldman & Rao, 2012).<sup>29</sup> It is important to note that this study was conducted among NBA basketball players, so it is data accumulated from the most highly skilled players in the world. Home audiences often can energize the team it is supporting and yet it can also be detrimental in pressure situations, through no fault of their own. One of the explanations for this phenomenon is again the idea that self-focus is somehow over emphasized by athletes in these situations, which creates deviations from their usual routine. It appears that letting down supportive fans can cause great anxiety resulting in a

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<sup>29</sup> Goldman, M., & Rao, J. M. (2012). Effort vs. concentration: the asymmetric impact of pressure on NBA performance. In *Proceedings MIT Sloan Sports Analytics Conference* (pp. 1-10).

decline in performance, which begs the question, what are the true advantages of “home court advantage?”

## **Section Nine – Sleep**

Affective sleep is essential to realize athletic potential because sleep recharges the body and mind. The optimal amount of sleep is unique to different individuals. Therefore, understanding how much sleep each individual needs is important for realizing athletic potential. Collegiate athletes are often sleep deprived because of misallocation of time, social distractions and technological distractions. The affects of sleep deprivation are well documented as it can have negative consequences concerning reaction time, memory and learning skills. Physical performance may also suffer as weight lifting, cardiorespiratory functions and tasks requiring accuracy and consistency all declined in sleep-deprived athletes (Mah et al., 2011).<sup>30</sup> Analyzing athletes that received sufficient sleep or even extended sleep was conducted on the men’s basketball team at Stanford University.

Over two seasons at Stanford University the men’s basketball team’s sleeping habits and performance were studied, attempting to discover a correlation between sleep and performance. The athletes maintained their normal sleep patterns for 2-4-week span. This was considered the baseline period for each athlete. During the baseline period, athletes were limited to 6-9 hours of sleep a night (all sleep was recorded over night, naps were not included in total sleep). For the next 5-7 weeks after establishing a baseline, athletes were encouraged to obtain as much sleep as possible, with a minimum

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<sup>30</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. *Sleep*, 34(7), 943–950.

requirement of 10 hours in bed per night (Mah et al., 2011).<sup>31</sup> This practice is referred to as sleep extension, essentially receiving more sleep than what is required. Throughout the baseline and sleep extension periods' athletic performance, reaction time, daytime sleepiness, and overall mood were recorded.

In total, 11 men's basketball players were subjects in the sleep extension study. Sleep time increased during the sleep extension period on average of 110 minutes and subjectively players thought they slept much more than actigraphy sleep (non-invasive method to monitor "actual" sleep) indicated. During sleep extension, all subjects showed improvement in reaction time, with a decrease in lapses and minimum reaction time. Increases in athletic performance was another result from sleep extension, which is the most relevant information considering this study. Sprint time decreased and shooting accuracy increased significantly meaning players were better athletes just because they were obtaining extended sleep. Shooting accuracy increased from 7.9 made free throws per 10 shots to 8.8 made free throws with sleep extension. Three-point shooting performance also increased as during the baseline subjects made 10.2 shots out of 15 and during sleep extension accuracy increased to 11.6 made shots out of 15. Finally, the subjects noticed their improvements as their perception of their performance improved as well. Athletes subjective practice ratings improved from 6.9/10 to 8.8/10 (Mah et al., 2011).<sup>32</sup>

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<sup>31</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. *Sleep*, 34(7), 943–950.

<sup>32</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. *Sleep*, 34(7), 943–950.

Sleep extension has proved to be a great practice to help improve athletic performance. Regarding free throw shooting specifically, athletes saw their free throw percentage increase by 9%, by only extending their sleep. Sleep is a variable for athletes that can be controlled by being efficient with one's time and completed tasks in a timely fashion. During the baseline portion of the test, athletes on average received 6.68 hours of sleep on average (Mah et al., 2011).<sup>33</sup> This meant those most athletes were performing in the midst of a sleep debt and their athletic performance suffered because of it. Not only does sleep improve motor skills, but it also has a positive impact on the athlete's mind. When athletes experienced more sleep, subjects reported an improvement in self-perception of performance. This information is important because previously positive self-talk and confidence training were mentioned as important determinants of successful free throw shooters. If sleep can improve self-perception, that will also positively influence positive thoughts and increase an athlete's confidence at the line as proven by the 9% increase in accuracy during the study.

### **Synthesis of Literature**

It is important to understand how the previous studies were conducted to analyze the variables associated with free throw shooting. All of the studies did not adjust or teach shooting form, which is critical because in order to develop a generic template to improve free throw shooting, shooting form and technique cannot be a concern.

Understanding the variables controlled in each study allow similar experiments to be conducted, only accounting for different variables. All the components that play a direct

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<sup>33</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. *Sleep*, 34(7), 943–950.

role in the accuracy of free throw shooting are mentioned above and now the task becomes sorting conducting independent studies to analyze which variables are most imperative to free throw improvement and which combination of these variables yields the best results.

With all of the data from the various studies, it is clear that routine, self-talk, mindfulness, anxiety reduction, perceptual training, hydration and sleep all affect free throw shooting. Each variable, if performed with moderation, can be beneficial; but also with too much focus on one, or neglecting others completely, can cause performance to suffer. Some may believe that if you apply all of these variables to your free throw shooting routine, you will become an improved shooter, which is false. With any athletic skill, it takes practice and repetition to improve; and the same diligence must be applied when developing a routine consisting of multiple variables in order for improvement to occur. Again, understanding the right combination of techniques to apply to free throw in a generic fashion would allow for coaches at all levels to provide beneficial teaching in this specific aspect of the game. The goal is to establish a strong foundation for youth basketball players that can be built upon as they progress to higher levels of basketball.

It is clear from the research that some variables seem to have a greater impact on free throw percentage than others. Sleep extension seemed to yield the most significant improvement, while other variables such as anxiety reduction showed far more modest improvements. The difficulty now lies in determining an optimal routine template for players that can be followed; yet also allow them to personalize their routine for optimal comfort. In all these studies, it is clear that free throw shooting is a unique skill, and all



players have different qualities and capabilities both mental and physical. The goal of processing the information from previous studies is understanding what affects free throw shooting positively and developing a simple generic “blueprint” for players to improve their shooting percentage.

Analytics continues to play an increasing role in decisions being made on the basketball court. Companies such as Synergy Sports provide analytical breakdown for all teams that apply to their program. A majority of collegiate basketball teams now use the program, which speaks to the increased reliance of analytics in basketball. Using algorithms and advanced statistics to aid decision-making allow of more informed decisions from coaches and management, analytics can reinforce perceived weaknesses and strengths from an individual and team perspective (Salador, 2011).<sup>34</sup> Identifying weaknesses such as forcing a player to his/her non-dominant hand may increase the chances of the defensive team not surrendering a basket. The higher the level of basketball, the increasingly crucial role analytics can play because even the slightest information can provide a competitive advantage for a team. At the collegiate and professional levels, a tactic based on analytical analysis known famously as “Hack-a-Shaq” has become popular as a way to disrupt rhythm and force the other teams weakest foul shooter to make pressure induced free throws (Skinner, 2011).<sup>35</sup> Analytics and free throws are for this and various reasons an integral part of basketball now and

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<sup>34</sup> Salador, K. (2011). Forecasting performance of international players in the NBA. MIT Sloan Sports Analytics Conference.

<sup>35</sup> Skinner, B. (2011). Scoring Strategies for the Underdog: A general, quantitative method for determining optimal sports strategies. *Journal of Quantitative Analysis in Sports*, 7(4).

understanding the importance of each aspect of the game can contribute to a competitive advantage for teams.

Understanding the variables that affect free throw percentage can not only increase free throw percentage, but also contribute to wins. Using analytics can determine the players to intentionally foul at the end of games, as coaches not only look at statistics such as basic free throw percentage, but also situational free throw percentage. Analytics allows coaches to see which free throw shooters struggle to shoot in the fourth quarter or in pressurized situations (Goldman & Rao, 2012).<sup>36</sup> Again by studying this subject, coaches can use the findings to not only determine the best decisions from a defensive or offensive perspective but also from situational perspective (playing with a lead or trailing an opponent).

Free throw shooting is often an undervalued aspect of basketball practice and training time. In 2014, NBA team's percentage of total points from the free throw line ranged from 14% - 22%. This means that 1/5 of a team's total score can come from the free throw line and yet coaches rarely dedicate the appropriate amount of time to properly train consistent free throw shooters (Sampaio, 2003).<sup>37</sup> Coaches must understand all the variables associated with free throw shooting and how they individually can influence a player's free throw percentage. In close games, the importance of free throw makes only intensifies as the game nears its conclusion, placing added value and importance on players that can make clutch free throws.

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<sup>36</sup> Goldman, M., & Rao, J. M. (2012). Effort vs. concentration: the asymmetric impact of pressure on NBA performance. In *Proceedings MIT Sloan Sports Analytics Conference* (pp. 1-10).

<sup>37</sup> Sampaio, J. (2003). Importance of free-throw performance in game outcome during the final series of basketball play-offs. *International Journal of Applied Sports Sciences (IJASS)*, 15(2), 9-16.

## **CHAPTER TWO: METHODOLOGY, ANALYSIS, AND IMPLICATIONS**

### **Problem Statement**

This study addressed the issue of the rising use of analytics and the perception of analytics' role in improvement from the perspective of players and coaches, specifically regarding free throw shooting. Using a mixed method approach, we analyzed practice free throw percentage and used analytical data with the players to see if changes in free percentage occurred. The first phase of the study was quantitative, collecting data on free throw percentage while isolating specific variables to analyze (hours of sleep, free throw frequency, timing in game). Following the quantitative data collection, interviews were conducted with individual players and coaches, asking questions regarding their perceived influence of analytics in their free throw shooting ability. This was the second phase and the qualitative portion of the study. The athletes and coaches were asked their perceived importance of analytical analysis regarding free throw shooting. It must be understood that analytics has identified certain variables that most influence free throw shooting, such as routine consistency, sleep, anxiety reduction, hydration/fatigue and pressure. All of these variables have been proven to affect free throw percentage and using analytics to help control these variables and improve overall free throw percentage.

## **Research Questions**

### **Quantitative**

How does the use of analytics over two seasons influence free throw shooting performance?

### **Qualitative**

What is the perception of analytics among player's and coaches? Do they support the use of analytics and do they believe there is a correlation between analytical analysis and improved individual performance?

### **Mixed Methods**

How do player perceptions of analytics compare to their actual performance on the basketball court?

## **Variables**

### **Independent Variables**

**Player** – This variable measures the individual player. The players will be collegiate athletes, meaning experience and age will differ on an individual basis.

**Coach** – This variable refers to the individual coach. Some coaches place more of an emphasis on analytics than others. It depends on the individual coach's teaching style and preference.

**Position** – The position they most frequently play during competition. (Point guard, Shooting guard, Small Forward, Power Forward or Center)

## **Dependent Variables**

**Perception of analytics** – The individual coach or player’s views concerning analytics and its importance in the game overall, as well as its effect on their individual performance.

**Routine** – The sequence of physical and mental actions a player will experience before shooting a free throw attempt. (this is unique to each individual player.) The mental and physical actions often act as cues to trigger focus and reduce anxiety a player may experience at the free throw line.

**Hydration/Fatigue** – This variable measures an athlete’s ability to hydrate properly as athletic motor skills decline as athletes become dehydrated.

**Sleep** - This variable measures the amount of sleep an individual player receives. Studies have shown that free throw percentage declines if players are experiencing a sleep deficit. Free throw percentage increases if players have a surplus of sleep.

**Score entering last 10 minutes** – This variable gives us an indication of the pressure that may be associated with certain free throw attempts. In a close game, pressure is intensified, and in a blowout, focus or other qualities may be compromised influencing general free throw percentages.

## **Hypothesis**

The use of analytics over a season will improve free throw performance. The perceptions of the effectiveness of analytics will differ between player and coaches, as coaches will value and implement analytical application more than players will.

## Population

This study analyzed the use of analytics associated with free throw shooting, as well as the perceived perception of analytics influence on free throw shooting. George Mason men's basketball team served as the study population. In total, 14 men's basketball players participated in the study; and ultimately only 11 healthy athletes were able to fulfill the requirements of the study (to date). Health and disciplinary issues prevented all team members from completely participating in the study. Only the subjects that participated in the complete study contributed to the data collected for specific demographic characteristics. There are 351 Division 1 basketball programs and roughly 14 players on each team, which gives a population size of approximately 5000 collegiate basketball players. This study may also be applicable to all collegiate male basketball players regardless of level of competition, which would increase the variety of demographics as well as the population size. The demographics characteristics chosen for this study are Division 1 male basketball player, experience (freshman, sophomore, junior and senior), position on team, race, and physical dimensions (height and weight).

Table 1 - Demographics

Race	Subjects
Caucasian (%)	2.0 (15.4%)
African American (%)	11.0 (84.6%)
Sex	
Male (%)	13.0 (100)
Height (ft)	6'5.8 ft

Range	5'7 – 6'11
Weight (lbs)	205.2 lbs
Range	161lbs – 245lbs
Year in School (avg)	2.6 years
Range	1-5
Position on Team	
Guard (%)	8 (61.5%)
Forward (%)	3 (23.%)
Center (%)	2 (15.4%) (Mah et al., 2011) <sup>38</sup>

### **Determination of Sample Size**

The population size for Division 1 male basketball players is approximately 5000 athletes. With 351 Division 1 programs and roughly 14 players on each team (13 scholarship players), each player could benefit from the findings of this particular study. For a 95% confidence level and confidence interval of +/- 5, the study would have to consist of 357 subjects. With access to only one basketball team satisfying that particular confidence level and interval, this percentage is unrealistic. This should not deter the potential benefits from this study, as the players will have the same coaching message and practice/game schedule which will control those particular variables. George Mason's basketball team only has 14 men's basketball players and 5 coaches (Mah et al.,

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<sup>38</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep, 34*(7), 943.

2011).<sup>39</sup> All of the players were not be able to fulfill all of the requirements of the study to be considered full participants because of varying minutes of in game experience and opportunity. It was projected that 11 players will fulfill the practice and game requirements associated with free throw shooting. Injuries and disciplinary issues disrupted the initial data collection for 3 players, which reinforces the projection of only having 11 players complete the full study requirements (Creswell & Clark, 2007).<sup>40</sup>

### **Sampling Procedure**

The study featured a convergent parallel mixed methods design. This is when both qualitative and quantitative data is collected and analyzed separately. The results of the collected data are then compared in an effort to confirm or disconfirm each other. The qualitative portion of this study was conducted through interviews. Players and coaches were interviewed, with questions focusing on establishing their perception of the importance and influence of analytics on their personal performance and overall impact on the game in general. This allowed for personal insight on the role of analytics and the

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<sup>39</sup> Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep*, 34(7), 943.

<sup>40</sup> Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research.



varying differences of importance players believe it has on the game. With the growing use of analytics in basketball, it will be interesting to contrast the opinions of coaches and individual players on the subject. The quantitative portion of the study analyzed free throw shooting and how analytics can help improve performance at the free throw line. Many studies have been conducted on exercises and habits that help increase free throw shooting percentage. Establishing a consistent routine, reducing anxiety, focus level, sleep, hydration, distraction and pressure all affect free throw percentage. Using this data, can we improve both practice and game free throw percentages? Practice free throw percentages were recorded as players shot 20 free throws at the end of practice. All game free throws were accounted for, meaning there were different sample sizes for players based on how often they get to the free throw line. After both qualitative and quantitative data was collected, a comparison of the results confirmed or disconfirmed commonalities between the two methods.

### **Sampling Bias**

In this study, selection bias occurred because access was only granted to one basketball team and only 14 players in total (8 players in both seasons). Selection bias is the selection of individuals (or groups) for analysis in a way that does not allow for proper randomization to be achieved. This means that the sample is not representative of the population intended for analyses. By only analyzing George Mason's men's basketball program, it did not allow for proper representations of the varying demographics that Division 1 men's basketball offers. For example, George Mason has no athletes that are currently juniors, which means that this particular group of the

population will not be represented by the sample. Because the study is analyzing only the George Mason basketball program because of accessibility, this can be considered a convenience sample as well. Convenience samples are not as reliable because inferences are not as reliable as a random sample.

The analysis of a single team is another form of sampling bias that leaves some members of the population inadequately represented by the sample. This again is a case of this particular sample, not representing juniors because George Mason currently does not have one on the roster. Race, height and position groups may also not be adequately represented because of the limited access to only one particular team. The demographics of one team rarely are representative of the diverse population of Division 1 men's basketball.

The last form of bias that was present in this study is voluntary response bias, especially in the qualitative portion of the study. The players provided that quantitative data regardless of the study because it is a requirement of the team and stats are taken at every practice. However, the interviews were completely optional, as players could choose to participate or not. This made the interview section a voluntary response bias. Ideally it would be preferable to have access to the stats from a variety of teams and a larger sample population. This would have allowed for a larger sample size and random selection of the sample population, which would limit bias and increase the validity of the outcomes of the study.

The biases mentioned above limited the validity of the study because the sample size was not representative of the population. The study will still provide useful

information and there are advantages to analyzing one team as opposed to individual players on a variety of teams. All the players received similar coaching, repetitions at the free throw line in practice, and were in similar pressurized situations in games. This scenario can legitimize other aspects of the study, but ideally a more appropriate representation of the whole population of Division 1 basketball players would have yielded the most valid results.

### **Research Design**

Subjects shot their normal free throws throughout practice and games for the 2015/16 season. This allowed a baseline for both practice and game free throw percentages for each individual player. The players also participated in a survey to establish their perception of the importance of analytics in the game of basketball from a team and individual standpoint. By doing the survey before presenting analytical assistance with each player's free throw shooting, it created unbiased qualitative data on each player's perspective of the importance of analytics. During the 2016/17 season, subjects attempted to increase their sleep per night, a goal of 9 hours a night (by waiting until after the tenth game it also is a time when the athletes do not have academic obligations and therefore can focus on obtaining more sleep), establishing consistency in free throw routines and using anxiety-reducing methods. A few players had the beginning portion of the study conducted at a later time because of missed game action due to injury.

Using the analytical data that has been proven to help free throw shooting was presented to the players individually. The information was presented in a generic

fashion, in order to deliver a consistent message to each player. This way, the players were more likely to be receptive to the information and it insured that all players received the information the same way. Before the 2016/17 season, players received analytical assistance with their free throw shooting. Practice and game free throw percentages continued to be charted in the same fashion. This process data collection continued for the season. After the use of analytics concerning the players' free throw shooting, another survey was conducted in order to assess deviations in the player perceptions from the original survey. An important note is that the players did not analyze the quantitative data before participating in the final survey. The coaches participated in the qualitative portion of the study in order to analyze the different perceptions of players and coaches concerning the importance of analytics.

The rationale for this research design was to explore the perception of players and coaches' views on analytics in a sport that is increasingly using the method. The unique angle of this study was receiving before and after perspectives of analytics from players and coaches. As analytics becomes a greater aspect of the game of basketball, it is important for coaches to understand how much their players believe in the analysis of numerical data. This allows coaches to adjust their teaching method based on the player's perceptions, understanding that if a student/player does not believe in a method, then they must be convinced or more realistically; the teaching strategy must change. The qualitative portion of the study was crucial because players are often overloaded with analytical data and may not recognize the correlation to improvement or success. By focusing the use of analytics on individual players, they can see the benefits (or not) first

hand. The survey at the end of the study solidified previous perceptions of the importance of analytics, or altered their perceptions in favor or rejecting the importance of analytics.

There were many threats that challenged the validity of the study and addressing these issues was critical to produce the most reliable study possible. Especially concerning game free throws, there were variables that could not be controlled. Internal validity was influenced as maturation is a threat as players have varying levels of experience and this can influence comfort level at the free throw line. The players were of similar age, 18-23; however collegiate playing experience varied greatly among the participants of the study. This is why the study was conducted over 2 seasons because it is difficult to adjust sleeping habits midseason and ask players to dedicate more time to rest while balancing school and athletics. Testing can be a challenge, especially during the qualitative phase. The players were interviewed twice and the questions were similar. Players may have understood the main thrust of the study and given answers that the interviewer wanted to hear. An external threat to validity is interaction of setting and treatment. The study was only conducted on one team, giving a small size to analyze. It would have been more reliable if multiple teams could have participated in the study simultaneously.

Players did not receive uniform playing time or the opportunity to shoot free throws at an equal rate. Other variables associated with games are pressure intensive free throws (free throws in a game +/- 5 points with under 10 minutes left to play), distractions from crowd, dehydration and fatigue. These factors all influence free throw

shooting percentages, and information to combat these issues can only be presented to the athletes. Ultimately, the athletes control led their ability to use techniques to combat these variables. Obviously, there were deviations among the players that could not be addressed from an outside source. By studying practice free throws as well, this potentially nullified some of the deviations in attempts from player to player in a game. Every player shot 20 free throws at the end of practice and therefore they all had a uniform number of attempts that were analyzed as well. Another issue that challenged the validity of the study was the sample size and only studying one team. Style of play and coaching style can influence free throw shooting and therefore the results may not be directly applicable to all Division 1 male basketball players.

### **Instrumentation**

The players answered the interview questions without any influence from outside sources. The players identified themselves and identified their position on the basketball court. This reduced confusion regarding the independent variables of the study. For the dependent variables of the study, players associated a numerical value to variables such as sleep, hydration/fatigue and routine consistency. They associated a value to these variables on a scale of 1-5. This allowed for a greater understanding of how they perceived their consistency of addressing the dependent variables associated with free throw shooting.

Addressing the questionnaire and the qualitative portion of the study was slightly more difficult. In order to ensure reliability, the same person for every individual participant conducted the questionnaire/interview. This ensured that if any clarification is

needed from the participants, the interviewer could answer with consistency. Also the interviews were conducted before and after the study, which again is extra data that contributed to reliability of the study.

The validity of the questionnaire was based on addressing the hypothesis of the study as well as the various variables associated. Participants should have answered truthfully because it is an issue that directly effected their performance, and analytics is becoming increasingly prevalent in the game today. This is essentially known as face validity, referring to the transparency or relevance of a test, as it appears to test participants. The study will be measuring analytical analysis's influence on free throw shooting and the perception of analytics from a player's and coaches perspective. This mixed study directly measured both of those concerns. Interview questions were submitted to and approved by George Mason University's Institutional Review Board (IRB) in accordance with ethical considerations for conducting research.

### **Research Setting**

The research was conducted during practice and game times only specifically for George Mason's men's basketball team. It took place in a legitimate regulation basketball court. This excluded any free throw shots taken on a player's own time that did not occur in a game or practice setting. This also means players were in practice or game attire. A coach was present for all free throws, whether it is on the sideline, during a game, or practice. The full team was also present for all free throws. Free throw shooting is one of the most mental intensive skills in basketball and therefore simulating game-like atmosphere in practice is important to simulate game situations. Also if the

players were allowed to be in a gym by themselves, then the data collected could not be verified which would have reduced the reliability of the study.

The qualitative portion of the study consisted of one-on-one interview/survey questions that players answered in the locker room. The players were not able to hear or listen to each other's answers in order to make sure that each answer was independent and not influenced by another player. The same individual conducted the interview/survey every time in order to remain consistent, as some players may have responded to different interviewers differently. Controlling variables was difficult in a "real" setting such as this study. It also allowed for more applicable results as players and coaches were in their natural setting and therefore could maintain a sense of normalcy when participating in the study.

### **Procedures for Data Collection**

Using a mixed method study, the aim was to analyze practice free throw percentage and use analytical data with the players to see if changes in free percentage occurred. The first phase of the study was quantitative, collecting data on free throw percentage while isolating specific variables to analyze (e.g., hours of sleep, free throw frequency, timing in game). Following the quantitative data collection, interviews were conducted with individual players and coaches, asking questions regarding their perceived influence of analytics in their free throw shooting ability. This was the second phase and the qualitative portion of the study. The athletes and coaches were asked their perceived importance of analytical analysis regarding free throw shooting. Analytics has identified certain variables that most influence free throw shooting, such as routine



consistency, sleep, anxiety reduction, hydration/fatigue and pressure. All of these variables have been proven to affect free throw percentage and using analytics is a way to help control these variables and improve overall free throw percentage.

## **Data Analysis**

Free throw shooting scores were examined during the baseline (2015/2016 season) and the post analytical help (2016/2017 season). The first ten games acted as a baseline to get a complete picture of how individual players shoot free throws in both practice and games. Free throw percentages during the analytical phase of the study were then compared to examine the difference in free throw shooting performance.

By using both practice and game situations, it allowed for examination of the difference in free throw percentage in the two settings. Then with the introduction of analytical assistance to each individual's free throw routine, it was possible to examine the effects it had on practice, a game and overall. The simplicity of analyzing free throw data was convenient as it is solely based on makes and misses, meaning there was no subjectivity involved in the analysis.

The players participated in an interview before and after both stages of the free throw data collection occurred. Each individual was asked a variety of questions concerning their perception of the importance of analytics in basketball. A similar interview was conducted after the data collection. This allowed for examination of the difference in perception from pre-experiment to post-experiment. Did their perception match the results? Was there disconnect between the qualitative and quantitative data?

In order to properly determine the significance of the relationship of free throw shooting from a team and individual perspective, it is best to use a paired t-test. Using the same samples for this study allowed the researcher to properly use a paired t-test. This allowed for the determination of the means of these changes in free throw shooting and reported whether these differences in mean values was statistically significant.

## Results

The baseline for data collection was established during the 2015/2016 season. This reference point would be used to determine the improvement after players were given analytical suggestions to improve their free throw shooting without manipulating their shooting form. Out of the 8 players that participated in both seasons, 5 of the 8 improved in game shooting percentages, while two athletes made significant improvements. Let us analyze the results from a group perspective before narrowing our focus to individuals.

Table 2 – Free Throw Shooting Results

\*If removing players who did not attempt a game free throw in the 2015/16 season, the 2016/17 season would rise to **75.4%**.

\*Practice free throws are shot at the end of practice. If a student athlete has class after practice he may not shoot his free throws. This is the reason for the fluctuation in free throw attempts.

Names	Practice	Practice	Live Practice	Games	Games
	2015/16	2016/17	2016/17	2015/16	2016/17
Player #1	211/271 = 77.8%	414/536 = 77%	41/53 = 77%	95/140 = 67.9%	150/216 = 69.4%
Player #2	300/350 = 85.7%	432/493 = 88%	12/15 = 80%	81/112 =77.7%	109/120 = 90.8%
Player #3	250/312 =	414/513 =	25/39 =	30/56 =	39/47 =

	80.1%	81%	64%	53.6%	83%
Player #4	289/352 = 82.1%	378/484 = 78%	8/11 = 73%	26/37 = 70%	5/7 = 71.4%
Player #5	269/336 = 80%	505/651 = 78%	11/18 = 61%	13/20 = 65%	5/7 = 71.4%
Player #6	314/385 = 81.5%	476/601 = 79%	28/46 = 61%	54/78 = 69.2%	93/137 = 68%
Player #7	188/230 = 81.7%	403/515 = 78%	4/7 = 57%	N/A	6/9 = 66.7%
Player #8	N/A	403/503 = 80%	29/32 = 91%	N/A	54/73 = 74%
Player #9	N/A	397/504 = 79%	30/43 = 70%	N/A	46/64 = 71.9%
Player #10	N/A	313/427 = 73%	18/28 = 64%	N/A	6/15 = 40%
Player #11	N/A	361/450 = 80%	9/10 = 90%	N/A	14/17 = 82.4%
Player #12	273/321 = 85%	306/418 = 73%	6/15 = 40%	5/6 = 83.3%	3/5 = 60%
Player #13	319/350 = 91.1%	558/625 = 89%	38/42 = 90%	13/16 = 81.3%	6/8 = 75%
TEAM	83%	79.7%	72%	68.1%	74.5%

\*If removing players who did not attempt a game free throw in the 2015/16 season, the 2016/17 season would rise to **75.4%**.

\*Practice free throws are shot at the end of practice. If a student athlete has class after practice he may not shoot his free throws. This is the reason for the fluctuation in free throw attempts.

Prior to the first official practice, players were presented with information that could improve their free throw shooting regarding subjects such as sleep, routine (mental and physical) and anxiety reduction. Interestingly, the 2016/17 season concluded with a team free throw percentage of 75.4% (excluding freshmen), which is a 7.3% increase from the 68.1% shot in 2015/16. This increase in team free throw percentage ranked 5<sup>th</sup> in the Atlantic 10 Conference, compared to ranking 11<sup>th</sup> in the Atlantic 10 conference the previous season. Over the course of the season, 10 games were decided by 5 points or

less. Close games put an emphasis on free throw shooting, with George Mason finishing 7-3 in games decided by 5 points or less. During the 2015/16 season, George Mason participated in 7 games decided by 5 points or fewer and finished 4-3 in such games. Obviously, free throw shooting is not the only determinant when close basketball games are decided, but they are important; and an improvement in free throw shooting contributes to more success in close games.

Interestingly, practice free throw percentage declined from 2015/16 season to 2016/17 season. Players in 2015/16 shot 83% in practice during the 2015/16 season and only 79.7% in 2016/17. Free throws are shot competitively at the end of practice between two players in an effort to maintain focus and not simply go through the motions. Players shoot 20 free throws each and the best score records a win, with their record being kept throughout the season. However, maybe the most appropriate metric recorded during practice that translates to game free throw percentage is live practice free throw percentage. In 2016/17, George Mason shot 72% during live practice action which is 3.4% less than the 75.4% shot in games. Live practice free throws would simulate a game setting based on player's frequency of shooting free throws and energy exerted before approaching the free throw line.

Individually, players experienced some deviation between seasons with significant changes taking place. Two players made significant improvements in their individual free throw percentage. Player #2 shot 77.7% in 2015/16 and finished shooting the 2016/17 season shooting 90.8%, which is a 13.1% increase. Player #3 increased his free throw percentage by 29.4% which is a remarkable improvement. Interestingly, both

Players' #2 and #3 practice free throw percentage remained relatively similar; but in game free throw percentage drastically rose. Other players' free throw percentage fluctuated, but the amount of game free throw attempts was not sufficient in determining whether the changes were impacted directly.

By using a paired t-test, we were able to determine the statistical significance of individuals in game free throw shooting percentage from the 2015/16 season to the 2016/17 season. After completion of the paired t-test, the two-tailed P value was 0.6394 which means that the results are not considered to be statistically significant (to maintain a 95% confidence interval the P values must be 0.05 or less). This means, based on the confidence, we cannot conclude that the statistical variations in free throw shooting cannot be attributed to the use of analytical analysis and mental training. Interestingly, there was a strong statistical significance between practice and games during the 2015/16 season, practices during the 2015/16 and 2016/17 seasons and finally practices in 2016/17 and games in 2016/17.

Based on this information, using analytic analysis may positively influence free throw percentage slightly. The degree to which analytical analysis impacted this correlation is difficult to precisely determine because of other variables that contribute to free throw percentage. However, using a mixed method study allowed athletes to state their impact of how analytical analysis helped their performance. The interviews after the 2016/17 showed that the participants in the study found that there was a stronger correlation between analytical analysis and improved individual performance. This change in player perception of the importance of analytics shows that players believed

that analytics helped contribute to improvements in free throw percentage. When the coaches were interviewed they believed that analytics played a prominent role in helping with improvement and after the 2016/17 season the players opinions of analytics became closer to mirroring that of the coaching staff.

## **Conclusion**

Improving free throw shooting without adjusting shooting mechanics could help every basketball player. By using analytics and creating different habits to increase free throw shooting percentage, it can improve free throw shooting in a shorter period of time and possibly with less of a time commitment concerning practice. The results gathered during the study support the hypothesis as analytics did improve individual (in majority of cases) and team free throw percentage. Interestingly, the qualitative section of the study also originally supported the hypothesis. The coaches believed analytics was far more important and impactful in the context of player development, players did not see analytics as impactful. Players recognized there were benefits to analytics but did not necessarily believe analytics were as important as coaches. This gap is understandable as players are in control of their individual performance and make numerous different plays during the course of a game. Comprehending analytical correlations can be difficult to do without dedicating adequate time to reflect. The research indicated there was a positive correlation between analytics and game free throw percentage. This is the main finding of the research; and although the sample size was small, the game free throw percentage increased by over 7% which is beneficial to winning basketball games. However, it was interesting to find that practice free throw percentage actually declined while game free

throw percentage increased. This relationship was not anticipated because the common belief is that practice free throw percentage has a direct correlation to game free throw percentage. Coaches commonly tell players that in-game free throw percentage is often 10% less than practice free throw percentage. This is simply just a common phrase used by coaches without necessarily a significant amount of confidence in the claim. The research contradicts this popular claim used by coaches. Based on these results, rather than assume a decline in free throw percentage from practice to game attempts, instead coaches can try and better simulate game free throws in practice. This would imply that the closer the correlation between practice and game free throws, the more accurately practice free throws simulate game free throws.

The results suggest that by addressing variables that affect free throw shooting such as sleep, reducing anxiety, physical and mental routines these things can help improve in-game free throw percentage. Players that reported obtaining more sleep and consistently maintaining their physical and mental routines improved their free throw percentage in game situations. The results also show that the perceived correlation between practice free throw and game free percentage may be misleading. Individual athletes shot a better percentage in game as opposed to practice which did not support the hypothesis. This can be explained by possibly having a lack of focus and different exertions of energy as opposed to a game. The difficulty of simulating a game atmosphere can work in two ways; the majority of athletes will find it difficult to maintain a normal focus level because of distractions and pressure, while other athletes focus more because of the increased stakes associated with a game. When coaching, this

is why it is important to understand that not all athletes are the same and they are affected by the same variables differently. Based on previous studies, sleep seems to be the most influential variable needed by athletes as seen by this study as well as the study Stanford University completed with its student athletes.

The qualitative portion of the study allowed for a look inside the perception of analytics from coaches and players within the George Mason basketball team. Originally there was a considerable gap between the perception of analytics between coaches and players. Players believed that analytics were less important than coaches. This can be explained by players being in control of their results and therefore the numbers were simply just a reflection of their performance. By the players being in control of their performance, it allowed them to not need to acknowledge analytical analysis to the same degree as coaches. Coaches, on the other hand, lack control (especially during an in-game setting) and analytics allows coaches to support their thoughts and suggestions with numerical facts. The interviews that concluded the 2016/17 season showed that the gap had closed concerning the perception of analytics between players and coaches. The players reported perceiving analytics as more important than they previously had in the original interview. This means that players must experience how analytical analysis can affect their game and if there is a correlation they will become more aware and engaged in analytical analysis. Coaches often use analytics regarding individual player improvement, team efficiency and scouting reports. The more players believe in the necessity of analytics, the more receptive they will be to the information. This can only



help coaches relay their message to their players and allow for a more coachable environment.

Creating a uniform methodology for all coaches to use to help improve their players free throw shooting would be extremely beneficial. It would allow coaches that may not specialize in shooting form to be able to help players improve in a very important aspect of the game. Free throw shooting is perceived as an easy skill; but in recent years, free throw percentage at various levels has declined overall. In many cases, it is the variables associated with free throw shooting other than form that have impacted players ability to consistently make free throws. At the collegiate level, this could be the difference between a team making the NCAA tournament or watching the spectacle from home. Often, it is the simplest skills that can have the greatest influence on outcomes.

## Appendix A

### Interview Questions

- 1) How important are analytics in the game of basketball from your perspective?  
Not Important 1                      2                      3                      4                      5                      Very Important
- 2) Does analytical analysis impact your game?  
Not at all 1                      2                      3                      4                      5                      Yes, greatly
- 3) Are you open to using analytics more in your individual development?  
No 1                      2                      Neutral 3                      4                      5                      Yes in all aspects
- 4) Do you think improvement of free throw shooting can be done using analytics?  
Has no effect 1                      2                      3                      Neutral 4                      5                      Absolutely
- 5) How many hours do you sleep a night? (sleep in number of hours)  
Less than 4                      5                      6                      7                      8                      9 or more
- 6) Do you have a consistent physical routine at the free throw line?  
Different every time 1                      2                      3                      Sometimes 4                      5                      Always the same
- 7) Do you have a consistent mental routine at the free throw line?  
Different every time 1                      2                      3                      Sometimes 4                      5                      Always the same
- 8) How much does crowd noise/distraction affect your focus?  
Never 1                      2                      Sometimes 3                      4                      All the time 5
- 9) Does the situation of the game affect you at the free throw line?  
Never 1                      2                      Sometimes 3                      4                      All the time 5

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## **BIOGRAPHY**

Bryson Johnson graduated from St. David's Catholic High School, Waterloo, Ontario, Canada in 2009. He received his Bachelor of Science from Bucknell University in 2013. He worked as the Graduate Assistant of the men's basketball program for two years and received his Master of Science in Sport and Recreation studies from George Mason University in 2017.