Exploring Visually and Hearing Precluded Free Throw Trials Among Elite Basketball Players: A Practical Training Method?

by

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Abstract

The purpose of this study was to explore the impact of a visually and hearing precluded free throw training intervention on lower and higher skilled university level free throw shooters. The study examined athlete's shooting percentage, attentional focus, and imagery. Vision was precluded using occlusion goggles however restored while the ball was in midflight to provide knowledge of results (KR). Auditory factors were significantly reduced using hearing protection ear buds. The study revealed that the intervention group significantly improved compared to the control group at post-test, challenging the reliability of the specificity of practice hypothesis. Further, it was discovered that intervention funneled attention internally for some, but not all participants, as just under half of the intervention group used imagery when shooting without vision and hearing. Lastly, the imagery use and imagery vividness of the intervention group did not significantly increase at post-test when compared to the control group.

List of Abbreviations Used

SPH	Specificity of Practice Hypothesis
NBA	National Basketball Association
AUS	Atlantic University Sport
CIS	Canadian Interuniversity Sport
FIBA	International Basketball Federation
CS	Cognitive Specific Imagery
CG	Cognitive General Imagery
MS	Motivational Specific Imagery
MG-A	Motivational General Imagery
MG-M	Motivational General Mastery Imagery

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Chapter 1: Introduction

Purpose and Background

The game of basketball is primarily a dynamic sport consisting of externally-paced skills (Williams et al., 2010, p. 336). That is, during live play the athletes are continuously reacting to different variables and making rapid decisions. There is however an aspect of basketball classified as a self–paced skill (Williams et al., 2010, p. 336), as it occurs in a much more predicable environment and is initiated entirely by the athlete. A *free throw* is a shot awarded to any player who gets fouled during the shooting motion of a live play situation (FIBA basketball rules and regulations, 2012). Once the referee calls a shooting foul, the player who was fouled steps to the free throw line and shoots when ready. Further, the parameters of a free throw attempt do not change. The shot is taken exactly 5.8 meters from the baseline, directly in front of the basket (FIBA basketball rules and regulations, 2012). However despite the controlled nature of free throws, this aspect of the game remains a challenge for many players and teams. For example the average Atlantic University Sport (AUS) men's basketball team attempted 22 free throws per game in the 2012 - 2013 season. Out of those 22 free throw attempts, an average of 15.4 were successful. Additionally, in the 2012- 2013 men's AUS season, approximately 33% of games were decided by 5 points or less. When considering the average men's AUS team missed 6.6 free throws per game in the 2012/2013 season, and approximately 1/3 of those games were decided by 5 points or less (AUS Statistics, 2013), it is clear that free throws are an imperative element of basketball.

Another notable theme within elite basketball is the high frequency of short-range shooters attempting a large volume of free throws (i.e., mid range shots). In many cases the center position attracts an extremely large number of shooting fouls, despite requiring very little shooting during the game from outside of 3.7m (Miller & Bartlett, 1996). This element of the game is unique in that the tallest players often play in the center position, requiring them to spend considerable time in close proximity to the basket and therefore adopting shooting kinematics and release speeds intended for this range (Miller & Bartlett, 1996). Well-known National Basketball Association (NBA) star Dwight Howard provides a clear example of this phenomenon. As a center for the Houston Rockets, Howard attempted an average of 9 free throws per game in the 2013-2014 season and was successful 54.7% of the time. Not only was this percentage well below the team average of 71.2%, the number of free throws he attempted was by far the most on his team, accounting for 9 of the teams 31.1 average attempts per game (NBA Statistics, 2014). Additionally, Howard attempted 92% of his live play shots in the 2013-2014 season from distances less than 5.8m – the distance of a free throw, and 87.3% from distances less than 3.7m (Vorped Shot Chart, 2015). These statistics outline a paradoxical element within basketball in which players who rarely shoot the ball from outside of 3.7m from the basket (i.e., short range) are often required to take valuable free throw attempts from 5.8m from the basket (i.e., mid range). The importance of free throw shooting within the sport of basketball cannot be understated, nor can the reality that players in the center position who posses little experience from beyond short-range distances often shoot statistically critical free throws.

Outside of the center position, players can also play the positions of point guard or forward (also commonly referred to as shooting guard). Point guards attempt on average the most shots from far distances, while forwards attempt on average the most shots from medium or mid range distances. For instance a study by Miller and Bartlett (1994) revealed that 80% of the shots taken in 200 English National League games came from the following distances: centers, 0 - 3.7m from the basket; forwards/shooting guards, 3.0 - 6.4m from the basket; and point guards, 5.5 - 7.3m from the basket. Although not specified by Miller and Bartlett (1994), these distances are also likely relatively accurate indicators of short-range, mid-range, and long-range shots within the sport of basketball. Additionally, Miller and Bartlett's (1996) later study examining basketball kinematics in relation to playing position reported that point guards displayed more consistent changes in kinematic patters with changes in shooting distance when compared to centers. This finding suggests that it is easier for players to make adjustments based on shot distance when playing a position in which a large percentage of shots are taken from long range rather than short range. This relationship is obviously not advantageous for players in the center position who must adjust shooting kinematics acquired for 0 - 3.7m range shots, to shooting kinematics effective for a 5.8m shot when shooting free throws. For this reason, the current research project had the purpose of investigating a free throw training method that could improve the success rate of free throws, particularly among lower skilled free throw shooters, at even the highest levels of play.

Primary Research Areas

The first focal point within the current research project pertaining to the visually and hearing precluded nature of the proposed intervention was the specificity of practice hypothesis. This hypothesis suggests that in order to achieve optimal results, the environment in which athletes' train should resemble that in which they perform as closely as possible (Proteau & Carnahan, 2001). The specificity of practice hypothesis is closely linked to the current study because of the sensory differences between the intervention and post-test stages of the study, and has previously been explored in relation to visual sensory information by a number of researchers. For example in a study by Moradi, Movahedi, & Salehi (2014), the visual conditions in which free throw shooters trained was altered by limiting lighting to expose only the desired target (i.e., the basket). At post-test, participants returned to executing free throws under regular lighting conditions. The findings within the study by Moradi and colleagues provided evidence to support the specificity of practice hypothesis, as participants showed significantly poorer performance when transferred from the target only vision condition to the full vision condition. Other researchers (Bennett & Davids, 1997; Proteau, 2005) have investigated the specificity of practice hypothesis regarding other aiming tasks in a target only condition and found similar results, however gaps in the research remain. For instance little information exists regarding the transfer of information and skills acquired in a no vision condition to a full vision condition among elite performers. Tremblay and Proteau (1998) suggest that as a task is practiced, the source of afferent information best suited to ensure task accuracy rapidly advances while other less effective sources decline. Participants within the current study had less information available to them throughout the visually and hearing precluded intervention stage when compared to the pre-test and post-test stages of the study. The goal of this design was to help provide insight into whether the dominant information source utilized during the intervention phase transferred when vision and hearing were restored. Additionally, much of the previous research investigating the specificity of practice hypothesis and aiming tasks has examined participants who are in the early stages of learning (i.e., not experienced in the motor task being examined). The current study examined experienced varsity basketball players and was more interested in enhancing error detection and kinesthetic awareness rather than discovering who was better able to learn a new task in altered visual conditions. Although gaps exist in the specificity of practice research, it was difficult to hypothesize that the proposed intervention would benefit the participants based exclusively on it. Therefore, other research topics pertinent to the training method were also explored.

The second primary research topic addressed within the current study was attentional focus. High-level athletes such as those competing in both the AUS and NBA must be able to meet the attentional demands of varying sport specific situations (Williams et al., 2010, p. 338). When exploring how to effectively improve free throw performance it is vital to consider which psychological and attentional factors have an impact on the execution of the skill. Other researchers have investigated similar questions (Nideffer, 1976; Bernstein, 1996), and as a result the role of attentional focus during athletic performance was identified. Within the field of sport psychology the term attentional focus refers to selectively attending to internal and external performance cues, while ignoring irrelevant distractions (Williams et al., 2010, p. 336). Research on attentional focus has examined differences between an internal and external focus of attention in relation to both skill type and skill level. Perkins-Ceccato, Passmore, and Lee (2003) conducted a study in which external focus was described as the effect in the environment that is produced as the result of body movement (e.g. aiming for a target), while internal focus was described as directing attention to the production of body movement (e.g. form during skill execution). The findings within this study revealed that low-skilled inexperienced participants benefited significantly when using an internal focus of attention, while high-skilled experienced participants benefited significantly when using an external focus of attention during the execution of a self-paced skill (Perkins-Ceccato et al., 2003). This relationship between focus type and skill level is supported by the work of other researchers in this field, however inconsistencies do remain. For instance Toner and Moran (2014) contend that there may be circumstances in which an internal focus of attention could prove beneficial regardless of skill level, while Gray (2004) suggests that transitioning between attentional processes may also be beneficial depending on the situation. Lastly, attentional focus is also closely connected to the three primary phases of learning identified within motor learning research, defined as the cognitive phase, the associative phase, and the autonomous phase (Coker & Fischman, 2010, pp. 22). Research in this area suggests that internal and external focus strategies relate to the specific stage of learning an athlete is in. This is very relevant to the current study when considering the findings of Miller and Bartlett (1996) mentioned earlier in this chapter indicating that the acquisition of shooting mechanics can depend on playing position. Based on this evidence it was reasonable to hypothesize that participants who play the center position would be in an earlier phase of learning than participants who play the guard or shooting guard positions for shots outside of 3.7m. For this reason the current study explored attentional focus while also considering that differences may exist between the lower and higher skilled free throw shooters based on the phases of learning research.

When considering the visually precluded nature of the intervention, it was also considered that imagery would be utilized as a psychological strategy throughout the study. The use of imagery, defined as creating or re-creating images in the mind, is strongly supported as a performance enhancement technique within the sport psychology field (Vealey & Greenleaf, 2010, p. 267). The current study examined imagery with exploratory purposes to determine if the proposed training method promoted the use of imagery and if image vividness was enhanced as a result of the visually and hearing precluded intervention. This aspect of the research project was included to ensure that all primary psychological variables were explored.

In summary, the current study aimed to examine how a visually and hearing precluded free throw intervention would impact lower and higher skilled free throw shooters within an elite varsity population comprised of Canadian Interuniversity Sport (CIS) athletes. Secondly, the study examined if removing athlete's vision and hearing (i.e., external factors) during skill execution resulted in the use of an internal focus of attention. Lastly, the study aimed to discover if the proposed intervention promoted the use of imagery or enhanced image vividness among those athletes who used imagery as part of their free throw routine. It should also be noted that the athletes within the study were considered elite based on the high standing reputation of the CIS as an elite university league known for producing National level and Professional level basketball players. Additionally, the average number of years playing basketball among the participants in the study was 11.7 years, which can also be considered valid justification for classifying the participants as elite when compared to other research in this area. For instance Oudejans (2012) considered participants to be elite basketball players who had an average of 9.8 years of competitive playing experience and a mean age of 18.3 years, while Castaneda and Gray (2007) considered college participants to be highly skilled baseball players who had an average of 13.2 years of competitive playing experience and a mean age of 19.5 years. Although the current study did not specify years of experience as "competitive" within the demographic measure used at the beginning of the study, it was assumed that the majority of playing experience years among the participants were competitive based on their current standing with a CIS level team. It would be highly unlikely for a player to make a CIS roster without playing competitively for the majority of their time as a basketball player up to that point.

It should also be noted that the nature of the current study prompts discussion on research pertaining to both vision when aiming at a target, and various motor learning topics. A great deal of research has been done examining comparable tasks to the one examined in the current study (i.e., aiming and shooting) within the visual and motor learning fields, however little research has examined the mindful or explicit mental techniques that may be contributing to performing these various tasks. Therefore, the current study was devoted to examining not only the practicality of the proposed training method, but also to exploring the self-reported mental techniques utilized by athletes while executing tasks in varying environments and conditions.

Chapter 2: Review of Literature

Specificity of Practice

The title of the current research project revealed that not only was the study exploratory in nature, but also that it intended to provide insight into a practical training method for elite basketball players. As in most other areas of sport, the effectiveness of a training method can often best be measured by the impact it has on performance in standard performance conditions. For example hockey players should only practice shooting with weighted pucks (i.e., pucks that are heavier than standard pucks) if this training method increases the power and accuracy of their shot under normal circumstances. Furthermore, soccer players should only practice dribbling with a smaller ball (i.e., a tennis ball) if it enhances their dribbling abilities with a standard size soccer ball. Otherwise, these training methods may prove to impact performance in purely unpractical ways. The current study explored a visually and hearing precluded free throw training method with the goal of validating its practicality for elite basketball players performing in the natural sport setting. The examples provided above, as well as the training method within the current study, are closely linked to what is referred to by many researchers as the specificity of practice hypothesis (SPH). The SPH suggests that in order to achieve optimal results, the environment in which athletes train should resemble that in which they perform as closely as possible (Proteau & Carnahan, 2001). The current study most closely linked to specificity of practice research examining the visual information available in a training environment. Proteau (1992) suggests that the removal and addition of vision within the practice environment has detrimental effects on aiming performance. Tremblay and Proteau (1998) also contend that the addition of visual factors (i.e., changing from less to more vision) deteriorates performance because these additions dominate previous sources of information used to complete a task, resulting in inadequate information available for movement planning. Additionally, Bennett and Davids (1997) propose that to maximize performance athletes should increase their dependence on the specific information that will be available to them in the natural sport setting (i.e., game like scenarios). It should be considered however that all of the researchers mentioned thus far have made these conclusions by altering (i.e., reducing or increasing) the visual information available during acquisition, rather than actually removing it completely in the acquisition phase. Bennett and Davids (1997) offer one viewpoint to interpret what previous research has concluded when vision is reduced, which is that when participants are transferred from a target only vision condition (i.e., less vision) to a full vision condition, they neglect previously used information in favor of the newly added visual factors (i.e., visual dominance). This however outlines an essential gap in much of the previous research examining vision and the SPH in that participants have predominantly been exposed to performing with varying amounts of vision available, yet rarely examined transferring information acquired in a no vision condition to a full vision condition. Therefore, it is possible that the information accessed to complete tasks in a target only condition is still dominated by visual factors (i.e., the target), potentially limiting one's ability to utilize kinesthetic information (i.e., body movements). The current study suggested that such kinesthetic information would be beneficial for error detection and correction. It is also noteworthy to mention that Bennett and David's (1997) study actually did not support the SPH (i.e., participants who practiced in the target only condition were not significantly outperformed by those who practiced in the full vision condition at transfer test) when examining a manual aiming task. As outlined in their discussion, one of the possible reasons for this finding was that participants could have been able to exploit the addition of new information in the full vision condition in order to build upon, and ultimately improve performance. The implication that participants were able to combine various sources of information to successfully build an effective movement plan outlines the essence of one of the main research question within the current study: Could information gathered in a no vision condition be advantageous to performance at post-test, when vision was fully restored?

Although most researchers agree that the SPH is prevalent when examining the visual conditions of training or acquisition, other gaps in the literature also remain. How well learned participants are (i.e., skill level) prior to completing a task in a visually controlled environment remains as an unpredictable variable. For instance in the study by Bennett and Davids (1997) examining the accuracy of a manual aiming task in a full vision or target only vision condition, results generally did not support the SPH. The participants however were completely inexperienced in the manual-aiming task they were asked to perform in the study. Studies by Proteau (2005), Proteau and Carnahan (2001), and Tremblay and Proteau (2001) supporting the SPH also exclusively examined participants who were inexperienced in the task they were asked to perform. The current study examined the SPH among performers with extensive experience in the task, and therefore a skill that was not being learned for the first time throughout the study. As a result, it was reasonable to speculate within the current study if participants would make kinesthetic adjustments and/or corrections to an already existing movement plan in the no vision condition, and successfully transfer those adjustments to the full vision condition.

There is little evidence suggesting this process would occur exactly as described above, however based on the lack of applied research in this area it was deemed beneficial to find out.

Further, researchers examining the catching performance of inexperienced participants (Whiting & Savelsbergh, 1992; Whiting, Savelsbergh, & Pijpers, 1995) have reported somewhat conflicting SPH results. Participants in these studies showed increased performance scores when transferred from a ball-only visual catching condition to performing in a full vision condition. These results conflict with the work of other researchers (Mackrous & Proteau, 2007) who have successfully documented the SPH in manual aiming tasks. For example Mackrous and Proteau (2007) had participants move a device similar to a computer mouse toward a number of targets on a screen in both a full vision and target only vision condition. Their results indicated that participants had significantly greater error when transferred from one condition to the other, signifying the superiority of visual feedback over other sources of information. Based on their findings, Mackrous and Proteau (2007) suggest that the availability of visual information during performance may actually play a role in preventing the processing of kinesthetic information. This had important links to the current study which had the goal of enhancing the kinesthetic information processed throughout the visually and hearing precluded intervention trials. Consistent with the recent suggestion by Mackrous and Proteau (2007), the current study removed vision completely in effort to maximize kinesthetic awareness (i.e., internal focus of attention).

In another study by Proteau (2005) examining the SPH and vision, the researchers explored the effects of switching the visual conditions every few trials from full vision to target only vision. The results of this study indicated that alternating between visual conditions resulted in participants attempting to rely on the information gathered from the full vision condition to plan their movements in the target only condition. Additionally, Bennett and Davids (1997) reported a similar finding indicating that participants who had extensive training in the full vision condition were able to significantly increase their performance in the target only condition. The study stated, “subjects were able to transfer some aspect of the successful strategy learned during normal light acquisition to enable more accurate performance in the target only condition” (p. 388). Although this relationship was not reported when transferring information in the opposite direction (i.e., from less vision to more vision), it was encouraging in that it indicated participants were able to transfer information from one condition to another. The current study however required information transfer in the opposite direction (i.e., from no vision to full vision) for participants to benefit at post-test. The findings by Proteau (2005) and Bennett and Davids (1997) provide evidence signifying the benefit of having the same amount of visual factors available during acquisition and transfer (i.e., the SPH for target only conditions), however do not provide insight or confirmation regarding the transfer of information from a no vision condition to a full vision condition, particularly among elite performers. The current study will further explore if elite performers can transfer movement information acquired in a no vision condition to a full vision condition.

As discussed earlier in this chapter, Moradi et al. (2014) also examined the SPH in relation to the basketball free throw. The researchers controlled the visual conditions in which free throw shooters trained by limiting the lighting to expose only the desired target (i.e., the basket). At post-test, participants returned to executing free throws under regular lighting conditions. The findings from this study provided evidence to support the SPH, as participants showed significantly poorer performance when transferred from the target only vision condition to the full vision condition. However, once again participants in this study were all inexperienced in the task prior to participating in the study. In addition to exploring the SPH and how it is impacted by skill level, the current study removed vision completely rather than reduce it to target only as seen in much of the previous research.

Oudejans, Koedijker, Bleijendaal, and Bakker (2005) examined the effectiveness of elite basketball players performing jump shots from behind a screen which served the purpose of preventing the athletes from seeing the basket until they were airborne (i.e., vision was only available in the final instances prior to shooting). Although specificity of practice was not the primary focus of the study, it did examine performance scores at post-test in a normal vision condition after participants completed a visually manipulated intervention – a design consistent with the current research project and relevant to the SPH. Oudejans et al. (2005) reported that after weeks of training with the screen intervention method, participants shooting performance improved significantly at post-test, citing a minimum improvement of 10%. In a follow up study by Oudejans in 2012, participants completed a similar task however this time wearing goggles that served the same function as the occlusion goggles used in the current study. Similar to the current research project, the goggles (Plato© liquid crystal goggles) had the ability to be closed and opened within milliseconds. The purpose of the goggles used by Oudejans (2012) was to remove participant's vision during the brief dribbling phase prior to shooting, and quickly restore vision just prior to releasing the ball. The design and purpose of the study were almost identical to the earlier study by Oudejans et al. (2005), with the slight adjustment of goggles being used to alter vision instead of a screen. The chief interest of the study was once again to examine the post-test performance scores of elite participants after they completed a visually controlled intervention. Analogous to earlier findings by Oudejans et al. (2005), the shooting performance of the participants in the second study significantly improved at post-test, in this case by an average of 8%.

The findings by Oudejans et al. (2005) and Oudejans (2012) provide evidence to not only support the use of visual control training in basketball shooting, but also indicating that SPH is not perpetually accurate, at least in the field of visual control. It should be noted however, that there are at least two significant discrepancies between the work of Oudejans et al. (2005), Oudejans (2012), and the current research project. The studies by Oudejans et al. (2005) and Oudejans (2012) examined the benefits of training athletes using purely late vision when shooting basketball jump shots, rather than no vision and KR (i.e., the design of the current research project). The purpose of the late vision training methods used by Oudejans et al. (2005) and Oudejans (2012) were to explore training techniques that could enhance one's ability to use last second information regarding the location and distance of the basket when shooting. This differs from the current research project in that it explored a training technique designed to enhance one's kinesthetic awareness while shooting based largely on the available KR. Secondly, the studies by Oudejans et al. (2005) and Oudejans (2012) examined players shooting from a variety of locations on the court rather than a fixed location such as the free throw line. Including various locations was a necessity in the late vision training experiments as the distance of the basket was an important measure when determining the effectiveness of enhancing one's late vision. In contrast, the current research project examined one specific shot that is always taken from 5.8m, and therefore explored the possibility of shooters "locking in" the movement pattern to successfully make the shot without vision.

Focus of Attention

Where an athlete directs their attention during skill execution has been shown to impact the outcome of performance in a variety of sport specific situations (Wulf, Hob, & Prinz, 1998; Gray, 2004). Furthermore, factors such as skill level, skill type, focus preference, and performance environment have been shown to interact with the effects of different focus of attention strategies (Perkins-Ceccato et al., 2003; Gray, 2004; Weiss, 2008; Toner & Moran, 2014). When considering that the nature of the intervention within the current research project had the aim of impacting focus of attention, previous literature in these areas, and attentional focus in general, has been reviewed.

As briefly mentioned in Chapter 1, a study done by Perkins-Ceccato and colleagues (2003) examined attentional focus among highly skilled and low skilled golfers as defined by handicap. The highly skilled golfers had handicaps between 0 and 8 (mean = 4), while the low skilled group had handicaps between 20 and 36 (mean = 26). The study examined the internal and external directional components of attentional focus as identified by Nideffer (1976). External focus of attention was described as the effect in the environment that is produced as the result of body movements, while internal focus was described as directing attention to the production of body movement. The classifications of internal and external focus of attention described by Perkins-Ceccato et al. (2003) are consistent with those used by Nideffer (1976), Williams et al. (2010, p.

339) and many other researchers, and therefore served as the classifications within the current research project as well.

Perkins-Ceccato et al. (2003) examined external focus by asking participants to aim at an external target on the green, while internal focus was examined by asking participants to focus on the form of the golf swing during execution (i.e., wrist movement). The researchers instructed both the highly skilled and low skilled golfers to complete 40 chip shots from varying distances while using each focus type (internal and external) from each distance. The findings within the study by Perkins-Ceccato et al. (2003) revealed that the success of each focus type depended on the skill of each individual athlete. The low skilled golfers showed greater accuracy when using internal focus techniques, while the highly skilled golfers showed greater accuracy when using external focus techniques. The study by Perkins-Ceccato and colleagues (2003) exhibits an important parallel with the current research project, as well as some significant differences. The parallel is that the researchers examined the direction of attentional focus during the action of a self-paced motor skill. The first significant difference is that the golfers performed shots from varying distances (i.e., shot a chip shot from one distance and then immediately moved to a different location for the next shot), while the free throw shot in always taken from the same distance. The permanently closed nature of the free throw skill may require different attentional processes when compared to a skill with ever-changing distance requirements. A second difference is that the golfers were placed in skill level groups based on overall golf handicap rather than a measure of their ability in the actual skill being examined. The current study identified lower skilled and higher skilled free throw shooters based specifically on free throw scores, not overall basketball ability. Each of these sports (i.e., golf and basketball) demand a number of different skills in different situations and therefore overall performance ability may not accurately represent one's abilities in a single element of the game. This gap in the literature will be discussed in greater detail later in this section. Further, the golfers within the study by Perkins-Ceccato et al. (2003) were instructed to guide their attention either externally or internally (i.e., on the green or on wrist movement) before executing the task from each distance. The current study instructed participants to execute the task and then collected information regarding their focus of attention in a reflective manner. Lastly, the design of the study by Perkins-Ceccato and colleagues (2003) was essentially opposite to the design used within the current study when considering the role of vision and knowledge of results (KR). Perkins-Ceccato and colleagues (2003) had participants execute the chip shots with vision, however removed vision instantly after each shot was complete using occlusion goggles to prevent participants from receiving KR. The authors suggested that the strength of the manipulations would be greater if information regarding the outcome of each shot was not available stating, "post-action feedback is generally considered to be a leading contributor to trial-to-trial changes in motor behavior". The current study was interested in what changes participants would make while executing without vision based on the KR they received after each trial, and therefore used post-action feedback as a primary mechanism for guiding focus of attention in future attempts. The key difference being highlighted here is that the study by Perkins-Ceccato and colleagues (2003) made pre-performance manipulations, which may have been compromised by KR, while the current study measured focus of attention reflectively.

Gray (2004) examined the directional components of attentional focus using a baseball-batting simulator and reported similar findings regarding skill level and focus of attetnion. Expert batters experienced decreased performance when using skill focused attention (i.e., attention paid to body movements), while novice batters showed decreased performance when using environmentally focused attention (i.e., any environmental foci not directly related to skill execution). Castaneda and Gray (2007) duplicated these findings concluding that expert batters should attend to external environmental cues rather than internal skill based cues, while novice batters would benefit more from a skilled-focused attention. Qualitative evidence promoting a similar mind-set has recently surfaced in the literature as well. Paul McGinley was quoted as saying, "at no time did I even consider the mechanics of the stroke" when asked about his Ryder Cup winning putt in 2002 at The Belfry (Kremer and Moran, 2013, p. 72). Perkins-Ceccato et al. (2003), Gray (2004), Castaneda and Gray (2007), and Paul McGinley's quote all provide reasonably consistent views of internal and external focus of attention in relation to sport performance among varying skill levels, however conflicting findings on this topic have also been reported.

Hansel and Seelig (2003) examined novice level golfers performing in both internal and external focus conditions and found no significant performance differences between the groups. The findings of Hansel and Seelig (2003) are not consistent with the previously discussed research in that the novice golfers revealed no performance advantages to using an internal focus of attention. Furthermore, in an earlier study examining the direction of attentional focus by Wulf et al. (1998), inexperienced participants performed slalom-type movements on a ski-simulator. Two significant findings were noted from this study. First, the study revealed that the external focus group displayed greater improvement across the two day trial period when compared to the internal focus group. This relationship is once again not entirely consistent with the findings of Perkins-Ceccato et al. (2003), Gray (2004), and Castaneda and Gray (2007) who found that low skilled, inexperienced athletes showed greater benefits when using an internal focus of attention. It is possible that this inconsistency is the result of the studies examining different skill types, which highlights a gap in the literature and further promotes the need for additional research in this area. Secondly, the findings of the study by Wulf et al. (1998) determined that the participants who received no instruction at all (control group) also outperformed the internal focus group. This finding suggests that an internal focus of attention may actually hinder performance even for completely inexperienced performers. Wulf and her colleagues however, have also reported external focus of attention advantages in sports such as tennis (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000) and golf (Wulf, Lauterbach, & Toole, 1999; Wulf & Su, 2007) among novice performers, igniting further debate concerning skill level and skill type. A study by Zachry, Wulf, Mercer, and Bezodis (2005) further validates the use of an external focus of attention in sport performance, however in many ways also conflicts with previously discussed findings. The study found increased performance scores among those using an external focus of attention when examining the basketball free throw, however participants in this study reportedly had “at least 1 year of basketball experience at the physical education class and/or high school level” (p. 305). Due to the unclear nature of the participants involved in this study it would be difficult to apply these findings in a practical fashion or relate them to a certain cohort of athletes. The current study aimed to close this gap in the literature by advancing knowledge on focus of attention among higher and lower skilled shooters within an elite population.

The findings of several recent researchers (Perkins-Ceccato et al., 2003; Gray, 2004; Wulf et al., 1998, 2000; Zachry et al., 2005) in many ways reinforce earlier theories by Bernstein (1996), who suggested that expert athletes with developed skills should use an external focus of attention because their movement patterns have been sufficiently automatized. Bernstein (1996) presents the rationale that otherwise expert athletes would be implementing a mode of control more practical for less skilled athletes and used more effectively for skill development and construction. Bernstein (1996) describes a practical scenario in which an experienced bicycle rider focuses on the road in front of the bicycle rather than being fixed on the movement of his or her arms and legs. In a sport related context Bernstein (1996) suggests that the attention of an experienced tennis player should be directed at the ball, the top edge of the net, or the movements of the opponent rather than at his or her own legs, arms, or racket. In summary, Bernstein (1996) provides a rationale congruent with many other researchers when suggesting that skill execution for highly skilled athletes is better achieved using an external focus of attention. This logic is also supported by Horn (2002, p. 441- 444) who suggests that most skills when first learned require a great deal of attentional focus, however once the skill is well learned it can be done unconsciously, no longer requiring direct attentional focus. Horn (2002, p. 441-444) suggests that using an internal focus of attention can disrupt the motor behavior of certain actions, resulting in inefficient movement patterns. This also supports the work of earlier researchers (Fitts & Posner, 1967; Anderson, 1982) who suggested that skill execution for non-expert performers requires direct attention to actions (i.e., control processing), while expert performers require very little working memory to optimally perform (i.e., automatic processing). Similarly, Weiss and Reber (2012) advise performers to direct their attention toward external sources and away from their bodies. When relating these theories to the work of Wulf and colleagues (1998) regarding inexperienced participants on a ski simulator, it may be possible that the task was rudimentary enough for an internal focus of attention to interrupt automatic movement patterns even among participants who had never previously performed the task. This inconsistency regarding the classification of skill level and skill development in connection to attentional focus provided additional motivation for the current research project.

The distinction of skill level referenced in much of the literature reviewed thus far presents another gap addressed within the current study. Previous research in the area of attentional focus has examined differences between novice and expert performers, in many cases citing years of experience or level of play (e.g., less than 3 years or national team member) as the key distinctions between the two classifications. For example Makaruk and Porter (2013) reported increased distance scores when examining shot put throws among national level throwers who were instructed to use an external focus of attention. In this particular sport classifying participants as experts based on their current standing with a national program likely ensures they are in fact experts, as the sport requires only one primary task or position. This however may not be an accurate distinction when examining many positional or team sports. For example in the study by Castaneda and Gray (2007) examining attentional focus among baseball batters, years of playing experience were used as the distinction between novice and expert participants.

When considering that baseball is a game with many positions and roles within a team, this may be an accurate measure of general skill level but not an accurate measure of batting skill level specifically. This gap was also identified earlier in this chapter when discussing the study done by Perkins-Ceccato et al. (2003), who classified expert and novice golf chippers by using overall golf handicap. The current study included exclusively experienced university athletes whom all were considered experts, but more specifically it examined expert athletes performing a unique self-paced skill within a dynamic positional sport. Although all players at the university level would commonly be considered expert basketball players, it has been suggested within the current study that this distinction alone does not fully clarify that they are highly skilled or expert free throw shooters. This suggestion is largely based on the fact that each position in the game of basketball requires a much different skill set. As mentioned within the introduction of the study, shots taken in 200 English National League games came from the following distances: centers, 0-3.7m from the basket; forwards/shooting guards, 3.0-6.4m from the basket; and point guards, 5.5-7.3m from the basket (Miller & Bartlett, 1996). For this reason, the current study referred to participants as expert basketball players who are either *higher* skilled or *lower* skilled free throw shooters. It should not be assumed that expert basketball players (i.e., NBA star center Dwight Howard) should also be considered expert shooters, as he attempted 87.3% of his shots in the 2013-2014 season from less than 3.7m from the basket.

Furthermore when assessing effective focus types in connection to skill level, Gray (2004) proposes that even expert athletes may benefit from learning how to move quickly from one processing stage to another, depending on the required action and/or circumstances. This could have substantial implications in the sport of basketball when considering the differences between dynamic live play situations and the self-paced free throw skill. Similarly, Toner and Moran (2014) argue that performance can be improved at the expert level through the use of *somaesthetic awareness*, which they describe as "the role of consciousness in body awareness and skill learning" (p. 2). Within their position statement, Toner and Moran (2014) do not contend the notion of using an external focus of attention as an expert athlete, but rather offer an additional viewpoint suggesting that some degree of bodily awareness may be required in order for expert athletes to continually improve. They suggest that attention to body movements (i.e., an internal focus of attention) may be detrimental in some performance circumstances, however may actually assist performance in others, such as a training scenario where one must increase their awareness of the necessary movement changes required to enhance proficiency. Shusterman (2008) outlines three circumstances in which somatic attention could aid in skill development, which are when athletes need to correct, adjust, or relearn particular habits. Toner and Moran (2014) have also recently written a perspective paper further praising conscious or somaesthetic awareness as a performance enhancing focus technique, drawing on research based evidence indicating that even expert performers are required to reflect on, or experiment with how their body moves during performances and throughout training. Such evidence comes from Nyberg (in press) and Bernier (2011) who, using stimulated recall research approaches (i.e., reflective interviews based on video or audio recording of performance), found expert freestyle skiers and expert golfers shifted between focus types (i.e., between internal and external) to ensure proper rotation in the air or to effectively transition from the pre-shot to shot phase, for example. Toner and Moran (2014) also make reference to Michael Phelps changing his swimming stroke in 2009 after winning eight Olympic gold medals in 2008. Phelps stated, “It’s a significant change. You’ll be able to tell exactly what I did after the first stroke” in an interview with The Telegraph (Andersson, 2009). He went on to win 6 more medals at the 2012 London Olympics, four of which were gold. An additional and more recent example can be drawn from Tiger Woods, who changed his golf swing in 2014 after winning countless tournaments and major championships in years prior stating, “I wouldn’t have made the changes if I wasn’t devoted to the game of golf and winning tournaments”, and “sometimes you have to make a shift, and I did” (Murray, 2015). The success of Tiger’s swing adjustments is clearly still to be determined.

There is also evidence of expert athletes using body movement related cue words to enhance performance within the competition context. For example 70% of 113 professional golfers examined in a study by Jenkins (2007) used at least one “swing thought” when hitting their shots throughout the study. Furthermore, Mullen and Hardy (2010) found that female university basketball players were able to enhance free throw shooting percentage in high anxiety circumstances by focusing on a holistic or global process goal while shooting the ball. These athletes were encouraged to use a thought that embodied the shot as a whole, for example “smooth”, “extend”, or “soft” while releasing the ball.

The above examples provide clear evidence of conscious body awareness (i.e., internal focus of attention) at the expert and professional levels of play both in training and competition. The current study aimed to shed light on this concept, as it hypothesized that the participants would revert to an internal focus of attention throughout the visually and hearing precluded intervention stage of the study, and possibly improve performance at post-test as a result. Toner and Moran (2014) also indicate that there has been very little research done examining the use of different focus types over an extended time period. Most research on this topic has explored the effects of using an internal or external focus of attention to perform a motor task, but has not yet explored the effect of using an internal focus of attention to adjust or correct a movement pattern over an extended time period (i.e., the off season). The current study aimed to offer insight into the effect of adjusting focus of attention over a three week time period, which is likely long enough for some degree of learning and adjusting to occur. Based on the lack of research in this area, it was possible to theorize that removing vision and hearing throughout the free throw action would enhance the athlete's awareness in other areas (i.e., body movements), allowing for adjustments to made that previously went undetected.

Another research gap regarding attentional focus and sport performance is the methods in which previous researchers have examined different focus types. Previous studies have instructed participants to focus on a particular internal or external focus cue providing little evidence indicating that this is truly what the participants were focused on while performing (i.e., no manipulation check). This is a significant limitation within this field of research because it is possible that participants have been using multiple focus types, (i.e., possibly the wrong one for the purpose of the research), while preforming tasks in previous studies. Perkins-Ceccato et al. (2003) attempted to control for this in their study examining golf chip shots by removing KR (i.e., they removed the outcome of the shot as an information source for making future adjustments), however this method does not completely remove the possibility of participants using another undesired focus strategy while performing (i.e., imagery). Gray (2004) is one of very few researchers who has recognized this limitation and has helped further develop what is referred to as a dual task methodology. Beilock, Wierenga, and Carr (2002) provide a great example of a study that used dual task methodology as a means of more accurately examining attentional focus. In their study novice and expert golfers were asked to perform simple golf shots while also monitoring basic auditory signals. The study revealed that while simultaneously performing both tasks, the mean error of the novice golfers was significantly worse than that of the expert golfers. This finding suggests that expert golfers have the attentional capacity to monitor the auditory signals without negatively impacting performance, whereas novice golfers do not. This finding also generally validates theories suggesting less skilled performers require skill-focused or internally focused attention to maximize performance in that they were unable to maximize performance when attention was directed away from the task. The current study has recognized the same limitation, however has taken a different approach to address it. Participants in the current study had vision and hearing removed while executing the free throw skill in an attempt to alter their focus of attention, possibly funneling it toward internal factors. Participants were not given verbal instruction directing their focus, but rather asked to perform in circumstances with the potential to alter their attentional focus naturally. Once participants completed their trials, they were asked to reflect on their focus of attention throughout each stage the study. To my knowledge, this is the only study that has used this method to examine the internal and external directional components of attentional focus during the execution of a self-paced skill.

Recent research has also recognized focus of attention preference as a variable capable of impacting performance. Weiss, Reber, and Owen (2008) suggest performance may suffer when participants are asked to use a different attentional focus style than the one they prefer to operate while performing. Weiss et al. (2008) found that performance generally suffered when participants were asked to throw darts using a focus type they did not report as their preference prior to executing the task in the study. This relationship was especially evident among participants who preferred an external focus of attention and were instructed to switch to an internal one, which may further support theories suggesting an internal focus of attention is undesirable for athletes who are able to use automaticity. Schorer et al. (2012) reported that participants in their dart throwing study perceived focus of attention instructions as interference with their normal focus routine. Further, the study found that performance declined during the focus instruction conditions when compared to the pre-test, no focus condition throwing scores. Interestingly, Weiss et al. (2008) also reported that participants showed very little hesitation when declaring their preferred focus type, possibly suggesting some trial and error with the focus types prior to entering the study. Additionally Weiss et al. (2008) stated that 54 of the 100 participants who took part in their study examining dart throwing preferred an external focus of attention, while 46 preferred internal. In another experiment by Weiss et al. (2008) examining the basketball free throw a similar ratio was reported, with 59 participants preferring an external focus of attention and 41 preferring internal. Both studies however examined primarily novice performers, a notable difference when compared to the current study. It should also be noted that Weiss et al. (2008) could not sufficiently examine the effect of preference in their study examining the basketball the free throw due to unclear effects of self-efficacy throughout the study. Interestingly in this experiment, Weiss et al. (2008) told participants who were instructed to continue using their preferred focus type throughout the study that it was proven to be the most effective way to focus. Conversely, participants who were instructed to switch focus types were told that the focus strategy they were switching to was proven to be the most effective way to focus. Ultimately, Weiss et al. (2008) decided that by telling some participants they had preferred a focus strategy that was ineffective they may have also lowered their confidence prior to shooting. This raises additional questions about the methodology used within previous studies in this area, and furthermore about the interaction between focus strategies and athlete perception.

A final research area worthy of review and discussion within the field of attentional focus relates to the phases of motor skill learning. As athletes learn and develop new skills they progress through three primary phase of motor learning which have been defined as the cognitive phase, the associative phase, and the autonomous phase (Coker & Fischman, 2010, pp. 22). Each of these phases of motor learning has been reported to correspond with a specific attentional style, therefore having direct implications within the current research project. The cognitive phase is the introductory phase of learning that occurs when an athlete is attempting a completely new skill or task. Within this phase athletes guide most of their attention toward the conscious movements of their body and the actions they are trying to accomplish (i.e., rely heavily on an internal focus of attention) (Coker & Fischman, 2010, pp. 22). As a skill or task becomes more familiar, comfortable, and consistent, athletes gradually shift out of the cognitive phase and into the associative phase. This phase is largely focused on skill refinement rather than skill development, and as athletes transition from one learning phase to the other, so does their focus of attention. Within the associative phase of learning attentional focus is guided more toward external factors such as the desired outcome of the movement, environmental cues, and strategy. This is largely because proprioceptive information also becomes more applicable within this phase as athletes begin to better use information concerning feel to plan their movements, and rely less on vision (Coker & Fischman, 2010, pp. 23-24). Lastly, once athletes are able to consistently and accurately execute a skill without paying conscious attention to it, they enter the autonomous phase. Within this phase attention is guided completely toward external factors and environmental cues while skill execution is retained at an elite level (Coker & Fischman, 2010, pp. 25). Although there is no way to establish exactly what phase an athlete is in, it is important to recognize that these phases represent benchmarks on a relatively subjective continuum of learning. Therefore, there is no clear moment in time or definite indicator signifying when an athlete is transitioning from one phase to the other. As a result, the current study had no way of accurately determining which phase of learning the participants were in, however based on previous knowledge in this area it was anticipated that the lower skilled shooters would be in an earlier phase of learning than the higher skilled shooters. Aside from the statistical evidence provided within the study supporting this (i.e., shooting percentage differences at pre-test), additional evidence by Miller and Bartlett (1996) regarding shooting kinematics was also provided in Chapter 1. Additionally, Coker and Fischman (2010) suggest “coaches should also be aware that an athlete can be in one stage for a given skill and in a different stage for another skill. For example, a soccer player may be in the autonomous stage for dribbling but in the cognitive stage for heading the ball…" (pp. 22). This quote supports a crucial perspective embraced within the current study suggesting it is highly possible for elite level and even professional basketball players to be in the autonomous phase for some skills, however in an earlier phase for others (e.g., Dwight Howard). Based on the framework of the phases of motor learning and their connection to attentional focus, it was reasonable to hypothesize that those who were lower-skilled shooters at pre-test would benefit more from a visually and hearing precluded intervention because it would increase their internal awareness, resulting in more effective skill refinement. This intervention however would likely benefit the higher skilled shooters less because they were closer to, or further in, the autonomous phase. Therefore, these athletes would suffer when using conscious awareness, as they have less to refine in their movement plan.

To conclude, a long history of research indicates that attention can be directed toward ether internal (i.e., body movements) or external (i.e., target point outside of the body) factors when performing motor tasks. Additionally, many researchers agree that most performers employ an internal focus of attention early in skill acquisition, only shifting to an external focus of attention when their skills no longer require direct and conscious control (Perkins-Ceccato et al., 2003; Gray, 2004; Wulf et al., 1998, 2000; Zachry et al., 2005; Bernstein, 1996). The use of an external focus of attention at the expert level has also been disputed in the literature (Hansel and Seelig, 2003; Wulf et al., 1998; Toner and Moran, 2014), however largely because of the reported interactions between focus type, motor task, focus preference, and performance environment. When considering the recent perspectives of Toner and Moran (2014) on the use of conscious awareness among experts (e.g., Michael Phelps), as well as the established research indicating the use of an internal focus of attention during skill acquisition, the current study felt it was reasonable to hypothesize that attention would be directed internally when external factors were significantly reduced. Further, the current study believed this would allow for fine detail movement refinements to be made by the participants, resulting in increased performance at post-test. Based on the literature reviewed thus far, it also seemed reasonable to suggest that this design would benefit lower skilled shooters more than higher skilled shooters because they are likely in an earlier stage of learning. As mentioned in Chapter 1, some of the lower skilled shooters within the study play positions that require almost no repetitions from outside 3.7m, whereas many other participants are likely very comfortable shooting from beyond that range (Miller & Bartlett, 1994). Based on this information, the current study felt it essential to examine the attentional focus strategies and preferences of the varying athletes and skill levels involved.

Imagery

Although it was unclear what information participants would use to plan their movements throughout the proposed intervention, it was hypothesized that once vision and hearing were minimized, imagery could also become a factor. Imagery is the use of the senses to create or recreate images in the mind (Vealey & Greenleaf, 2010, p. 267), and is often a skill executed without any purposeful training or instruction. For instance Weiss (1991) reported that young children naturally use imagery with no formal instruction, and Munroe-Chandler et al. (2007) reported that all of the age groups in their study (i.e., 7-14 year olds) utilized mental rehearsal techniques with no preceding instruction. Similarly, a study by Parker and Lovell (2009) examining different imagery types found that 16-18 year old athletes with no formal imagery training executed multiple forms of imagery throughout their study stating, “this study has established that youth sport performers are using imagery irrespective of the introduction of imagery training programs” (p. 12). Lastly, Cumming and Hall (2002) reported that elite level athletes used imagery more than recreational athletes, while a study by Murphy, Jowdy, and Durtschi (1990) revealed that 90% of Olympic athletes reported using imagery in some way, with 97% of those athletes indicating that it helped their performance. As outlined, a considerable amount of research on imagery use within sport indicates that athletes commonly use the imagery skill as a mental strategy, and also that this technique is often used even in the absence of formal training or instruction. As a result, the current study hypothesized that some participants would use imagery as a focus strategy to successfully make free throws without vision and hearing.

A foundational skill required for an athlete to benefit from imagery according to Vealey and Greenleaf (2010, p. 267) and Weinberg and Gould (2011, p. 307) is vividness. Vividness is described as the ability to use all of the senses to create a scene with as much detail as possible, therefore mimicking the actual performance environment (Weinberg & Gould, 2011, p. 306). Many researchers have reported that imagery vividness improves with increased imagery practice (Cumming & Ste-Marie, 2001; Rodgers, Hall, & Buckolz, 1991), and therefore it was also hypothesized within the current study that participants who used imagery would also improve their image vividness along the way. This seemed like a reasonable hypothesis when considering other researchers have reported imagery improvements occurring in a 5-week time period

(Cumming & Ste-Marie, 2001). The current study examined a 3-week time period in which imagery could be practiced on a daily basis.

Conclusion

The specificity of practice has been linked to performance by many researchers when examining the visual conditions in which participants practice (Tremblay and Proteau, 2001; Proteau, 2005). Much of the research in this area has indicated that the visual conditions in which one practices negatively impacts performance when they are transferred into an environment with different visual conditions, however in some cases this appears to depend on the type of task being performed (Whiting and Savelsbergh, 1992; Proteau, 2005). Research in this area has also shown that vision often dominates other sources of information regardless of the information available in the training condition (Proteau, 2005). The current study has examined the specificity of practice hypothesis in relation to visual conditions among participants who are experienced in the task being studied.

Research examining attentional focus has in many cases supported the use of an external focus of attention for expert performers (Perkins-Ceccato et al., 2003; Wulf et al., 1998). However more recently the work of Tonner and Moran (2014) on somaesthetic awareness has suggested that expert performers may benefit from using an internal focus of attention, as it may allow for necessary movement adjustments or corrections to occur. A similar notion has been suggested by Gray (2004) who discusses the possible benefits of being able to transfer from one focus type to another depending on the sport specific circumstances. Furthermore, there appears to be inconsistencies in the literature concerning the distinction between novice and expert performers in connection to specific positional skills within some team sports, as well how these factors interact with focus preference. The current research project intended to narrow these gaps by examining visually and hearing precluded free throw trials among lower and higher level free throw shooters within an elite population. This intervention had the goal of impacting focus of attention by minimizing all external factors during skill execution.

Lastly, imagery has been identified by a number of researchers to be both a common and beneficial mental training tool for athletes (Parker and Lovell, 2009; Murphy et al., 1990). When considering the nature of the current intervention, it was possible that participants would use imagery as a mental technique to adjust their free throw shooting accuracy. For this reason, imagery was included as a measured variable for exploratory purposes.

Research Objectives, Questions, and Hypotheses

The research objectives of the current research project were to examine the impact of removing vision and hearing during the execution of a self-paced skill on *(a)* overall performance, *(b)* focus of attention, and *(c)* imagery. Furthermore, the study set out to determine if the proposed intervention had a more significant impact on lower skilled or higher skilled free throw shooters within an elite population.

The research questions investigated within the current research project were: Does training the free throw skill in a visually and hearing precluded condition *(a)* impact performance at post-test, specifically among lower skilled shooters? *(b)* Channel focus internally throughout the intervention and at post-test? And *(c)* impact the use and vividness of imagery.

The research hypotheses within the current research project suggested that: *(a)* this intervention would improve performance among lower skilled free throw shooters, but have no significant impact on higher skilled free throw shooters at post-test. Additionally, *(b)* that training the free throw skill without the use of vision and hearing would result in athlete's utilizing an internal focus of attention throughout the intervention, and possibly at post-test. And lastly, *(c)* that training the free throw skill without the use of vision and hearing would impact imagery use and image vividness throughout the study.

Chapter 3: Methods

Participants

The study sample consisted of 12 male and 6 female (n = 18) varsity CIS level basketball players who were on an official game or practice roster. The average age of the participants was 19.1 years, the average number of years playing basketball was 11.7 years, and the number of participants in each playing position was 5 centers, 7 shooting guards, and 6 points guards. Using an effect size of f = 2.5 and an alpha level of .05, an a priori power analysis conducted by the software program G-power estimated a sample size of 54. However, due to the researchers only having access to one pair of occlusion goggles, 30 Canadian Interuniversity Sport (CIS) level basketball players were recruited as the participants. Due to injuries and schedule conflicts, 18 participants were able to complete the entirety of the study. Although both male and female players were asked to participate in the study, it was not the aim to have an equal number of males and females because a sex difference was not expected to occur. Both men's and women's teams were recruited to maximize sample size.

Study Design

The study design consisted of a 2 (intervention vs. control) x 2 (higher vs. lower skilled) repeated measures intervention. The study required a 100 shot pre-test, 300 shot intervention/control, and a 100 shot post-test, over a 5-week time period. Pre-test free throw scores determined which athletes were considered higher skilled shooters and which were considered lower skilled shooters (relative to the study population) using a median split procedure. All participants completed the pre-test stage prior to the median split being calculated to achieve stable percentages in the lower skilled and higher skilled shooting groups. Once participants were assigned to either the lower skilled or higher skilled group, they were randomly assigned to either the intervention or control group using SPSS software prior to the start of the intervention phase. Pre-test and post-test scores were collected through standard free throw attempts. The intervention stage of the study consisted of free throw attempts with both vision and hearing precluded. A control group was asked to complete the same procedure as the intervention group over the same time period, however vision and hearing were not manipulated. An exit interview (Appendix A) was used to explore the direction of attentional focus during the shooting motion, as well as the possible use of imagery throughout the course of the study. Free throw shooting percentages were assessed before (pre-test), during, and after (post-test) the intervention/control phase, however only pre-test and post-test data was analyzed for the purposes of the study.

Measures

Participants completed a brief demographic measure (Appendix E) following the consent procedure and prior to the pre-test. This measure included age, sex, number of years playing basketball, and playing position. Free throw shooting data was recorded in all 3 stages of the study. No instrument was required to achieve this (only the lead researcher or research assistants being present to instantly record each trial manually).

An exit interview and exit survey developed by the lead researcher was used to collect data pertaining to attentional focus and the use of imagery (Appendix A and Appendix B). The exit interview (Appendix A) qualitatively explored the direction of attentional focus throughout each stage of the study. For example participants were asked to think back to the pre-test stage of the study and describe generally where their focus was directed during the shooting motion. Qualitative data was collected from the survey questions using the audio recording application built into the password-protected iPad. The participants were read the survey questions aloud immediately following the final post-testing free throw trials. The exit interview responses occurred in the same setting the post-test took place in (the gymnasium), or in a classroom just outside the gymnasium. The exit survey (Appendix B) quantitatively explored imagery use by asking participants to reflect back on each stage of the study and determine if they included imagery as part of their typical routine. Furthermore, the survey explored how clear their images were if they did use imagery as a focus technique throughout any stage. All quantitative survey data was collected and stored using Opinio, a Dalhousie University hosted, secure online survey program.

Task and Procedure

Prior to the study and participant recruitment, study approval was sought from the institutional Research Ethics Board (REB). To recruit participants, varsity basketball coaches were emailed a letter summarizing the project (Appendix D). The lead researcher proposed a meeting with each coach to discuss the project further and answer any questions the coach may have. The interactive nature of this project was likely to result in a few specific questions from each coach, and therefore individual meetings were included in the recruitment plan. The coaches were then asked to allow the lead researcher to speak to their athletes to invite them to participate, using the general script outlined in Appendix E. The primary reason for the involvement of the varsity coaches was to allow the researcher to access their athletes during the season. The athletes who were interested in participating were asked to read and sign a consent form (Appendix C) prior to participating. Participants were also informed that a SportChek gift card would be presented to the player who made the most successful free throw shots over the course of the entire study. All data collection took place on a university basketball court. The space required to collect participant data within this facility was a regulation basketball net, with a regulation foul line painted on the court. Due to the nature of the study and its requirements, it was inevitable that other people (teammates or community members) were present during data collection. The lead researcher notified anyone in the gym during testing that participants were employing specific training techniques and to refrain from nearing the basket in use during this training.

During stage 1 of data collection, all participants were instructed to complete 100 free throw trials in a 5-day time period (20 per day) as a means of generating individual pre-test free throw percentages. A median split procedure was completed using this data to identify lower skilled and higher skilled shooting groups relative to the study population. All participants completed the pre-test stage prior to the median split being calculated to achieve stable percentages in the lower skilled and higher skilled shooting groups. Within each of these groups (lower skilled and higher skilled shooters) participants were randomly assigned to either the control or intervention group using the SPSS program. This, and every other stage of data collection occurred either inside or outside of regular practice time depending on what both the coach and athlete preferred. The 100 trials were accomplished by shooting 20 free throws per day for 5 consecutive weekdays. Participants were instructed to take 4 warm up trials prior to officially starting their 20 trials each day. The second and final instruction given to the participants in the pre-test stage was to “shoot to score” on each attempt. The entire pre-test process took approximately 10 - 20 minutes per day for 5 consecutive days.

During weeks 2, 3, and 4 of data collection, participants were asked to complete the intervention phase of the study consisting of an additional 300 free throw trials over a 3-week time span. Once again participants were asked to shoot 20 free throws per day for 5 consecutive weekdays, however in this case spread over 3 weeks. Participants were instructed to take 4 warm up trials prior to officially starting their 20 trials each day. Unlike in the pre-test stage, participants in the intervention group wore occlusion goggles manually controlled by the lead researcher, and ear buds while performing their free throw trials during this stage. These apparatuses served the purpose of removing two of the most dominant external information sources available during the free throw, vision and hearing. Occlusion goggles were selected as the apparatus used to remove vision for the study because they allowed the researcher to provide participants with the knowledge of results (KR) for each trial. The goggles were manually controlled by the researcher and therefore vision was restored instantly as the ball was in mid flight. Each day participants were asked to complete their 4 warm up trials and 20 official free throw trials while wearing the occlusion goggles and ear buds. Participants had their vision manually removed once they had received the ball in their hands and both feet were in the desired shooting position on the free throw line. Once the participant released the ball toward the basket, the lead researcher manually restored their vision to provide knowledge of results. Vision remained restored until this process restarted. Hearing was significantly reduced through the use of ear buds for the entirety of the trials and warm up trials. Once all 20 trials were completed, participants were instructed to remove both apparatuses. The entire intervention process took approximately 10 - 20 minutes per day for a total of 15 days (over approximately a 3 week time period). Lastly, participants were asked to complete a 100 shot post-test. The post-test stage was identical to the pre-test stage and occurred immediately following the intervention phase (the following week).

To ensure that any findings were not simply the result of generally training the free throw skill over a 5 week time period, a control group was also tested. This group performed the exact same amount of trials over the same time period (same procedure, same time period), however all of the trials were standard free throw attempts without the use of occlusion goggles or ear buds.

To explore the topics of attentional focus and imagery, a questionnaire and short exit survey were used (Appendix A and Appendix B). Once each participant fully completed the free throw trials portion of the study, they were asked to take part in a 10-minute questionnaire and 10-minute exit survey. All questionnaire and survey questions were read aloud to each participant by the lead researcher on the final day of data collection. The lead researcher recorded all questionnaire responses using the audio recording function built into the password-protected iPad, and all survey responses using the Opinio survey software.

Data Analysis

To test hypothesis 1, the dependent variable was the change in free throw percentage between pre-test and post-test time periods (repeated measures) within and between the participants in each skill level group (higher skilled and lower skilled shooters) and intervention group (intervention and control group). The independent variables being examined were (1) skill level of the participants (higher skilled vs. lower skilled shooters), and (2) the intervention (intervention vs. control group). Sex was examined and controlled for in the analysis as a covariate. The data were analyzed using a 2 x 2 x 2 mixed factorial ANOVA. To test hypothesis 2, participants' responses from the questionnaire were examined for common themes and coded using content analysis. No direct quotations were used. To test part 1 of hypothesis 3 pertaining to imagery use, exit survey data was analyzed using a 2 x 3 (group [intervention, control] x time [pre-test, intervention, post-test]) mixed ANOVA. To test part 2 of hypothesis 3 pertaining to imagery vividness, a 2 x 2 (group [intervention, control] x time [pre-test, post-test]) mixed ANOVA was conducted.

Chapter 4: Results

Descriptors and Group Validation

To support the median split method used to classify the lower and higher skilled shooting groups, an independent samples t-test was conducted to compare shooting percentage between the lower and higher skilled groups at pre-test. There was a significant difference in the scores for lower skilled shooters (M = 72.8%, SD = 8.1) and higher skilled shooters (M = 87.8%, SD = 4.1) $t(16) = 4.75$, $p = .000$ at pre-test, providing support for the median split (see Table 1). An independent samples t-test was also conducted to compare shooting percentage between the intervention and control group participants at pre-test. There was no significant difference in the scores for intervention group participants (M = 77.3%, SD = 12.2) and control group participants (M = 81.6%, SD = 7.3) $t(16) = -.89$, $p = 0.386$ at pre-test, therefore allowing accurate post-test comparisons to be made between the groups (see Table 1).

	Skill Level	**Group**	**Mean Shooting %**	**N**
Pre-Test Total Percentages	Intervention Group	Higher Skilled Group	87	4
		Lower Skilled Group	69.60	5
		Total	77.3	9
	Control Group	Higher Skilled Group	88.5	4
		Lower Skilled Group	76	5
		Total	81.56	9
	Total	Higher Skilled Group	87.75	8
		Lower Skilled Group	72.80	10
		Total	79.44	18

Table 1. Descriptive pre-test statistics showing the mean shooting percentage of each group.

It should be noted that the free throw attempts recorded in the fourth round of post-test shooting for participant #10 were identified as invalid by the lead researcher, and therefore treated as outliers. Participant #10 completed all 20 free throw attempts during this round of shooting, however did not attempt 20 reasonable shots (i.e., plainly performed below their true skill level) as observed and recorded by the lead researcher. The lead researcher noted that this participant, in comparison to their previous attempts, showed a clear lack of pre-shot routine, a lack of focus, a lack of care devoted to the outcome of each attempt, lethargic technique, and an overall rushed and careless effort. It was also brought to the attention of the lead researcher that this round of testing took place immediately after the participant received news regarding their role in an upcoming league game, which may have contributed to the emotional and rushed behavior of the participant. The participant shot 9/20 throughout this round of testing, which was their lowest single round score throughout both the pre-test and post-test stages of the study. The participant's valid post-test trials ranged from 16 to 18 with an average score of 16.75/20. The average score of the valid post-test trials was used to replace the invalid outlier.

Hypothesis Testing

Hypothesis 1 stated that training the free throw skill without the use of vision and hearing would improve performance among lower skilled free throw shooters, but have no significant impact on higher skilled free throw shooters at post-test. To test this hypothesis, a 2 x 2 x 2 (group [intervention, control] x skill level [lower, higher] x time [pre-test, post-test]) mixed factorial ANOVA was conducted. There was no significant main effect of time $F(1,14) = 2.81$, $p = 0.116$, indicating that the participants as a whole did not significantly improve from pre-test to post-test. There was also no significant interaction between time, skill level, and group $F(1,14) = 0.452$, $p = 0.512$, indicating that the visually and hearing precluded intervention did not significantly improve lower skilled shooters when compared to higher skilled shooters over time. There was however a significant interaction effect between time and group $F(1,14) = 5.26$, $p = 0.038$, indicating that the intervention group did significantly improve when compared to the control group (see Figure 1). There was also a significant interaction effect between time and skill level $F(1,14) = 8.84$, $p = 0.01$, indicating that the mean change score for lower skilled shooters (M = 7.17%) was significantly greater than for higher skilled shooters (M = -2%).

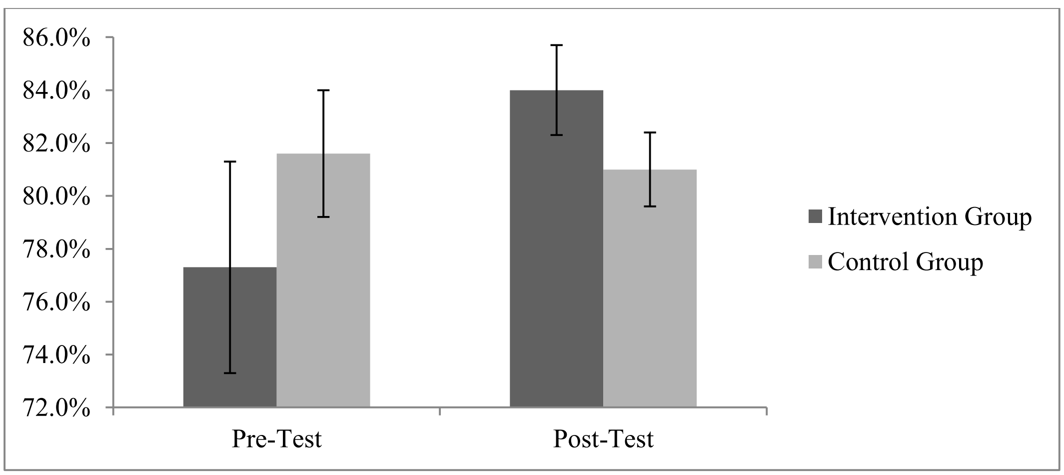

Figure 1. Bar graph showing the average pre-test and post-test free throw shooting percentages of the intervention and control participants with error bars representing the standard error of the mean.

Hypothesis 2 stated that training the free throw skill without the use of vision and hearing would result in participants utilizing an internal focus of attention to complete the task during the intervention and at post-test. In order to test this hypothesis exit interviews were conducted to qualitatively explore the participant's focus of attention throughout the study. Content analysis was used to code repeating ideas within the exit interviews, as well as to establish and organize these ideas into themes. Responses of the intervention group participants revealed three primary focus of attention themes, often contingent on what stage of the study the participants were reflecting on. These themes were labeled as external, internal, and external + internal focus of attention (i.e., both). Participant responses stating attention was guided toward either the rim, the center of the basket, the arc of the ball, the line of the ball (i.e., shooting the ball straight), or any combination of these focus points, were labeled as using an external focus of attention. This label also includes participant responses stating that they imagined either the rim, the center of the basket, the arc of the ball, the line of the ball, or any combination of these throughout the intervention stage of the study when vision and hearing were removed (i.e., imagery of external factors). Participant responses stating attention was guided toward the movement(s) of their body while shooting the ball were labeled as using an internal focus of attention (i.e., high release). The diversity of focus points used across these participants was very broad, including but not limited to elbow position, release height, knee bend, body tension, and hand placement. Lastly, participant responses stating that attention was guided toward at least one external and one internal focus point throughout the shooting process were labeled as using both an external and internal focus of attention. For a complete breakdown of all participant responses and how they were categorized see Table 2.

External Focus (With vision or by using imagery)	**Internal Focus**
Front rim	*Elbow position*
Back rim	*Knee bend*
Center of the basket	*Hand placement*
Arc of the ball	*Forward movement*
Line of the ball	*Technique*
	Jerking motion
	Relaxation
	Release technique

Table 2. Breakdown of terms used to describe focus of attention and how each response was categorized.

Based on the information gathered throughout the coding process, it was determined that 5 participants guided their attention internally throughout the visually and hearing precluded intervention. Four of these participants used exclusively an internal focus of attention and 1 participant combined both focus types. At post-test, 4 participants guided their attention internally. Of these participants, 1 used exclusively an internal focus of attention and 3 combined both focus types. When considering all pre-test, intervention, and post-test responses, it was concluded that 4 participants switched their focus of attention from external during the pre-test to internal during the intervention, and 2 of those 4 participants continued to guide their attention internally, at least partially, during the post-test (i.e., in combination with external factors). Furthermore, 1 participant used an internal focus of attention throughout the entire study, 3 participants used an external focus of attention throughout the entire study, and 1 participant used both focus types while shooting in the natural setting, and switched to external throughout the intervention stage (see Table 3 and see Figure 2).

Intervention Participant	Pre-Test	Intervention Stage	Post-Test
1	External	External via Imagery	External
2	External & Internal	External via Imagery	External & Internal
3	External	External via Imagery & Internal	External
4	External	Internal	External & Internal
5	External	External via Imagery	External
6	External	Internal	External & Internal
7	External	Internal	External
8	Internal	Internal	Internal
9	External	External via imagery	External

Table 3. Individual focus of attention trends for intervention group participants.

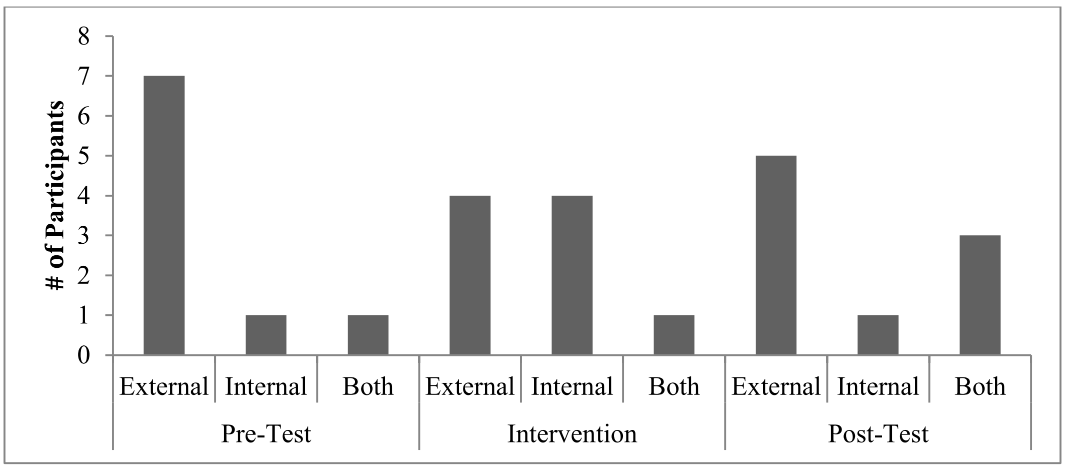

Figure 2. Bar graph showing the number of intervention group participants who utilized each focus type during each stage of the study.

The focus of attention of the control group participants was also determined using exit interviews and content analysis. Five of the 9 control group participants used an external focus of attention throughout the entire study, while 2 participants used an internal focus of attention throughout the entire study. Of the remaining 2 participants, 1 participant combined both focus types at pre-test followed by internal for the remaining trials, and 1 participant used external at pre-test followed by a combination of both focus types for the remaining trials (see Table 4 and see Figure 3).

Control Participant	Pre-Test	Control Stage	Post-Test
1	External & Internal	Internal	Internal
2	External	External	External
3	External	External & Internal	External & Internal
4	Internal	Internal	Internal
5	External	External	External
6	External	External	External
7	Internal	Internal	Internal
8	External	External	External
9	External	External	External

Table 4. Individual focus of attention trends for control group participants.

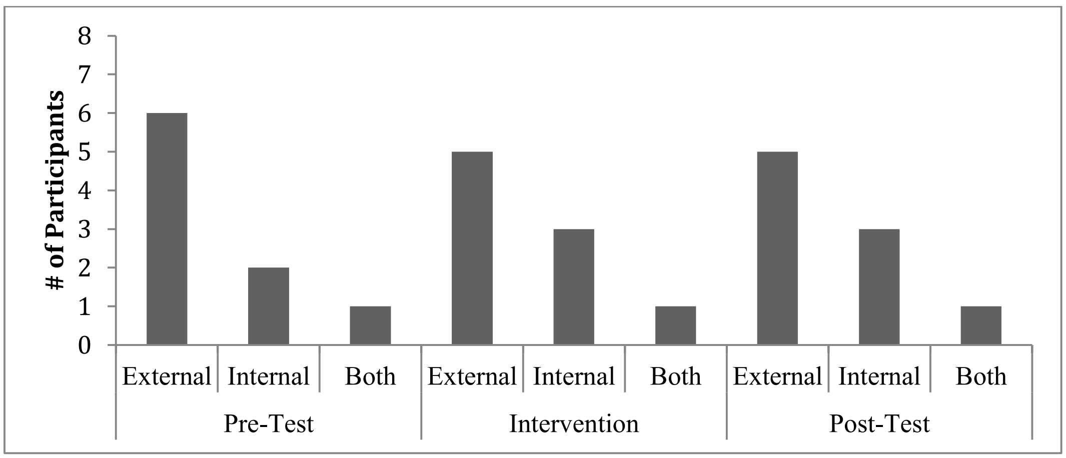

Figure 3. Bar graph showing the number of control group participants who utilized each focus type during each stage of the study.

The third research objective within the study aimed to explore imagery use and imagery vividness throughout the study. To analyze imagery use, a 2 x 2 (group [intervention, control] x time [pre-test, post-test]) mixed ANOVA was conducted. There was a significant main effect of time $F(1,9) = 3.638$, $p = 0.008$, indicating that imagery use across all participants did significantly increase from pre-test to post-test. There was no significant interaction between time and group $F(1,16) = 0.434$, $p = 0.520$, indicating that the imagery use of the intervention group did not significantly increase from pre-test to post-test when compared to the control group.

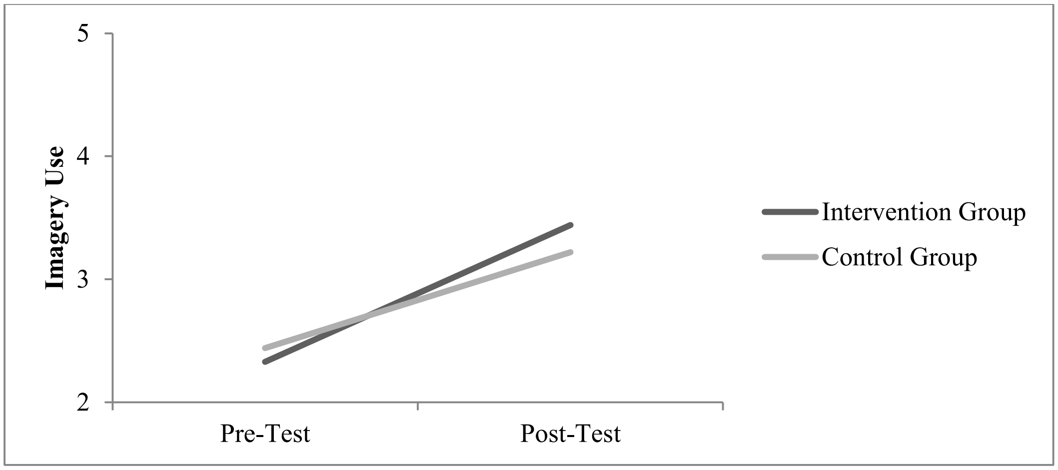

Figure 4. Line graph showing imagery use across all time points for the intervention and control groups.

Hypothesis 3 stated that training the free throw skill without the use of vision and hearing would impact image vividness among those who used imagery throughout the study. To analyze imagery vividness, a 2 x 2 (group [intervention, control] x time [pre-test, post-test]) mixed ANOVA was conducted. Participants who did not report using imagery in the pre-test stage of the study were not included in this analysis, as they did not provide a base-line vividness score. There was no significant main effect of time $F(1,9) = 4.998$, $p = 0.052$, indicating that the imagery vividness across all participants did not significantly improve from pre-test to post-test. There was also no significant interaction between time and group $F(1,9) = 2.66$, $p = 0.618$, indicating that the imagery vividness of the intervention group did not significantly improve compared to the control group (see Figure 5).

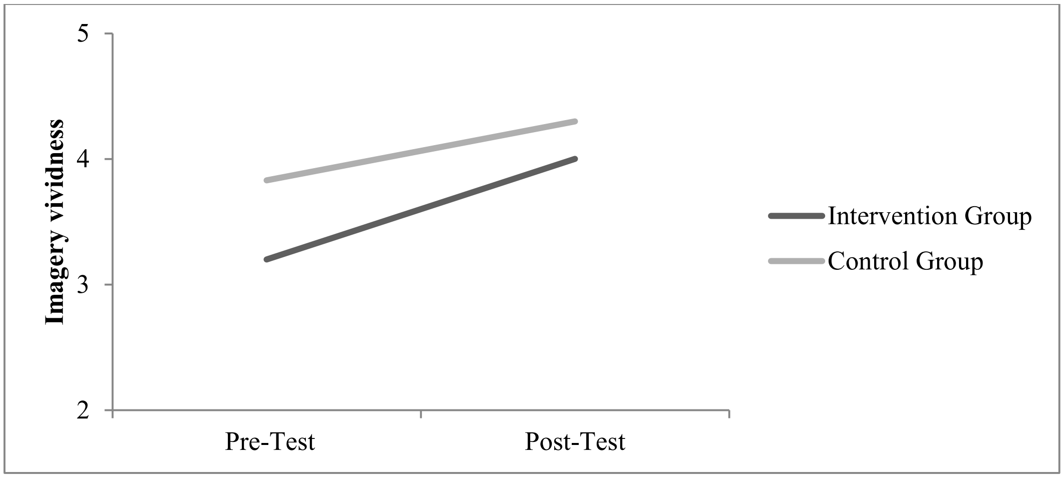

Figure 5. Line graph showing the average pre-test and post-test imagery vividness scores among intervention and control group participants.

Chapter 5

Discussion

The purpose of the current study was to explore the impact of a visually and hearing precluded free throw training intervention on lower and higher skilled university level free throw shooters. Specifically, the study aimed to examine the effects this intervention would have on athletes' shooting percentage, attentional focus, and imagery.

Hypothesis 1

The first hypothesis within the study suggested that the visually and hearing precluded intervention would improve performance among lower skilled free throw shooters, but have no significant impact on higher skilled free throw shooters at post-test. This hypothesis was largely based on the notion that the proposed intervention would benefit those in an earlier phase of learning more than those in a later phase, as well as gaps in the specificity of practice hypothesis regarding no vision and target only vision conditions. The results of the free throw trials indicated that the lower skilled intervention group participants did not significantly improve compared to the higher skilled intervention group participants at post-test.

Overall, it was expected that the lower skilled shooting group would have a greater percentage of players who play positions that traditionally require little mid or long range shooting (i.e., centers) (Miller & Bartlett, 1994). This prediction was validated by the descriptive statistics collected at the start of the study, which indicated that all of 5 centers who participated in the study were assigned to the lower skilled shooting group. Based on the work of Miller and Bartlett (1994) and Coker and Fischman (2010, pp. 22-25), it was also reasonable to anticipate that these players would have less automatized shooting movements from the free throw shot distance, and therefore would be more likely to break the free throw movement into "chunks" using an internal focus of attention. The study revealed that being a lower skilled free throw shooter did not impact overall improvement compared to being a higher skilled free throw shooter, therefore suggesting that lower skilled shooters do not benefit more from a visually and hearing precluded free throw intervention. It is possible however that significance did not emerged pertaining to skill level because of the small sample sizes within the study groups, and furthermore because of the use of a median split procedure to distinguish the lower and higher skilled groups. For example the fifth ranked shooter in the lower skilled group (i.e., middle of the pack in the lower skilled shooting group) and the fourth ranked shooter in the higher skilled group (i.e., middle of the pack in the higher skilled shooting group) were separated by only 11%. Furthermore, the top ranked lower skilled shooter and the poorest ranked higher skilled shooter were separated by only 1%. As mentioned previously, a median split was used to establish the two groups based on sample size and overall feasibility, however when considering the factors mentioned above this method likely did not allow for completely accurate conclusions to be made concerning skill level and overall improvement. Future studies should continue to investigate the effectiveness of a visually and hearing precluded free throw training program by dividing participants into well defined lower skilled and higher skilled shooting groups, possibly by identifying specific shooting percentage parameters for each group. This would allow for more accurate conclusions to be made regarding the practicality of this training method for these specific shooting groups. The results within the current study provide additional support for this future direction in that the three lowest ranked intervention group participants improved by an average of 17%, while the three lowest ranked control group participants improved by an average of 2.7% (see Figure 6).

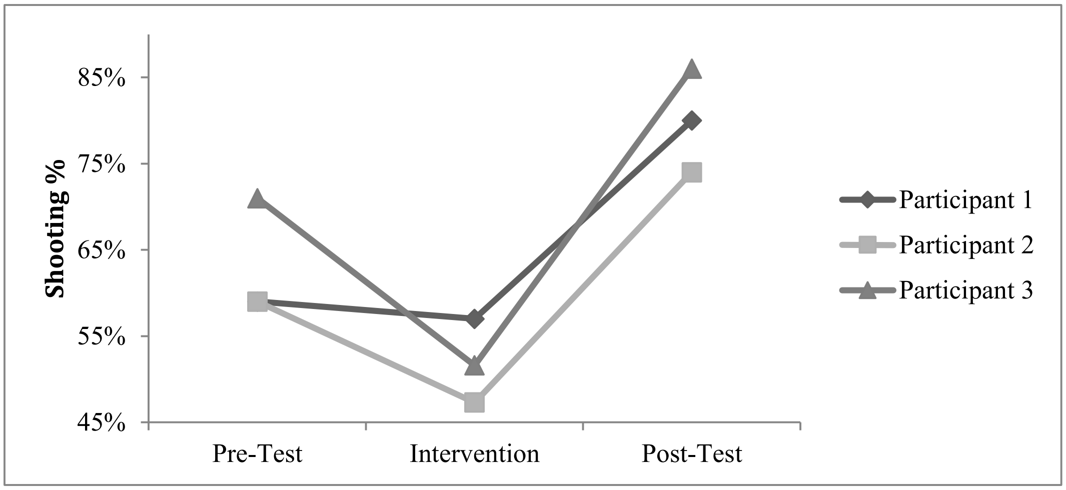

Figure 6. Line graph showing the shooting percentages of the three lowest skilled intervention group participants at all three time points of the study.

These data ignite further discussion around the idea of more clearly distinguishing players who are truly lower skilled free throw shooters and players who are not. Based on this trend, future research should also consider the use of a quartile split method rather than a median split to define lower and higher skilled shooters. Additionally, these data also provide preliminary evidence suggesting players who are in an early phase of learning for a specific skill within their sport may benefit from training methods suited more specifically for the attentional style associated with the motor learning phase they are in for that skill. Based on the trends represented in Figure 6 shown above, it appears as though beneficial learning occurred as a result of the visually and hearing precluded intervention among those in the earliest phases of learning within the study. It is possible these participants were able to enhance the "feel" of the free throw shot throughout this unique training process, therefore allowing them to better refine the deficiencies within their movement plan. As outlined by Coker and Fischman (2010, pp. 22-25), it is not uncommon for players to be in the autonomous phase for some of the skills within their sport, while in the associate phase for others. The current study provides initial evidence validating a training method designed to help mitigate this issue for elite basketball players who struggle from the free throw line.

Although the results of the study indicated that the lower skilled intervention group shooters did not significantly improved compared to higher skilled shooters, the intervention group as a whole did significantly improve compared to the control group. This finding is substantial because it provides preliminary empirical evidence suggesting that precluding vision and hearing to train a self-paced task with fixed parameters is effective for improving performance, as well as reveals valuable information concerning the specificity of practice hypothesis. For instance Proteau (1992) suggested that the removal and addition of vision within the practice environment has detrimental effects on aiming performance, while Bennett and Davids (1997) proposed that athletes should increase their dependence on the specific information that will be available to them in the natural setting. The results of the current study however contend this line of thinking based on evidence that the no vision group significantly improved compared to the control group. As mentioned in Chapter 1, there are several inconsistencies within the visual SPH research that could contribute to alternate findings, however likely none more impactful than the distinction between the removal of vision and the reduction of vision. For instance Moradi et al. (2014) reported a significant decrease in free throw shooting scores after participants completed a target only intervention (i.e., only the rim was under adequate lighting), displaying a clear contrast to the results of the current study. Other researchers have also explored the effects of a target only intervention (Mackrous & Proteau, 2007) reporting similar results to that of Moradi et al. (2014). This indicates there may be significant differences between no vision and target only training methods, possibly because of both explicit and implicit factors. As suggested by Bennett and David's (1997) and Mackrous and Proteau (2007), it is possible that target only conditions simply re-route visual focus externally, rather than funnel it elsewhere (i.e., internally to kinesthetic cues). Therefore, participants in both target only and full vision conditions are subject to visual dominance, possibly resulting in turbulence when transferring from one visual condition to the other. The current study may have avoided this trend by completely removing vision throughout the intervention, however more research is required to better isolate the differences between the two methods. The current study also provides additional evidence suggesting target only conditions may limit kinesthetic awareness when considering 4 of the 9 intervention group participants switched their attention from external to internal when vision was precluded. It is less likely that this trend would occur when vision is re-routed or altered externally (i.e., a target only condition). When considering the performance improvement of the intervention group, it is reasonable to suggest that the SPH cannot be applied to all visual conditions with equal merit. Based on this evidence it is also reasonable to suggest that more research is required to explore both the psychological and visual factors associated with altering vision as a method to enhance performance while executing a motor task.

Hypothesis 2

The second hypothesis within the study stated that training the free throw skill in a visually and hearing precluded condition would result in athlete's utilizing an internal focus of attention to complete the task during the intervention stage of the study. Furthermore, it was hypothesized that this focus strategy would transfer to post-test trials. This hypothesis was based on evidence indicating that an internal focus of attention is fundamental in skill acquisition during the early stages of learning (Bernstein, 1996; Horn, 2002, p. 441), as well as evidence suggesting that conscious movement awareness has been used by athletes of varying skill levels as a method of making fine detail adjustments (Toner & Moran, 2014). It was also anticipated that providing trial-by-trial feedback (i.e., KR) using manually controlled occlusion goggles would result in participants exploiting the KR to make the necessary kinesthetic adjustments to be successful on future attempts. The hypothesis that participants would utilize an internal focus of attention throughout the intervention was supported by the study's findings for some, but not all intervention group participants. The results of the exit interviews revealed that 4 of the 9 intervention group participants completely guided their attention internally throughout the visually and hearing precluded intervention, while 1 participant combined both focus types. Additionally, 4 of the 9 intervention group participants reported switching their attention from external at pre-test to internal when vision and hearing were precluded, and 2 of those 4 participants continued to utilize an internal focus of attention when shooting at post-test, however both in combination with external factors. The participants who did not switch to an internal focus of attention throughout the intervention stage of the study elected to use imagery as their focus technique to execute the skill.

Although focus of attention trended externally throughout the pre-test stage of the study, there was a relatively even split of focus strategy throughout the visually and hearing precluded intervention. This may somewhat complement the work of Weiss et al. (2008), who reported in two separate experiments that just over half of the participants preferred to use an external focus of attention, and just under half preferred an internal focus strategy. The findings of the current study provide additional evidence suggesting focus preference is a relevant factor in performance, and furthermore that it persists as a factor even in a visually precluded condition. Additionally, when considering the circumstances of the intervention within the current study, it is possible that some participants were unable to create clear images throughout the intervention due to lack of imagery experience (Gregg, Hall, McGowan, & Hall, 2011) and therefore "settled" on focusing internally because it was more familiar or achievable. Consequently, it is unclear whether these results serve as a better indicator of imagery ability, or focus preference. More research is required in this area to explore what information can truly be extracted from such attentional focus results. In addition to hypothesizing participants would focus internally throughout the intervention, it was also hypothesized this focus strategy would, in some regard, transfer to the post-test trials. The results of the study indicated that 2 participants utilized an internal focus of attention at post-test who did not at pre-test. These participants also reported switching their attention from external to internal from the pre-test to intervention time points, indicating that the visually and hearing precluded intervention was responsible for this adjustment in focus strategy. The finding that participants displayed such individualized focus of attention trends across the study simply elicits more questions concerning attentional focus preference and its impact on motor performance.

The current study also provided insight into focus preference under normal conditions. For example in the pre-test stage of the study 13 of the 18 total participants reported using an external focus of attention (i.e., without instruction and before the intervention), 3 participants reported using an internal focus of attention, and 2 combined both focus types. This ratio is weighted more toward an external focus of attention compared to the findings reported by Weiss et al. (2008), who examined dart throwing and basketball free throws. This inconsistency could be attributed to the low sample size in the current study, or to the different skill levels examined in each study. The experiments by Weiss et al. (2008) examined mostly novice performers with little to no experience, while the current study examined experienced basketball players with many years of experience.

Researchers interested in exploring anxiety-performance relationships have examined different forms of conscious processing under pressure, including the effects of using global and specific internal process thoughts while executing different tasks. This line of research has commonly presented advantages to using global internal focus cues rather than specific ones (Jackson, Ashford, and Norsworthy, 2006; Gucciardi and Dimmock, 2008; Mullen & Hardy, 2010). The current study revealed that all but one participant chose to use a specific internal thought cue rather than a global or holistic one. This finding is interesting in that it highlights a potential gap between where athletes should focus when under pressure (i.e., on global thought cues such as “smooth”)

(Mullen & Hardy, 2010), and where athletes chose to focus (i.e., on specific movement processes such as "elbow in") when given no instruction. The altered visual conditions as well as the lack of induced anxiety within the current study stand as obvious differences between these bodies of research, however more research in this area could provide valuable information contributing to mental training methods tailored to helping athletes properly focus when in high anxiety conditions. For instance the conscious processing theory established by Masters (1992) suggests that performance decrements under pressure are due to athletes attempting to consciously control their step-by-step movements. Building on the work of Gucciardi and Dimmock (2008) and Mullen and Hardy (2010) promoting the use of global thought cues in self-paced tasks, the current study suggests that purposeful mental training and focus strategies may be required to ensure athletes use a global internal thought cues rather than specific ones. This type of focus training would be both feasible and advantageous pending further evidence validating its effectiveness. It should also be noted that previous studies in this area tend to neglect the element of focus preference, as they provide no opportunity for participants to declare their preferred focus strategy prior to taking part in the study. For instance Mullen and Hardy (2010) allowed participants to generate their own global or specific internal thought cues, but did not inquire into what focus type participants preferred to use in the natural sport setting. This gap in the research needs to be addressed if practical training methods are to emerge from this field of research.

Responses from the exit interviews also suggested that the inclusion of KR had a very minimal impact on the explicit focus strategies of the participants. None of the exit interview responses mentioned or alluded to the use of KR as a focus theme. This is somewhat surprising when considering performance feedback (i.e., KR) has been well documented as a primary contributor to trial-by-trial adjustments (Perkins-Ceccato et al., 2003). The exit interviews also revealed that almost all of the participants who used an internal focus of attention throughout the intervention chose a specific cue such as "elbow in" or "bend your knees" which, based on the exit interviews, was not altered as a result of the KR. It is possible however that the KR facilitated implicit learning (i.e., learning without being consciously aware) (Chun and Jiang, 1998), which was then embedded in the thought cues chosen by the participants. For instance if an athlete used "bend your knees" as a thought cue and their most recent shot attempt came up short, they could have executed a deeper knee bend on the next attempt to generate more power. This theory would account for participants not referring to the use of KR within their exit interview responses. Additionally, it should also be mentioned that research by Wulf, Mcconnel, Gartner, & Schwarz (2002) has reported that external performance feedback (i.e., the result of movements) better promotes learning when compared to internal performance feedback (i.e., the process of movements) because it caters more to automaticity. The current study is unique in that it blended these concepts by removing the external target during skill execution while also providing external feedback for each trial. Future researchers should keep in mind that the combination of both external and internal factors used within the current study might help explain why performance improved at post-test.

Another important observation extracted from the focus of attention interviews was a trend regarding skill level and focus preference throughout the intervention stage. Four of the 5 lower skilled intervention participants chose to use imagery as their focus technique when vision and hearing were removed (some in combination with internal factors), while 3 of the 4 higher skilled participants chose to exclusively use an internal focus of attention. This is an interesting discovery when considering that most of the participants who chose to use an internal focus of attention were higher skilled shooters than those who reported to use imagery. As mentioned previously, it was generally expected that the opposite trend would be revealed (i.e., the lower skilled shooters would more comfortably focus internally when compared to the more automatized shooters). This observation further validates the work of Munroe-Chandler et al. (2007) and Parker and Lovell (2009) indicating that athletes commonly use imagery without any formal training or instruction, while also building on the research of Toner and Moran (2014) who suggested that even expert athletes performing at a world-class level see benefits in using an internal focus of attention to refine movements, referred to as somaesthetic awareness. Perhaps the higher-skilled shooters within the study embraced the opportunity to experiment with how their body moved throughout the shooting motion because they spend such significant amounts of time focusing externally when performing in the natural sport setting. Further, it is also possible that the lower skilled shooters adopted a somewhat opposite approach. Perhaps these participants primarily used imagery because they wanted to enhance their ability to make the shot using the external target as their main focus point, as that is what they were most invested in improving. Although these ideas are purely speculative, the point remains that the current study provided valuable data suggesting that increasing focus on the fine details movements required to achieve an outcome may be beneficial for performance, as suggested by Toner and Moran (2014). The data pertaining to internal focus and imagery are relatively incomplete however based on the limitation that the participants were not screened for their imagery skills or focus preference prior to taking part in the study. Therefore, it is possible that some participants were bias toward one focus type or the other (i.e., if a participant had extensive imagery training prior to taking part in the study). More research is required to help explain what governs focus strategies used by athletes in a visually and hearing precluded condition, as well as how these strategies are linked to skill type, skill level, and performance. It would also be beneficial for future research to better explore if participants are able to successfully correct, adjust, or relearn any skills specifically as a result of this type of intervention. This would help build on the work of Shusterman (2008) who suggests these three types of improvement are common when focusing attention somatically.

Lastly, there was no trend observed regarding the focus strategy used throughout the intervention and overall improvement. For example one participant who reported using imagery throughout the intervention stage improved by 21% at post-test, while another participant who used imagery throughout this stage experienced a 10% decrease in performance at post-test.

Hypothesis 3

Lastly, the study had the exploratory objective of determining if imagery use and imagery vividness were impacted as a result of the proposed training method. These factors were examined using an exit survey, which revealed that the imagery use of both the intervention and control group significantly increased from pre-test to post-test, and therefore neither group significantly increased compared to the other. There was however a significant difference between the groups at the intervention time point of the study, as the intervention group significantly increased imagery use when shooting without vision and hearing compared to the control group in normal conditions. These findings support the work of previous researchers who concluded that the use of imagery often occurs without formal training or specific instruction (Munroe-Chandler et al., 2007; Parker and Lovell, 2009). It was not considered however to inquire if participants had any previous imagery experience or training prior to taking part in the study. This was a limitation within the study procedure, as it would have provided useful information regarding participant's choice of focus strategy throughout the intervention. This finding also suggests that the use of imagery was transient for at least some of the intervention group participants (i.e., they only used it when they needed it). Lastly, it is not surprising that the imagery use of the intervention group significantly increased from pre-test to post-test based on the spike observed throughout the intervention, however it is generally surprising that it did not increase significantly more than the control group. There is little evidence suggesting why the imagery use of the control group significantly increased from pre-rest to post-test. It is possible that the control group participants increased their imagery scores throughout the survey process simply because they were asked to report their imagery use three times in a row, and therefore felt like they were "supposed" to be using imagery as they survey went on. It is also reasonable to suggest that the control group participants increased their imagery use because the start of their regular season edged closer and closer as the study went on. The post-test of the study occurred within a week of the first regular season game, possibly putting more value on each free throw attempt closer to that point, and therefore altering their focus strategies. These suggestions are entirely speculative however.

Previous research has also identified the five primary functions of imagery in sport, which are cognitive specific (CS), cognitive general (CG), motivational specific (MS), motivational general (MG-A), and motivational general mastery (MG-M) (Hall, Mack, Paivio, & Hausenblas, 1998). In short, CS imagery consists of imagining specific sport skills, CG imagery consists of imagining specific sport strategies, MS imagery consists of imagining desired outcomes, MG-A imagery consists of imagining desired arousal levels, and MG-M imagery consists of imagining feeling desired emotions (Hall et al., 1998). Although examining the specific imagery functions used by the participants was not included in the study's objectives, information on this topic also emerged from the exit interviews. All of the participants who conclusively used imagery reported imagining either the specific motion of the ball after it was released (i.e., the arc of the ball), or a specific target point (i.e., the back of the rim). The former imagery strategy mentioned very clearly falls into the category of CS imagery, however the latter imagery strategy is more difficult to categorize. For instance it could be argued that imagining only the target or end point of a future action, without actually imagining the execution of that action, would be considered CG imagery because it is primarily establishing a strategy rather than the execution of the skill.

The current study also hypothesized that imagery vividness would improve among those who used imagery across all three time points of the study. Previous research has suggested that imagining performances more frequently enhances image vividness (Cumming & Ste-Marie, 2001), however the current study did not support these findings. The intervention group participants who used imagery across all three time points of the study did not significantly improve their image vividness from pre-test to post-test. This was also true for the control group participants who used imagery across the entire study. A limitation to accurately assessing imagery vividness however was only being able to analyze the imagery vividness scores of participants who used imagery across all three stages of the study. Without all three time points it was not possible to examine vividness change over time, therefore excluding a number of participants who used imagery at one or two time points of the study (i.e., the intervention and post-test).

Additional Limitations

Firstly, it should be recognized that the shooting style of the participants was not considered at any point throughout the study. Shooting style refers to the height of ball release during a shot and is commonly broken into two groups defined as a low shooting style and a high shooting style (Oudejans, van de Langenberg, & Hutter, 2002). A low shooting style is one in which the ball and hands are typically at eye level throughout the shooting process, therefore blocking the field of view of the shooter (Oudejans et al., 2002). A high shooting style is one in which the ball and hands are above eye level throughout the shooting process, therefore not obstructing the field of view of the shooter (Oudejans et al., 2002). This is relevant because shooting style has been linked to performance in that it alters the visual information available to the shooter. For instance Oudejans et al. (2002) reported that participants with a high shooting style performed equally as well in a late vision condition (i.e., vision only available just prior to releasing the ball) as in a full vision condition. This however was not the case when the same participants performed with early vision (i.e., vision only available early in shot preparation and therefore unavailable just before releasing the ball). This finding suggests that participants with a high shooting style are better able to use last second information to accurately perform a basketball shot when compared to using earlier information. This may have impacted the results of the current study in that the participants with a high shooting style likely benefited less from the early vision (i.e., the vision available between trials, before the goggles were closed) when compared to those with a low shooting style. The high shooting style participants, similar to the participants in the study by Oudejans et al. (2002), may have been at a disadvantage because the low shooting style participants were likely more familiar with releasing the ball without sight of the target. Unfortunately, the study by Oudejans et al. (2002) did not include data pertaining to participants with a low shooting style. Different results were reported however in a similar study by Oliveira, Huys, Oudejans, van de Langenberg, and Beek (2007). Oliveira et al. (2007) asked participants of both shooting styles to shoot from various distances in a series of visual delay conditions. Participants in this study performed in a normal vision condition as well as three other conditions in which vision was occluded for 0-s, 1-s, and 2-s prior to shooting. Oliveira et al. (2007) hypothesized that participants with a low shooting style would be less susceptible to performance decrements in the delay conditions because they would pre-program their movements using the early vision available before the goggles were closed. However, contrary to their hypothesis no interaction was found between delay time and shooting style. The study by Oliveira et al. (2007) indicates that shooting style may not have played a significant role in the current study's results, but does effectively highlight another future direction pertaining to specific timing parameters when releasing the ball. Participants within the current study had their vision removed once the ball was securely in their hands, but were not given a cue or specific time period in which to shoot once this occurred. As a result, some participants released the ball very quickly upon receiving it (i.e., 1-s) while others took considerable time (i.e., 4-s). A study by Oliveira, Oudejans, and Beek, (2006) examining visual information pick-up preference among elite basketball players reported that participants preferred picking up the visual information that was last available to them in the shooting process, regardless of shooting style. This finding indicates that both high and low shooting style basketball players prefer late vision, however depending on one's shooting style the final visual information available appears either later or earlier in the shooting process. This finding is somewhat conflicting with a general observation made within the current study in that some participants took considerable time to shoot after receiving the ball and vision was removed. It would be expected based on the results of Oliveira et al. (2006) that the participants would have shot as quickly as possible after vision was removed, therefore displaying their preference for late vision. A possible reason for this inconsistency is that these participants may have preferred to use a different cognitive process to accomplish the task, such as imagery. Several participants within the current study indicated within their exit interviews that they preferred to imagine where the hoop was based on the visual information they had before receiving the ball. This imagery process may have taken a few seconds to complete. On the contrary however, it is also possible that the participants who released the ball quickly (i.e., less than 1 second after vision was precluded) used memory guided action as their primary mentally strategy for completing the task. This would provide a reasonable explanation pertaining to the observation that some participants urgently shot the ball after having their vision precluded, as they may have been trying to ensure the memory of the hoop's location was as fresh and accurate as possible. Future studies could mitigate this limitation by including time parameters regulating how long participants take to release the ball after their vision is precluded.

The presence of community members and/or teammates during each stage of the study was also a limitation within the study. A completely sterile environment would have been ideal, as this would have eliminated any social influences during testing. This was a limitation because some of the participants performed in a slightly different testing environment each day. For instance in some cases testing took place in a completely sterile environment, while in other cases testing took place with several teammates present. This could have impacted the psychological state of the participants (confidence, pressure, etc.). Further, testing was in some cases completed at the start of a team practice, while in other cases at the end. This was a limitation because players typically endured a number of emotional scenarios during practice (i.e., getting yelled at by their coach or other teammates), which also could have impacted their psychological state. When players completed their trials prior to training they generally seemed to be in better spirits psychologically, and likely less fatigued physically as well.

A third limitation was the availability of the participants. Due to schedule conflicts a number of participants were required to shoot 40 free throws on the same day to ensure they reached the required amount for that week. To minimize the impact of this limitation the lead researcher ensured these participants waited at least 10 minutes between each set of 20 shots, while also moving to a different basketball hoop (if available) to establish a fresh start and reduce any factors regarding rhythm.

The study also did not consider controlling for the Hawthorne Effect or the John Henry Effect. The Hawthorne Effect is described as "the nonspecific effect caused by participation in a study as such rather than by the specific intervention measures taken" (Wickstrom & Bendix, 2000). Therefore, the possibility that participants improved simply because they were a part of the intervention group remains open. The Hawthorne Effect is very similar to the Placebo Effect in that the participants may have improved because they believed they were supposed to (Wickstrom & Bendix, 2000). On the contrary, it is also possible that the control group performed above their average as a strategy to disprove the effectiveness of the proposed intervention, referred to as the John Henry Effect (Saretsky, 1972). The study did not control for these effects, therefore highlighting a limitation of the study design.

The validity of the measures used to examine focus of attention and imagery must also be considered a limitation of the study. Both the exit interview and exit survey were developed by the lead researcher to explore these areas, and were used in a reflective manner approximately 5 weeks after the first free throw was taken by each participant. Using these measures in a reflective manner presented a limitation in that it may have been difficult for some participants to reflect accurately, especially concerning the pre-test and intervention free throw trials, as they were the most distant. Additionally, it is also possible the measures did not measure exactly what they were supposed to (i.e., validity) when considering they were developed by the lead researcher specifically for the current study, and therefore not used in any previous research. For example the participants who indicated they focused internally throughout the visually and hearing precluded intervention could have used kinesthetic imagery to do so, however without indicating the use of kinesthetic imagery in the reflective attentional focus interview. In this case their response would not be completely accurate - possibly because of the overall validity of the measure (i.e., an incomplete question), but also possibly because they could not reflect accurately as a result of the time that had passed since the trial they were reflecting on.

Future Considerations and Conclusion

Based on the findings of the current study it is recommended that future research continue to investigate the validity and practicality of the proposed training method prior to bringing it into the applied world. Although the study's findings indicate that a visually and hearing precluded free throw training method is effective for enhancing performance, gaps still remain. Specifically, future research should investigate the effects of more clearly defining lower and higher skilled shooters within elite basketball populations. This would allow for more accurate conclusions to made regarding the effectiveness of this training method for the lower skilled free throw shooting population. Additionally, subsequent studies could examine which focus strategy (i.e., imagery or internal focus) should be instructed by coaches when utilizing this training technique with their players. The current study collected preliminary data on these focus techniques, however was unable to establish definitive trends. It would also be beneficial for future research to investigate how this intervention impacts key shot characteristics such as shot arc, release height, and aiming variability, in more detail. Through basic observation it appeared as though some participants increased the arc of their shot throughout the intervention, however more research is required to confirm this observation as well as to determine if such a change would have an impact on post-test performance. Additionally, it was also generally observed that the variance of aiming error decreased over time throughout the visually and hearing precluded intervention. Future research should investigate if this does in fact occur, and further what this would imply about its practicality. Future research could also investigate what the true source of improvement was within this study. For example if significant learning occurred throughout the intervention, subsequent studies should aim to discover exactly what was learned while vision and hearing were removed, and how this information was used to enhance performance under normal shooting conditions. It could be hypothesized for instance that the participants learned to self-regulate better through increased awareness (i.e., breath control, arousal levels, etc.) as a result of the intervention and were able to transfer that learned skill to the post-test trials. With a more detailed interview process subsequent studies could better investigate if skills such as self-regulation occurred throughout the intervention. Lastly, it should also be considered that performance may have improved among the intervention group participants simply because they had to put in more *mental work* to execute the task, regardless of what mental strategy they used (i.e., internal focus or imagery). Future research could explore the concept of enhanced mental engagement, possibly by including interview questions to assess athletes' perception of this theory.

The current study has provided exciting preliminary evidence suggesting that training the basketball free throw without the use of vision and hearing may be a beneficial training technique. Previous researchers have provided vast knowledge on specificity of practice, focus of attention, and imagery use, however little research has been done linking each of these principles to a practical training method for elite athletes to utilize. Overall, it was the aim of this study to empirically investigate a practical training method for elite basketball players to improve their free throw performance, and early sings suggest the method examined within this study is effective at accomplishing this goal.

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Appendix A: Focus of Attention Interview

Q1. For the purpose of sharpening your memory, describe in full what your typical free throw routine consisted of before this study began. Now think back to the pre-test stage of this study when you attempted the 100 free throw trials during week 1. Describe as best you can where your attention was directed while releasing the basketball during these free throw attempts. (If clarification or further probing is required here: To shoot the ball into the basket, what did you focus on while shooting the ball?)

Q2. Think back to the intervention stage of this study when you attempted the 300 shots during weeks 2, 3, and 4. For the purpose of sharpening your memory, what did your free throw routine typically consist of during this stage of the study? Describe as best you can where your attention was directed while releasing the basketball during these free throw attempts? (If clarification or further probing is required here: To shoot the ball into the basket, what did you focus on while shooting the ball?)

Q3. Recall the post-test, or final stage of this study when you attempted the 100 shots during week 5. Describe as best you can where your attention was directed while releasing the basketball during these free throw attempts? (If clarification or further probing is required here: To put the ball in the basket, what did you focus on while shooting the ball?)

Appendix B: Imagery Survey

Read definitions: Imagery can be defined as using one's senses to create or re-create an experience in the mind. Imagery vividness is described as the ability to use all of the senses to create a scene with as much detail as possible.

Think back to the first part of the study, during the 100 shot pre-test. How often did you use imagery during the pre-test stage of this study as part of your free throw routine?

1	2	3	4	5
(Never)				(Always)

If answered "never" skip to next question. If you used imagery at all during the pre-test stage of the study as part of your free throw routine, how vivid and detailed was your imagery?

1	2	3	4	5
(Unclear)				(Extremely Clear)

Think back to the intervention or practice stage of the study, during weeks 2, 3, and 4. How often did you use imagery during this stage of this study as part of your free throw routine?

1	2	3	4	5
(Never)				(Always)

If answered "never" skip to next question. If you used imagery at all during the intervention or practice stage of the study as part of your free throw routine, how vivid and detailed was your imagery?

1	2	3	4	5
(Unclear)				(Extremely Clear)

Think back to the last stage of the study, during the 100 shot post-test. How often did you use imagery during the post-test stage of this study as part of your free throw routine?

1	2	3	4	5
(Never)				(Always)

If you used imagery at all during the post-test stage of the study as part of your free throw routine, how vivid and detailed was your imagery?

1	2	3	4	5
(Unclear)				(Extremely Clear)

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Appendix C: Letter of Consent

Consent Form

Exploring Visually and Hearing Precluded Free Throw Trials Among Elite Basketball Players: A Practical Training Method?

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Project Title: Exploring Visually and Hearing Precluded Free Throw Trials Among Elite Basketball Players: A Practical Training Method?

Introduction

We invite you to take part in a research study being conducted by Bryce Tully who is a student at Dalhousie University, as part of his Master of Science in Kinesiology Degree. Taking part in the research is up to you and you can leave the study at any time. There will be no impact on your university sports career if you decide not to participate in the research. The information below tells you about what you will be asked to do and about any benefit, risk, or discomfort that you might experience. You should discuss any questions you have about this study with Bryce Tully or his supervisor Dr. Lori Dithurbide.

Purpose and outline of the research study:

A free throw often appears as one of the most basic elements in the game of basketball, however this sudden change of pace can present unique challenges at even the highest levels of play. The purpose of the current study is to explore a basketball free throw training method that consists of free throw trials without the use of vision and hearing. We believe that the most beneficial focus type during this skill may depend on the shooting ability of the athlete. Therefore, the application of the proposed training method will be examined among higher skilled and lower skilled shooters, as determined by shooting percentage. Vision may be removed during the shooting motion using occlusion goggles, however restored while the ball is in midflight to provide you with knowledge of results. All auditory factors may be significantly reduced using hearing protection earmuffs, however will not be restored midflight. Determining if both the results obtained and methods used during this intervention transfer into the practical setting will also be explored within the study.

Study design:

The study will consist of 3 stages: a pretest stage consisting of 100 standard free throw trials over a 1 week time period, an intervention stage consisting of 300 modified free throw trials (vision and hearing removed) over a 3 week time period, and a post-test stage identical to the pretest. The number of free throws attempted per day will remain consistent at 20 trials. Your task in each stage is to simply shoot free throws with the goal of the being successful in each attempt. There will also be control group asked to complete the same procedure within the same time period, however without taking part in an intervention of any kind. Lastly, you will be asked to take part in a short survey at the end of the data collection period.

Who can take part in the research study?

You may participate in this study if you are currently on the roster of a varsity CIS or college level basketball program and do not have an injury of any kind that may limit your shooting ability.

How many people are taking part in the study?

Approximately 60 participants will be taking part in the study.

What you will be asked to do:

To help us understand the effectiveness of the training method being studied, you will be asked to shoot approximately 500 free throw trials over the course of 5 – 7 weeks. You will shoot 200 of the trials as standard free throw attempts and 300 of the trials without the use of your vision or hearing if you are part of the intervention group. Your vision will be removed during the shooting motion using occlusion goggles, however restored while the ball is in midflight to allow you to see the result of your shot. All auditory factors will be significantly reduced using hearing protection earmuffs, however will *not* be restored mid ball flight. All of the data will be collected in the gym in which you currently train. You will be asked to complete 20 shots per day for 5 weeks (excluding weekends), which will take approximately 10 – 20 minutes of your time. If you are part of the control group, you will complete the same procedure in the same period, however you will not part in an intervention (vision and hearing will not be removed). Lastly, after all data collection is finished you will be asked to take part in an exit survey that will take approximately 15 minutes to complete. Some of the survey questions will require the lead researcher to audio record your answers on a password-protected iPad. No direct quotations will be used in the research findings.

Possible benefits, risks, and discomforts:

Participating in this study may present the benefit of an increased free throw shooting percentage over the course of the study, however this is still unknown. If this is not the case, your participation in this study may not provide any benefit to you, but we may learn things that will benefit you and others in the future.

The risks associated with this study are minimal. Participating in this study may present the risk of a decreased free throw shooting percentage over the course of the study, however this is still unknown. There will also be short periods of time (seconds) when you will have no vision and minimal hearing. No dangerous activity will be asked of you or going on around you during this time period, however it should be made clear that this will occur during the study.

What will you receive for taking part?

A SportChek gift card for $100 will be presented to the participant who has made the most successful free throw shots over the course of the entire study.

How your information will be protected:

All of your results throughout the entire course of the study will be kept private. Only the research team at Dalhousie University will have access to this information. We will describe and share our findings in an oral thesis defense presentation and a written thesis report. ***You will not be identified in any way in our reports***. The people who work with your information have special training and have an obligation to keep all research information private. All electronic records will be kept secure in a password-protected, encrypted file on the researcher's personal computer. Also, we will use a participant number (not your name) in our written and computerized records so that the information we have about you contains no names. Although all of your results and information will be kept completely confidential, there is a strong possibility that other people will be aware you are participating in the study. The data collection process will take place in primarily public gym space and in most cases with teammates and other community members present.

If you decide to stop participating:

You are free to leave the study at any time. If you decide to stop participating at any point during the study, you can also decide whether you want any of the information that you have contributed up to that point to be removed or if you will allow us to use that information. If you would like your data removed from the study you are able to do so anytime prior to the completion of the data analysis process. Once the researcher has completed the data analysis your data will not be removed.

How to obtain results:

Your coach will be provided with a short description of group results when the study is finished. You are also welcome to contact the researcher to obtain group results. No individual results will be provided.

Questions:

We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact Bryce Tully (Bryce.tully@dal.ca) or Dr. Lori Dithurbide (902 494-2477 lori.dithurbide@dal.ca) at any time with questions, comments, or concerns about the research study. We will also tell you if any new information comes up that could effect your decision to participate. If you have any ethical concerns about your participation in this research, you may also contact Catherine Connors, Director, Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca

Signature Page

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Understanding of Consent

I have read the explanation about this study and I understand the letter of informed consent. I have been given the opportunity to contact the investigative team and my questions have been answered to my satisfaction. I hereby consent to taking part in this study. However, I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

Do you give your consent to participate in this study?

- o YES, I give my consent and I have read and understand the letter of informed consent.
- o NO

Participant Signature ________________________, Date _______________________

Lead Researcher Signature_____________________, Date_______________________

Appendix D: Recruitment Letter to Coach's

Dear Varsity Coach,

My name is Bryce Tully and I am a Master's student in Kinesiology at Dalhousie University. For my Master's thesis I am exploring a basketball free throw training method that consists of free throw trials without the use of vision or hearing. The data collection process for this project will require approximately 15 minutes of monitored free throw trials per day with each athlete involved, for a time period of 25 days spread over the course of 5 – 7 weeks. These trials may take place either inside or outside of regular practice time. The study has been reviewed and permitted to move forward by the Dalhousie Health Sciences Research Ethics Board.

With your permission, I would like to speak to your athletes to invite them to participate in this research project. A script outlining what I will be asking can be seen below.

Thank you so much for your time. If you have any questions or concerns regarding the study please contact myself: Bryce Tully, Master's Student, Kinesiology, Dalhousie University (Bryce.tully@dal.ca) or my supervisor: Dr. Lori Dithurbide, Assistant Professor, Kinesiology, Dalhousie University (902-494-2477 lori.dithurbide@dal.ca).

Bryce Tully
Master of Science in Kinesiology Candidate
Dalhousie University

Appendix E: Script Outline

General Script:

My name is Bryce Tully and I am a Kinesiology Master's candidate at Dalhousie University working with Dr. Lori Dithurbide. I am here to invite you to participate in my research project. My study is exploring a basketball free throw training method that consists of free throw trials without the use of vision or hearing. The study will also require a control group and therefore not all athletes will be required to shoot without the use of vision and hearing throughout the course of the study. The data collection process for this project will require approximately 15 minutes of monitored free throw trials per day with each athlete involved, for a time period of 25 days spread over the course of 5 – 7 weeks. These trials may take place either inside or outside of your regular practice time. The project has been reviewed and permitted to move forward by the Dalhousie Health Sciences Research Ethics Board.

To participate in this study, please notify your coach or myself directly (in person) or via email. If you choose to participate in this study all of your results will be kept completely confidential. If you choose not to participate in the study, you may disregard this request.

Your participation in this study will be completely confidential. Your coach, teammates, and members of the community may be aware that you have participated in this study, however they will not under any circumstances be granted access to your results. Participating in this study will have no effect on your current or future varsity sport participation.

If you have any questions or concerns regarding the study please contact myself: Bryce Tully, Master's Student, Kinesiology, Dalhousie University (Bryce.tully@dal.ca) or my supervisor Dr. Lori Dithurbide, Assistant Professor, Kinesiology, Dalhousie University (902-494-2477 lori.dithurbide@dal.ca).

Thanks!

Bryce Tully
Master of Science in Kinesiology Candidate
Dalhousie University

Appendix F: Demographic Measure

Please fill in the following information:

Age:

Sex:

Number of years playing basketball:

Current Playing Position (Point guard, guard, or forward):

Appendix G

Health Sciences Research Ethics Board
Letter of Approval

July 23, 2014

Mr Bryce Tully
Health Professions\Health & Human Performance

Dear Bryce,

REB #: 2014-3339
Project Title: Exploring Visually and Hearing Precluded Free Throw Trials Among Elite Basketball Players: A Practical Training Method?

Effective Date: July 23, 2014
Expiry Date: July 23, 2015

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans.* This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,
Dr. Brenda Beagan, Chair