CHASING DREAMS: THE EFFECT OF LUCID DREAMING ON ATHLETIC PERFORMANCE

By

Tressa Christine Grummer

A dissertation to fulfill the requirements for a

DOCTOR OF PSYCHOLOGY IN COUNSELING PSYCHOLOGY

at

NORTHWEST UNIVERSITY

2019

Approved:

Kristin Mauldin, Ph.D., Chair

Leihua Edstrom, Ph.D., Committee Member

James Davison, Ph.D., Committee Member

Leihua Edstrom, Ph.D., Director and Committee Member

Matt Nelson, Ph.D., Dean of College of Social and Behavioral Sciences

Abstract

While many researchers have investigated the use of mental imagery to improve performance during wakefulness, the research in regards to using mental imagery while dreaming is still insufficient. A lucid dream is a dream in which the dreamer becomes aware they are dreaming and can sometimes gain control over the dream (Erlacher & Schredl, 2008). Previous researchers have shown psychological responses when people lucid dream about tasks, suggesting that lucid dreaming can be used as a technique to improve performance. The purpose of this study was to examine the effect of mental imagery during lucid dreaming on one's athletic performance. It was hypothesized that if an individual uses mental imagery during lucid dreaming, their athletic performance in sprinting will increase. It was also hypothesized that if an individual uses mental imagery during lucid dreaming, their athletic performance will increase more than an individual using mental imagery during an awake state. The participants (n = 48) were both males (24) and females (24), ranging in age from 26-66. They were randomly assigned into one of three groups: (1) Lucid dreaming group, (2) Mental practice group, and (3) Control (no practice) group. They recorded a timed 40 yard sprint before and after the study. They used their assigned form of practice for 30 days. The mental imagery group had a two percent increase in speed, the control group had a three percent increase in speed, and the lucid dreaming group had a four percent increase in speed. However, statistical analysis determined that there was no statistically significant difference between the groups and more research is needed in order to draw any direct conclusions. Future research would benefit from having a larger number of participants that were higher level athletes in order to increase motivation and consistency in participants.

Table of Contents

List of Tables and Figures

Chapter One

Sports and Exercise Psychology is a field of psychology that is fairly new (Barl-Eli, Blumenstein, Dreshman, & Weingstein, 2002). This psychology involves many different psychological techniques and theories that help improve athletes and sports performance (Barl-Eli et al., 2002). One of these techniques is the idea of mental imagery, or mental rehearsal. In recent years, there has been a fair amount of research on the use of mental rehearsal and how it can improve peoples' performance, regardless of the activity (Ellis, Hogard, Kelly, Smith, & Wright, 2008). Furthermore, this research has also expanded to now include ways to maximize those benefits depending on attitude, vision, and even the quality of the mental images, themselves.

Some have claimed that mental visual images are just a weaker version of visual percepts (Coelho, Fenn, Nusbaum, & Rosenbaum, 2012). This claim has been challenged by multiple researchers. This claim was investigated by comparing motor learning in variable practice conditions to motor learning in constant practice conditions (Coelho et al., 2012). This was done using 81 participants in the activity of golf-putting. The researchers asked one group to make a series of practice golf putts, another group to imagine themselves making those putts while holding the golf club, and a control group that imagined themselves kicking the golf ball instead of putting it. As a result, the researchers found that physical practice of putting the ball, and mental practice both created a significant amount of learning. However, they also found that variable practice was better than constant practice solely in the physical practice group. In the mental practice group it did not make a difference. The researchers showed that the mental

rehearsal was effective as an actual form of practice, rather than just a weaker visual percept (Coelho et al., 2012).

There have also been discussions regarding whether or not positive mental rehearsal performance effects are truly due to the mental rehearsal, or if they might be due to the verbal rehearsal that can typically go along with mental rehearsal techniques or practices (Saimpont et al., 2013). In this study, motor imagery is defined as, "the conscious simulation of a movement without its actual execution" and verbal rehearsal is defined as, "the silent rehearsal of the labels associated with an action" (Saimpont et al., 2013). The task used in this study was a foot-sequence task, and the aim was to determine whether or not mental rehearsal (motor imagery) or verbal rehearsal would be more effective in terms of learning and retaining this task. There were 30 total participants, all of whom were right-footed and ranged between 22 years old and 37 years old. There were three groups of randomly assigned participants: a group that used mental rehearsal to practice the sequence for five weeks, a group that used verbal rehearsal to practice the sequence for the same amount of time, and a control group that did not practice the sequence. The sequence that the participants were practicing involved different foot positions and a serial reaction time task. Before the participants began practicing, their times to perform the sequence was timed. The time to perform the sequence was timed again immediately after the participants finished their five week training, as well as six months after training.

The researchers found that the group that used just motor imagery had significantly higher speed improvement immediately after the training was complete (Saimpont et al., 2013). The verbal rehearsal group showed significantly higher

improvement than the control group, but not the motor imagery group. In terms of retention, there were no differences found in regards to response time among the three different groups. This could indicate that the mental practice, regardless of the type, did not have a lasting effect over a long period of time unless further training was administered (Saimpont et al., 2013). Overall, the researchers found that both mental rehearsal, specifically motor imagery, and verbal rehearsal both improve motor performance (Saimpont et al., 2013).

A specific type of mental rehearsal has been used in sports, and this approach is called the Wingate 5-step approach (Barl-Eli et al., 2002). This approach was used with a group of 38 swimmers, ranging from 11 years old to 14 years old (Barl-Eli et al., 2002). The swimmers were put into two groups: an experimental group that engaged in regular swim training and three stages of the Wingate mental training, and the control group that solely participated in regular training and relaxation techniques. A baseline measurement was conducted for the swimmers, and they were then evaluated on their scores and swimming performance twice during a period of 14 weeks. The researchers showed that the experimental group had a significantly higher increase in swimming performance. The control group had increases in performance, as well, but not as high. The researchers demonstrated the effectiveness of mental rehearsal, even when the athletes were very young (Barl-Eli et al., 2002).

Another study was used in order to determine how mental rehearsal might affect the performance of table tennis players, specifically in regards to their counterattack forehand and their backhand strokes (Lejeune, Decker & Sanchez, 1994). The way mental imagery and mental rehearsal were taught in this study was through a one week

course in mental rehearsal. This experiment consisted of 40 adults, who were divided into four different groups. These groups consisted of a group of participants that did not practice at all, a group of participants that only used physical practice of table tennis, a group of participants that physically practiced table tennis and experienced observational learning, and a group of participants that was provided with physical, observational, and mental rehearsal practice. The researchers found that all of the groups had significant improvement in terms of their table tennis stroke speed, except for the control group (Lejeune et al., 1994). The group that received mental rehearsal paired with observational and physical techniques had significant improvements in both qualitative performance and quantitative performance. The participants who experienced performance in the repetition of the skill also continued to properly execute the movements on a consistent basic. However, the researchers do suggest that the performance improvement might not solely be an effect of the mental rehearsal, and that further studies should attempt to narrow the study down in order to show proper effects of just the mental imagery and mental rehearsal practice on its own (Lejeune et al., 1994).

Although mental rehearsal has become well known in the field of sports psychology, some studies have also attempted to show how it can be useful for other and more complicated skill sets (Ellis et al., 2008). The researchers of a specific study aimed to test this idea by examining the effects of visualization of surgical skills versus studying surgical skills in textbooks on the ability to learn these basic surgical skills (Bramson et al., 2008). The study involved 64 medical students who were in their second year. These students were then assigned to a group of mental rehearsal or a group that focused on textbook studying. The typical skills courses of lectures, demonstrations, and physical

practices were still administered to both groups. Specific measures were also taken to control for confounding variables such as confidence level, anxiety, prior experience, attitude, and visuospatial ability. The performance of the participants was measured using a reliable rating scale, and it was measured at three different points during the study. As a result of this study, the researchers found that when both groups performed surgery on live rabbits, the mental rehearsal group performed significantly better (Bramson et al., 2008).

Another group of researchers aimed to determine the effectiveness of visualization training on the performance of nursing skills (Ellis et al., 2008). This study consisted of 56 pre-registered nursing students. PETTLEP is a form of imagery structuring that involves focusing on physical characteristics, the environment, the task itself, timing, learning, emotion and perspective. PETTLEP based imagery was the specific type of mental rehearsal used in this study. Half of the students in the study were given the PETTLEP-based imagery training for basic nursing skills and their results were then compared to the rest of the students. The students who received the rehearsal-based training techniques performed significantly better than the other students. These studies showed positive implications for using mental rehearsal to learn other skills besides sports (Bramson et al., 2008).

There are also a lot of very basic techniques used in the medical field, and clinicians are constantly looking for ways to improve the effectiveness of teaching these skills, since they are so essential and commonly used (Sanders et al., 2007). Mental rehearsal and mental imagery have been used in the medical field in order to teach these basic skills, with the hopes of increasing the likelihood of perfecting these skills. A study

was performed by researchers in order to teach venipuncture, or blood drawing, skills to medical students (Sanders et al., 2007). The researchers were particularly interested in using mental rehearsal for these skills, because blood drawing is a psychomotor skill, and previous studies had shown that mental imagery and rehearsal has been effective in the learning of psychomotor skills, regardless of the field (Sanders et al., 2007). The experiment that the researchers used was completely randomized, and the researchers compared mental imagery practice with physical practice in order to determine who would learn the blood drawing skills more effectively. First, the participants listed to and watched a blood drawing lecture, then they went through guided physical practice with the blood drawing instructor for 30 minutes. They performed this practice on plastic arms. After this practice, one of the groups was then allowed to continue this physical practice for another 30 minutes. A different group was guided through a mental rehearsal practice session for 30 minutes, instead of the extra physical practice. There was also a control group that did not receive any extra training after the guided physical practice.

As a result, the researchers found that both of the groups that received the additional 30 minutes of practice, whether it was physical or mental rehearsal, had their performance of blood drawing significantly improve compared to the control group (Sanders et al., 2007). The physical practice group and the mental rehearsal practice group also did not show any significant difference in performance from one another. This has large implications for the medical field, because the mental rehearsal practice was a more cost-effective learning method for the medical school, which could allow medical schools to use more funding elsewhere (Sanders et al., 2007).

Clinicians have researched ways to incorporate mental imagery and mental rehearsal into the field of medicine in regards to physical techniques and practices of medicine. However, clinicians and researchers are also investigating ways to incorporate mental rehearsal into the field of medicine in terms of the patient's usage of mental rehearsal, as well (Fell & Wrisberg, 2001). Fell and Wrisberg (2001) spoke of the possibility of including mental rehearsal in the treatment of geriatric rehabilitation. By their suggestion, the mental rehearsal would not be used as the sole intervention to help rehabilitate a patient, but would instead be paired with other treatments at the same time. Researchers have found that the strength and endurance of a person show significant improvement when the person is involved in both physical practice and mental rehearsal (Fell & Wrisberg, 2001). Although many researchers feel mental rehearsal can be beneficial to physical therapy treatment, specifically because it allows the patient to have a more holistic treatment approach, many of the accepted medical models of scientific research have previously been geared towards a different approach that is less holistic (Fell & Wrisberg, 2001). There have also been many studies that advocate for the use of mental rehearsal in order to increase physical performance, but a lot of research still needs to be done in order to discover why this reaction occurs (Fell & Wrisberg, 2001). This research could potentially include methods such as neuroimaging in order to properly investigate what is occurring in the brain in order to develop these significant relationships between mental rehearsal and physical performance (Fell & Wrisberg, 2001). The implications for this type of research could be very big, as the results could be used in order to cut down on costs for physical therapy, as well as the amount of time and

commitment needed in order for a person to undergo physical therapy (Fell & Wrisberg, 2001).

Although there is still a large amount of research that needs to be done in order to investigate the occurrences in the brain during mental imagery or mental rehearsal, Kraeutner, MacKenzie, Westwood, and Boe (2016) have contributed to this investigation through their research of brain plasticity. These researchers have found that motor learning depends highly upon plasticity in the brain in terms of neural networks, specifically regarding the parts of the brain that contain the functions of planning and movement execution (Kraeutner et al., 2016). Researchers do not deny that physically practicing a skill is usually the way to most effectively perfect motor learning. However, they have been working to demonstrate the effectiveness of pairing physical practice with mentally rehearsing the physical practice in one's head in order to perfect motor learning (Kraeutner et al., 2016). In this particular study, the researchers gave the participants an implicit sequence learning task. Their goal was to investigate the effectiveness of mental rehearsal used by itself versus the use of physical practice. This study consisted of two groups: one group where the participants went through implicit sequence learning training by the use of mental rehearsal, and another group where the participants went through implicit sequence learning training by using physical practice. The study consisted of 64 participants, with 31 participants in the mental rehearsal group, and 33 participants in the physical practice group.

As a result, the researchers found that the participants who practiced mental rehearsal without physical practice did experience significant growth in their skill set (Kraeutner et al., 2016). However, the participants who went through the physical

practice showed better performance for both random and implicit sequences than the participants who went through just the mental rehearsal. Although the physical practice was shown to be more effective in the learning of the skill sets, the participants who used solely mental rehearsal also saw significant performance improvement, which has broad implications for the use of mental rehearsal as a legitimate practice technique for motor skills (Kraeutner et al., 2016). Researchers still have yet to determine whether or not mental imagery or mental rehearsal alone, without any previous physical practice of movement, is able to produce a strong form of learning (Kraeutner et al., 2016).

Another study involving mental rehearsal in order to better learn a specific skill set was a study involving pianists (Rubin-Rabson, 1941). In this study, there were nine pianists who learned passages of piano music that were deemed as being particularly difficult (Rubin-Rabson, 1941). There were three different methods used during this study in order to learn the piano music. The first method consisted of piano players using mental rehearsal in order to practice the piano music. However, the mental rehearsal was introduced after the piano players had already practiced five keyboard trials, which was considered to be a halfway point in the learning. After the mental rehearsal, the pianists would continue to practice until they had memorized the music to a level that was considered perfection by the researchers. The second method consisted of the pianists rehearsing the music until they reached the researchers' desired level of perfect memorization, and then the pianists practiced four minutes of mental rehearsal. In the third method, the pianists practiced the piano music until perfect memorization, and then they practiced extra keyboard trials for four more minutes. The researchers found that the pianists who practiced mental rehearsal at the halfway point of practice had far superior

results in terms of learning the music. They also perfected it more than the other pianists who used other methods of practice (Rubin-Rabson, 1941). The pianists who used this method were able to reduce the required number of keyboard trials, and also were able to retain the music as well as the pianists who practiced using extra keyboard trials (Rubin-Rabson, 1941).

Mental imagery has also been used as a way to reduce negative behaviors, rather than just a way to improve and build positive behaviors. For example, in another study, the interaction between mental imagery and social anxiety was investigated, specifically social anxiety in terms of public speaking (Choi, Honeycutt, & Bodie, 2015). In this study, the participants used mental rehearsal in order to try and reduce anxiety that can be caused by public speaking, or giving a speech. There were two studies involved in this experiment. The researchers found through the first study that mental rehearsal had a significant effect in terms of silent pauses when giving a speech. The participants had less silent pauses when they participated in mental rehearsal before giving a public speech. However, they did not see a difference in the number of their vocalized pauses when giving a speech. In the second study, the researchers were interested in finding out how useful it would be to incorporate mixed modes of mental imagery when rehearsing the speech, rather than having the participants visualize giving the speech alone. The researchers found that when the participants used the mixed modes of mental rehearsal and also used other training paired with the mental imagery, they were able to see the most success in speech memorization and performance, and the participants gave themselves a higher self-reported speech evaluation afterwards (Choi et al., 2015).

The usage of mental rehearsal has also been explored as a way to improve emotional functioning (Woody, 2006). A particular group of researchers aimed to examine how effective mental rehearsal techniques were for musicians attempting to improve their expressive performance (Woody, 2006). The researchers of the study used 84 undergraduate and graduate music majors. The students were given research packets to complete during their practices, and they were all given three melodies, each of which had an accompanying visualization technique. They were told that their teacher had provided them with this technique in order to perform the music more expressively. These packets explained to the students how to consider the imagery-based instruction, how to practice it, and how to imagine giving a final performance. During this, the participants would also record their thoughts during the process, such as whether or not they personalized the imagery.

The researchers found that a large factor of the performance depended on whether or not they had felt they had already mastered the music. They found that the majority were not able to apply expressive emotions to the music and focus on the imagery very much if they had not already mastered the notes. However, when they did feel they had mastered the melodies technically, then the imagery techniques were found to be significantly effective, especially when they were personalized. The researchers showed that mental imagery can also be used to improve emotional expression, but may also be dependent on the mastery of technique (Woody, 2006).

Furthermore, while conscious mental rehearsal has shown to be effective, there has also been interest as to whether or not mental rehearsal could take place while one is dreaming during sleep and whether or not this technique could also be effective in

improving performance (Erlacher & Schredl, 2008). Previous researchers have shown different psychophysiological responses when people experiencing lucid dreams have undergone certain tasks during one of their lucid dreams, such as eye movement and different activities involving EMG (Erlacher & Schredl, 2008). However, Erlacher and Schredl (2008) wanted to perform a study to research how one's cardiovascular responses react to performing certain physical activities while dreaming. These researchers hypothesized that, "physical activity carried out in a lucid dream increases cardiovascular parameters in the sleeping body" (Erlacher & Schredl, 2008). The study consisted of five lucid dreamers, who were especially experienced in lucid dreaming. They stayed in a sleep laboratory, where they spent two to four nights. Previous to their sleep, the participants were told to perform certain tasks in their dreams. These tasks consisted of counting and performing squats. The researchers created a method for the participants to signal when they were lucid in their dreams, and these signals were also recorded during the study, in order to confirm that the participants were lucid dreaming.

There were a total of 14 complete lucid dream tasks that were verified with the researchers by the usage of eye signaling during the dreams. The researchers found that the participants experienced a significantly higher heart rate between the pre-exercise and exercise periods, as well as the post-exercise period (Erlacher & Schredl, 2008). However, in terms of respiration rates of the participants, the results were not conclusive. The researchers found that the respiration rate was higher during the exercise period than it was for the pre and post-exercise period, but they only found this to be a statistical significance for the second comparison. However, the results of the study supported the hypothesis and the notion that when one dreams about motor action, it can also have a

physiological effect on the person (Erlacher & Schredl, 2008). The size of the participant group was definitely a limitation of this study (Erlacher & Schredl, 2008). Further research would need to include far more participants, as well as a definite control group in order to determine causation of the interventions used.

In addition, the previous researchers wanted to build upon their previous study with the help of Stumbrys in order to investigate the effects of mental rehearsal while dreaming on the performance of a different task (Stumbrys, Erlacher, & Schredl, 2016). The aims of this study were to compare the effectiveness of practicing a task while lucid dreaming to the physical practice of this task, as well as mental practice during wakefulness (Stumbrys et al., 2016). This experiment was completed online with 68 different participants. The participants were split into four different groups: the lucid dreaming practice group, the mental practice during wakefulness group, the physical practice group, and a control group that did not practice at all. The participants were given a Pretest in the evening and a test again the next morning, and the participants practiced the task at night.

As a result of this study, the researchers found that all of the groups that practiced the tasks showed significant improvement in the performance of the task when comparing their pre-tests to their post-tests (Stumbrys et al., 2016). However, the control group did not show any significant improvements in their test performance. It was also a concern as to whether or not the groups would receive adequate sleep since they were practicing at night, but the researchers found that the night practice did not have an effect on the participants' subjective sleep quality. Overall, the researchers found that practicing a task while one is lucid dreaming did have a positive effect on the performance improvement.

Also, not only did the lucid dreaming practice significantly improve task performance, but the performance effect also seemed to be similar to actual physical practice of the task, as well as mental rehearsal of the task during wakefulness (Stumbrys et al., 2016). This suggests that lucid dreaming practice could be an equally effective method of rehearsal for a skill or task (Stumbrys et al., 2016). This research and type of mental rehearsal has very large implications, especially for the field of sport psychology (Stumbrys et al., 2016). If there was a way to increase the effectiveness of learning or mastering a skill set while sleeping, it would further maximize an athlete's potential to master that skill as quickly as possible, allowing them more time during the day to focus on other skill sets and training.

Although mental imagery has been shown to aid in a number of activities, there are also certain types of mental imagery that are best for certain types of situations (Chan, 2012). In this study, Chan explored which types of mental imagery would be best for promoting goal-directed behaviors. This particular study consisted of approach imagery, which is imagery geared towards achieving desired goal states, and this was compared with process imagery, which is an imagery that is geared towards steps for enacting behavior, and how effective these imageries are at promoting physical activity among inactive people. The study consisted of 182 people, and the researcher had them create mental images related to physical activity over a time period of four weeks. The researcher concluded that Approach Imagery was most successful in increasing motivations for physical activity (Chan, 2012).

There have also been concerns as to whether or not certain factors will cause people to have difficulty forming proper mental rehearsal images (Dixon & Glover,

2013). The researchers of this study investigated this by studying how context and vision effects affected mental imagery (Dixon & Glover, 2013). The study involved participants performing simple overt pointing tasks or analogous motor imagery tasks while their visual context and availability of visual information was being manipulated. Dixon and Glover found that visual illusions, word labels, and numeric labels all had similar effects on the overt pointing exercises and motor imagery. The researchers found that a common mental representation is used in both overt actions and motor imagery (Dixon & Glover, 2013).

Another factor that can affect the results of mental imagery is one's attitude, and researchers investigated this by showing how optimism affects mental imagery (Blackwell et al., 2013). This study consisted of 237 people, and they filled out surveys that had to do with measuring their mental rehearsal, optimism, and socio-demographic information. The researchers were particularly interested in whether or not the more optimistic people were able to form more vivid and positive forms of mental rehearsal for their future, such as positive goal-oriented mental imagery. As a result, the researchers found that this was the case, and people who were more optimistic were more likely to be able to form this type of mental imagery, and their imagery was also more vivid, even when the information was adjusted in order to account for sociodemographic factors and people who used imagery every day (Blackwell et al., 2013).

Although mental rehearsal has shown to be effective, especially in sports, there are some researchers that also show this mental imagery is only effective if the imagery is of a certain quality (Byblow, Collet, Guillot, Lebon, & Stinear, 2012). The researchers of this study explored how causality orientations, differences in imagery, and reward

contingency are related to performance and intrinsic motivation (Mailhot, Mouanda, & Thill, 1998). The 182 participants were males in the 10th grade. The activity used for this study was handball penalty shooting, and the study had three different stages. The first stage consisted of assessing their mental imagery capacities based on a questionnaire. The second stage consisted of having the students who scored high or low in imagery capacities make penalty shots and then fill out questionnaires on their performance and intrinsic motivation. In the third stage, they were asked to make the penalty shots again. As a result, the researchers found that the people with high mental imagery capacities had a significantly better performance. They also found that autonomy-oriented students claimed to have a higher interest and intrinsic motivation, and also performed higher than the control-oriented students. The participants with higher mental imagery ability not only performed better, but also had higher motivation (Mailhot et al., 1998).

In addition, another group of researchers investigated the corticomotor excitability and intracortical inhibition during mental rehearsal (Byblow et al., 2012). There were 23 adults involved in this study, and they all performed a simple finger muscle exercise. They then completed a questionnaire and imagery exercise based on the finger muscle activity to evaluate their mental imagery ability and quality. After this, they were separated into groups depending on the level of their mental imagery, and their corticomotor excitability, short-interval intracortical inhibition and short-interval intracortical facilitation were measured. For the results, the researchers showed that there was a relationship between imagery quality and motor cortex excitability. More specifically, they showed that when people had poor mental imagery, they still had an increase in corticomotor excitability, but it was not focused on the specific muscle

involved in the imagery. However, when people had higher quality mental imagery, they showed a muscle-specific temporal modulation of corticomotor excitability that replicated the specific excitability that occurred when they actually performed the initial muscle movement (Byblow et al., 2012). This finding has large implications for sports psychology, since much of the sports psychology focus is geared towards activating these brain areas.

As a whole, the authors of the literature on mental rehearsal were mostly in agreement in regards to the effect mental rehearsal had on performance, regardless of the activity. The authors not only showed that adding mental imagery to one's regular activity typically increased performance, but they also concluded that it increased performance more than other activities used to learn information (Bramson et al., 2008). In addition, when some of the researchers investigated this further in comparing one type of non-physical learning method to visualization, they found that the other learning method did not improve their skills after a certain point, whereas the visualization continued to improve their skills the longer they continued to use mental imagery (Bramson et al., 2008). However, this was not the case with physical activities, and other researchers showed that the opposite was true when comparing the physical practicing of a sport (Coelho et al., 2012).

Another interesting point to note was that the mental rehearsal practiced in all of these studies was very manageable. For instance, the study that required the most practice of mental imagery was practicing mental imagery for about 30 minutes a day for a span of four weeks (Chan, 2012). Most of the other studies required mental imagery practicing for only three days a week for 30 minutes (Ellis et al., 2008). People often think that

relaxation needs to be involved with mental imagery as well, in order for it to be most effective (Bar-Eli et al., 2002). However, this idea was challenged in one of the studies, where the researchers administered the visualization exercises in a stressful environment, and still showed a significantly better increase in performance (Bar-Eli et al., 2002). Furthermore, a separate study involved participants performing relaxation techniques with the non-experimental group that was not engaging in mental rehearsal, and the mental rehearsal group still performed better (Bramson et al, 2008).

Although there were many cross-sectional studies performed on mental rehearsal, there were not very many longitudinal studies performed on mental rehearsal. This could be an implication for further research, as it could show the effectiveness of mental rehearsal over a longer period of time (Barl-Eli et al., 2002). There also seems to be a need for further studies involving the ability of mental imagery to excite muscle-specific areas in the brain, especially when researching the application of mental rehearsal for sports psychology (Byblow et al., 2012). Regardless, there are currently many uses for mental rehearsal and mental imagery, and researchers are continuously discovering more and more about how to maximize one's mental imagery potential in order to achieve the optimum results (Ellis et al., 2008).

Rationale/Purpose of the Study/Significance of the Study

While many researchers have investigated the use of mental imagery numerous times during wakefulness, the research in regards to using mental imagery while dreaming is still insufficient. In the research by Stumbrys et al. (2016), the study was able to demonstrate that performance in an athletic task was increased when the participants used mental imagery while dreaming. However, further improvement could be made in

this research by increasing the number of participants, trying different athletic activities during lucid dreaming, and comparing these results more to the results of participants that only practice mental imagery during wakefulness. These improvements would help to further demonstrate the significance of using mental imagery during lucid dreaming. The effect of mental imagery during lucid dreaming on athletic performance was measured in this study, specifically through measuring the amount of time it took a participant to run a 40 yard sprint. This research and type of mental rehearsal has very large implications, especially for the field of sport psychology (Stumbrys et al., 2016). Present day athletes have become so competitive, often the slightest difference in training can separate them in terms of their performance (Barl-Eli et al., 2002). These differences can be dietary, physical, lifestyle differences, and mental. If there was a way to increase the effectiveness of learning or mastering a skill set while sleeping, it would further maximize an athlete's potential to master that skill as quickly as possible, allowing them more time during the day to focus on other skill sets and training.

Research Questions/Hypotheses

The purpose of this study was to examine the effect of mental imagery during lucid dreaming on the sprinting speed of an individual. I looked at the effect that mental imagery had on sprinting speed without the use of dreaming, in order to determine if the results of the lucid dreaming were due to the mental imagery or the dreaming, itself. I proposed the following hypotheses:

1. If an individual uses some form of practice, their athletic performance in sprinting will be improved in comparison to an individual not using any form of practice.

2. If an individual practices mental imagery, their athletic performance in sprinting will be improved in comparison to not using any form of practice.

3. If an individual uses mental imagery during lucid dreaming, their athletic performance in sprinting will be improved in comparison to use of mental imagery during an awake state.

Chapter Two

Methods

The purpose of this study was to examine the effect of mental imagery during lucid dreaming on the athletic performance, specifically the sprinting speed, of an individual. The current research available on the use of mental imagery during lucid dreaming is very limited. Athletic performance of different exercises or activities has not been properly investigated, and it is unclear whether the results of previous studies are due to the use of mental imagery during lucid dreaming or simply the use of mental imagery in general. For this reason, I decided to measure different athletic exercises than previous research, and I also had one group of participants use mental imagery without lucid dreaming. I made the following hypothesis: If an individual uses mental imagery during lucid dreaming, their athletic performance in sprinting will increase.

Participants

The participants of this study were taken from a convenience sample of different people from Facebook and Instagram, two social media websites, and word-of-mouth referrals. I also attempted to collect participants from lucid-dreaming forums in order to have participants that would be most likely to have lucid dreams for a month long time period. However, none of the people on these forums responded to multiple inquiries about the study, so I did not use anyone from these forums. There were 48 participants, who were both males (24) and females (24), all over the age of 18. The participants ranged in age from 26-66. I initially started with 180 participants, but had 132 participants drop out over the course of the study. The participants were asked to try to exercise no more than 75 minutes per week, and this was conveyed to them through the

informed consent form, as well as the instructional handout they receive for their research group. I contacted the participants through e-mail and through text messaging on their phones. The compensation for participation in the study was an automatic entry into a raffle for a $300 Visa gift card.

Materials and Procedures

Consent form. The consent form (see Appendix A) is a form listing all expectations, risks, and benefits of participation that all participants are required to read and sign before participating in the study.

Control group instructions. The control group instructions (see Appendix B) are an instructional guide, written by the researcher, instructing the participants in this group on what to do for the entire 30 days of the study.

Lucid dreaming group instructions. The lucid dreaming group instructions (see Appendix C) are a detailed instructional guide, written by the researcher, instructing the participants in this group on what to do for the entire 30 days of the study.

Mental imagery group instructions. The mental imagery group instructions (see Appendix D) are a detailed instructional guide, written by the researcher, instructing the participants in this group on what to do for the entire 30 days of the study.

Instructional video. The instructional video is a video guiding the participants in the lucid dreaming group as to how to begin lucid dreaming.

Self-report by participants. The participants in each of the groups all self-reported their before and after 40 yard sprint times through self-report. The times on their sprints that they reported were recorded by another person, but it was the same person for both the before and after times.

Stop watch. This was used to time the 40 yard sprint before and after the study. The participants were told that they could use any type of stop watch, including the stop watch feature on an iPhone.

Groups. The participants were randomly assigned to one of three groups: (a) Lucid dreaming group (b) Mental practice group (c) Control (no practice) group. All participants signed an electronic informed consent form and were free to withdraw from the study at any time.

Lucid dreaming group. Before they began the study, they had someone time them running a 40 yard sprint. Then, the lucid dreaming (LD) group used the lucid dreaming handout to induce lucid dreams for one week. After practicing lucid dreaming for one week, they then started attempting to lucid dreaming about sprinting for 30 days. After becoming lucid in their dreams, they were instructed to immediately start practicing sprinting 40 yards and to try to practice this for as long as possible while dreaming. They were instructed to practice the 40 yard sprints with 30 second rest periods in between each sprint. They attempted to lucid dream about and practice this sprinting four days a week for 30 days. At the end of these 30, they had the same person time them again in a 40 yard sprint. Each participant was sent a reminder via e-mail and text message once a week for the duration of the study in order to remind them to practice their technique and time their sprints on the indicated dates.

Mental practice group. Before they began the study, they had someone time them running a 40 yard sprint. The mental practice (MP) group used the mental imagery handout to instruct them as to how to visualize the physical activity. The MP group visualized themselves doing the 40 yard sprint once a day, four days a week. During this

one visualization session, they visualized themselves sprinting 40 yards five times, with thirty second rest periods in between each physical activity. They visualized sprinting four days per week for 30 days. At the end of these 30 days, they had the same person time them again in the 40 yard sprint. Each participant was sent a reminder via e-mail and text message once a week for the duration of the study in order to remind them to practice their technique and time their sprints on the indicated dates.

Postquestionnaire survey. This was a survey created on Surveymonkey.com that was given to the participants after they completed the study (Appendix G). It was a ten question survey sent to them through e-mail and text message. This was used to collect demographic information, as well as information about how physically active they have been previously in their lives, as well as during the study. It was also used to collect information about how often they practiced their technique, reasoning for being unable to practice, and how often they had lucid dreams about sprinting, if at all. The survey responses were only visible to the researcher.

Physical activity. The physical activity that was used in this study was a 40 yard sprint. The participants watched a video on how to run a 40 yard sprint with the correct form, so as to control for varying sprinting forms among participants. All of the groups had to run a timed 40 yard sprint once, before the study began, and again after they had been participating in the study for 30 days. They had an outside person record their sprinting time on a stop watch, and this person was the same person both times. The participants were also asked to try and dress the same for both the pretest and the posttest, in order to help control for outside variables.

The data for all of the pretest 40 yard sprint times was collected through self-report of the participant, specifically by e-mail. The data for all of the Posttest 40 yard sprint times was collected through self-report of the participant, also through e-mail. The data from the post test was then compared to the data from the Pretest, and was analyzed to see if the results were significant.

Analyzing the Results

The independent variable of the study was the type of practice in which the participants performed the sprints (mental imagery, lucid dreaming, or no practice). The dependent variable of the study was the time it took the participant to sprint 40 yards. In order to analyze the results of this study, I performed a one-way ANOVA. A one-way ANOVA is used to determine whether there are any statistically significant differences between the means of three or more independent groups, so I used this to compare the three groups in terms of improvement in sprinting time.

Summary

For this study, I recruited a convenience sample of individuals, attempting to get individuals who were not physically active on a regular basis. I divided them into three groups, a control group, a mental imagery group, and a lucid dreaming group. All of the participants recorded their 40 yard sprint time before they began the study. Then, two out of the three groups attempted to practice the 40 yard sprint four days a week for 30 days, whether it was through the usage of mental imagery, or lucid dreaming about the sprints. After 30 days, all of the participants recorded their 40 yard sprint time again. These times were reported to the researcher, along with their answers to a post-study questionnaire, where they gave demographic information, information about how many practice days

participants missed, reasoning for missed days, and other valuable information to the study. The times were compared and statistically analyzed in order to determine whether or not any of the results had significance.

The following hypothesis were tested:

*H*1: If an individual uses some form of practice, their athletic performance in sprinting will be improved in comparison to an individual not using any form of practice.

*H*2: If an individual practices mental imagery, their athletic performance in sprinting will be improved in comparison to not using any form of practice.

*H*3: If an individual uses mental imagery during lucid dreaming, their athletic performance in sprinting will be improved in comparison to use of mental imagery during an awake state.

Chapter Three

Results

In this study, I hypothesized that there would be a significant positive relationship between using some type of practice (mental imagery or lucid dreaming) and athletic performance in the form of sprinting. I hypothesized that the Lucid Dreaming group would have the largest significantly positive relationship between the technique used (lucid dreaming) and athletic performance.

Initially, I calculated the percentage of change in sprinting speed between the initial sprinting speed and the final sprinting speed for each of the participants in all three of the groups. After calculating each participant's percentage of change in their sprinting times, I then calculated and compared the means of all three groups. When calculating the means of the three groups, I discovered that all three groups had a positive relationship between their method of practice and their athletic performance through sprinting in that every group had an overall speed increase from their initial sprint to their final sprint. I concluded that the Mental Imagery group had the lowest percentage of change ($M = 0.02$, $SD = 0.028$) or roughly a 2% increase in speed. The control group had the second highest percentage of change ($M = 0.03$, $SD = 0.067$) or roughly a 3% increase in speed. Finally, the LD group had the highest percentage of change ($M = 0.045$, $SD = 0.085$) with roughly a 4% increase.

I performed a one way ANOVA in order to determine statistically significant differences between the means of three or more independent groups. Through the one way ANOVA, I determined that there was no statistically significant difference between the groups, $F(2, 45) = 0.321$, $p > .05$. I failed to reject the Null Hypothesis.

I performed a statistical analysis in order to determine if there was a significant relationship between participants who had a lucid dream and their athletic performance. I used a Pearson correlation and compared the number of times people had a lucid dream with their percentage of change in sprinting time. Results of the Pearson Correlation indicated that there was not a significant positive association between the amount of lucid dreams and the percentage of change in sprinting time, $r(24) = .213$, $p > .05$. I performed another statistical analysis in order to determine if there was a significant relationship between participants who had a lucid dream in which they were sprinting and their athletic performance. I used a Pearson Correlation and compared the number of times people had a lucid dream about sprinting with their percentage of change in sprinting time. Results of the Pearson Correlation indicated that there was not a significant positive association between the amount of lucid dreams about sprinting and the percentage of change in sprinting time, $r(24) = .209$, $p > .05$.

An additional exploratory analysis was conducted to determine if the confounding variables of age and gender had significant effects on sprint speed. I performed a Pearson Correlation and compared the ages of participants with their corresponding percentage of change in sprinting speeds. Results of the Pearson Correlation indicated that there was not a significant positive association between the age of a participant and the percentage of change in sprinting time, $r(47) = .359$, $p > .05$. Independent samples t-tests were also conducted in order to determine whether or not there were any significant differences based on gender. Females ($M = 0.032$, $SD = 0.081$) and males ($M = 0.007$, $SD = 0.172$) did not differ significantly on percentage of change in sprinting speeds, $t(46) = 0.625$, $p > 0.05$.

Summary

To summarize, there were two main results I found through my analysis of the data. First, I discovered that there was an improvement in sprinting speed from the initial sprint speed to the final sprint speed. However, there were no significant differences in percentage of change of sprinting speeds between the control, mental imagery, and lucid dreaming groups. Thus, my hypothesis was not supported.

Chapter Four

Discussion

In the present study, I examined the relationship between mental imagery during lucid dreaming, mental imagery in general and athletic performance in the form of the sprinting speed of an individual. I tested two hypotheses in this study. The first hypothesis stated that using mental imagery or lucid dreaming would increase an individual's athletic performance in sprinting in comparison to an individual not using any form of practice. The second hypothesis stated that using mental imagery during lucid dreaming would increase an individual's athletic performance in sprinting in comparison to an individual using mental imagery during an awake state.

The area being researched in this study was a previously barely studied area in the field of psychology and sport psychology. The previous researchers in this area had focused mostly on heart rate changes during lucid dreaming, as well as the ability to improve performance in a specific task on a computer after lucid dreaming about this same task (Stumbrys et al., 2016). No previous research has been done on measuring performance improvement in some type of athletic activity. Through my study, I introduced a new paradigm of study in sport and exercise psychology. Because of the lack of research in this area, it was difficult to predict what types of difficulties could potentially arise from methodology and participants. Future research using this new paradigm can greatly benefit from the contributions of this study. The methodology and results can be used to formulate future methodologies and help control for newly discovered extraneous variables. The results of this study can also be used in order to

decipher what new hypotheses and research questions will most accurately determine whether or not lucid dreaming can have a significant impact on athletic performance.

Through a comparison of all of the means of the groups, a positive relationship was found between mental imagery and sprinting speed. A greater positive relationship was found between mental imagery during lucid dreaming and sprinting speed, as well. Therefore, there was a numerical improvement, but it did not obtain significance through statistical analysis. However, a positive relationship was also found between the lack of practice and sprinting speed, so this did not support the first hypothesis. Although some hypotheses were supported in regards to positive increases in sprinting speed, I performed a further statistical analysis of the data with a one way ANOVA, and confirmed that none of the comparisons of change in sprint speed between the three groups were statistically significant.

Limitations

There were many different factors that could have affected the results of this study. I used a convenience sample in order to collect participants. I collected participants from a post with my social media accounts on Facebook and Instagram, which resulted in many of the participants already knowing me. This also resulted in the majority of the participants being around the same age as me (late 20s or early 30s). I also collected participants by referral of friends or family, which caused them to know someone personally tied to me. I attempted to gather participants from lucid dreaming forums, in order to increase the ability to lucid dream among participants. However, after multiple attempts and posts on these forums, no one from these sites contacted me with participation inquiries. As a result of my recruitment process and sample pool of

participants, many of the participants knew me, which could have been a limitation in the study. The lack of a blind research study could have caused the participants to try harder during the study in order to achieve a more favorable result, since they knew I would see their results. The fact that multiple participants were also recruited by someone close to me (a family member or close friend) could have also caused those participants to try harder in order to achieve a favorable time.

Using the method of self-reporting for having participants report their sprinting times could have also affected the results. There were many people who reported their sprinting times to me who expressed slight embarrassment or hesitation in telling me their sprinting time, sometimes even apologizing for having such a slow time. Although they had another person time their sprints, they could have still altered or falsely reported the sprinting time to me if they wanted, and could have reported a faster sprinting time in order to appear more "impressive" or "fast" to me. This was also shown through some of the reported times of participants, that were very unrealistic for an average person, and even unrealistic for a professional athlete. One of the participants reported sprinting a 40 yard sprint in 4.27 seconds and 4.58 seconds. These times would be very difficult to achieve for one of the top level NFL players, so the likelihood of this being an accurate time recorded for one of the study participants is very small.

Another limitation of the study was the extremely high attrition rate of the participants. I started with 180 participants for the study, and ended up with 48 participants. A total of 132 participants dropped out of the study over the span of five weeks. The most common reason for dropping out of the study was that the participant "had a lot on their plate right now." Although I knew many of the participants personally,

there was still a lack of motivation in the participants, especially since I was attempting to have participants who were not high level or consistent athletes, in order to control for those variables. The study was not of high importance to many of the participants, which resulted in groups that consisted of less than 30 people. The statistical power of the analysis was lessened due to the low N of the study.

There were also new extraneous variables that were discovered, as a result of the study. Multiple participants reported experiencing negative side effects in regards to their sleep once they began attempting to lucid dream. This was new information that was not included in previous research regarding the use of lucid dreaming as a means to increase performance. In terms of the negative side effects, some participants reported experiencing more restless sleep, and other participants reported experiencing insomnia. A fewer amount of participants reported experiencing "extremely vivid dreams," which did not bother them or fit the criteria for nightmares, but the participants still noticed a dramatic change from not previously having frequent dreams to now having very vivid dreams. Finally, an even fewer amount of participants reported having frequent nightmares after beginning the practice of lucid dreaming. Some of these participants chose to drop out of the study due to the increased frequency of nightmares, whereas other participants remained in the study and did not report the nightmares until the end of the study survey.

When confronted with this new information regarding potential side effects during the study, I reminded the participants that they could drop out at any time. When the participants did not notify me of the side effects until after the study had already been completed, I confirmed with the participants that the nightmares were not negatively

impacting their lives and asked them to please notify me if the nightmares continued. However, this new information regarding potential side effects would be important to take into consideration when designing future research involving lucid dreaming. It would be appropriate to include potential sleep-related issues into the informed consent form. It would also be appropriate to have resources available for the participants in order to eliminate any unwanted lasting effects of the lucid dreaming technique. These unexpected side effects could have been an additional limitation to this study, as well. If a participant experienced increased sleep issues, this could have decreased the motivation of the participant to continue to try to lucid dream due to the desire to avoid these side effects. This could have decreased the frequency for which they practiced the lucid dreaming technique, as well as the amount of time for which they practiced.

Future Directions/Recommendations

Previous researchers in the field of mental imagery and performance have determined that the use of mental imagery improves performance (Bramson et al., 2008). This was in alignment with the results of this study, in which athletic performance was increased when a participant used mental imagery or mental imagery in the form of lucid dreaming. The results of this study were also similar to results of previous studies in that all of the groups that practiced any kind of technique showed improvement in performance (Stumbrys et al., 2016). However, this study differed from previous research in that the control group that did not practice any technique also showed improvement in performance. Previous results from studies performed on the effect of lucid dreaming on performance were determined to be statistically significant after analysis was performed (Stumbrys et al., 2016). However, this also differed from my own study, since my results

were not statistically significant. Previous research in the field of lucid dreaming and performance has also been limited in regards to the number of participants, with one study having only 14 participants (Erlacher & Schredl, 2008). This was also a limitation in the present study. Although the number of participants was increased in the present study, it was still a less than desirable amount of participants, especially when investigating three separate groups of participants. This is an area upon which the research can still be improved.

For future research, it would be helpful to have a larger number of participants in order to be able to increase the statistical power of the analysis. Using the lucid dreaming technique with actual athletes could also increase motivation and consistency of practice among the participants. If higher level or collegial athletes could be used in future research, they would have a stronger personal desire to improve in their own athletic performance. If the study was performed with high level athletes, then the participants would also be more equal across the groups in terms of exercise level, performance level, and overall athletic ability. This would help control for outliers in terms of physical capabilities among the participants.

For future research, it would also be beneficial to investigate solely a control group and a lucid dreaming group in one study. Results of previous studies have been unclear as to whether or not the positive effect of lucid dreaming on performance was due to the lucid dreaming itself or the use of mental imagery used to induce lucid dreams. The purpose behind the design of the present study was to further investigate the direct source behind the positive effect on athletic performance. This was the reasoning for using a group in the study that consisted of participants using the mental imagery technique.

However, I did not anticipate that some of the participants in the lucid dreaming group would never lucid dream at all, even though they were still using the technique to induce lucid dreaming at night. Therefore, if future researchers were to perform a study using a control group and a lucid dreaming group, they could simply compare the athletic performance of the participants that did lucid dream with the participants that tried to lucid dream, but were unable to achieve any lucid dreams throughout the study. This would show whether or not the results were due to the technique used to induce lucid dreaming, or from the lucid dreaming itself.

For future research, it would also be helpful for the participants to not know the researcher or the person recording the sprinting times/athletic performance. It would also be useful if the person recording the sprinting times was then the person to report the times to the researcher. This would help eliminate potential false data reporting, such as exaggerated times. This would also help lessen the variable of social desirability when reporting sprinting times to the researcher.

Furthermore, it would be ideal to have more time inducing lucid dreaming or having participants that are already able to consistently lucid dream. The participants in the present study were only given a week to try to learn how to lucid dream and it was difficult to learn in that amount of time, especially if they were not consistent in the practice of inducing lucid dreaming.

Conclusion

In this study, I examined the effects of mental imagery during lucid dreaming and mental imagery in general on one's athletic performance in the form of their sprinting speed in a 40 yard dash. Through my results, I found that athletic performance in the

form of sprinting increased among all groups. Participants who used lucid dreaming as their form of practice had the highest level of increase in their athletic performance. However, after further statistical analysis in the form of a one way ANOVA, I determined that none of these results were statistically significant.

These findings could suggest that there might be a statistically significant relationship between lucid dreaming and athletic performance in the form of sprinting speed, especially since there was an initial increase in athletic performance due to lucid dreaming. However, a study needs to be performed with a larger group of participants in order to have more data to analyze.

The results of this study can be used to design future research in the area, especially in regards to participants and recording of data. It would be helpful for future researchers to collect participants with a higher level of motivation, ideally high level athletes who are looking to continuously improve their athletic performance. It would also be useful if future researchers did not know the participants and did not use self-reporting as a method of data collection. This would allow for more accurate results.

Previous researchers in the area of mental imagery and performance have found that the use of mental imagery increases performance. Furthermore, they have also found that the use of lucid dreaming increases performance in an activity. I found the use of mental imagery to increase athletic performance in my study, as well. However, despite a positive relationship between the form of practice used and the athletic performance of an individual, I failed to find statistically significant evidence that lucid dreaming or mental imagery in general have an effect on athletic performance in the form of sprinting speed.

References

Bar-Eli, M., Blumenstein, B., Dreshman, R., & Weingstein, Y. (2002). The effect of mental training with biofeedback on the performance of young swimmers. *Applied Psychology: An International Review, 51*(4), 567-581.

Blackwell, S. E., Carlier, I. E., Giltay, E. J., Middelkoop, V. D., Rius-Ottenheim, N., Schulte-van Maaren, Y. M., & Zitman, F. G. (2013). Optimism and mental imagery: A possible cognitive marker to promote well-being? *Psychiatry Research, 206*(1), 56-61.

Bramson, R., Fossum, T. W., Sadoski, M., Sanders, C. W., Van Walsum, K., & Wiprud, R. (2008). Learning basic surgical skills with mental imagery: Using the simulation centre in the mind. *Medical Education, 42*(6), 607-612.

Byblow, W. D., Collet, C., Guillot, A., Lebon, F., & Stinear, C. M. (2012). The modulation of motor cortex excitability during motor imagery depends on imagery quality. *European Journal of Neuroscience, 35*(2), 323-331.

Chan, C. (2012). Promoting physical activity with goal-oriented mental imagery: a randomized controlled trail. *Journal of Behavioral Medicine, 35*(3), 347-363.

Choi, C. W., Honeycutt, J. M., & Bodie, G. D. (2015). Effects of imagined interactions and rehearsal on speaking performance. *Communication Education, 62*(1), 25-44.

Coelho, C. J., Fenn, K. M., Nusbaum, H. C., & Rosenbaum, D. A. (2012). Imagined actions aren't just weak actions: Task variability promotes skill learning in physical practice but not in mental practice. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*(6), 1759-1764.

Dixon, P., & Glover, S. (2013). Context and vision effects on real and imagined actions: Support for the common representation hypothesis of motor imagery. *Journal of Experimental Psychology: Human Perception and Performance, 39*(5), 1352-1364.

Ellis, R., Hogard, E., Kelly, C., Smith, D., & Wright, C. (2008). Effect of PETTLEP imagery training on performance of nursing skills: Pilot study. *Journal of Advanced Nursing, 63*(3), 259-265.

Erlacher, D., & Schredl, M. (2008). Cardiovascular responses to dreamed physical exercise during REM lucid dreaming. *Dreaming, 18*(2), 112-121.

Fell, N. T., & Wrisberg, C. A. (2001). Mental rehearsal as a complementary treatment in geriatric rehabilitation. *Physical and Occupational Therapy in Geriatrics, 18*(4), 51-63.

Kraeutner, S. N., MacKenzie, L. A., Westwood, D. A., & Boe, S. G. (2016). Characterizing skill acquisition through motor imagery with no prior physical practice. *Journal of Experimental Psychology: Human Perception and Performance, 42*(2), 257-265.

Lejeune, M., Decker, C., & Sanchez, X. (1994). Mental rehearsal in table tennis performance. *Perceptual and Motor Skills, 79*(1), 627-641.

Mailhot, L., Mouanda, J., & Thill, E. E. (1998). On how task-contingent rewards, individual differences in causality orientations, and imagery abilities are related to intrinsic motivation and performance. *European Journal of Social Psychology, 28*(2), 141-158.

Rubin-Rabson, G. (1941). Studies in the psychology of memorizing piano music VI: A comparison of two forms of mental rehearsal and keyboard overlearning. *Journal of Educational Psychology, 32*(8), 593-602.

Saimpont, A., Lafleur, M. F., Malouin, F., Richards, C. L., Doyon, J., & Jackson, P. L. (2013). The comparison between motor imagery and verbal rehearsal on the learning of sequential movements. *Frontiers in Human Neuroscience, 7*.

Sanders, C. W., Sadoski, M., Wasserman, R. M., Wiprud, R., English, M., & Bramson, R. (2007). Comparing the effects of physical practice and mental imagery rehearsal on learning basic venipuncture by medical students. *Imagination, Cognition and Personality, 27*(2), 117-127.

Stumbrys, T., Erlacher, D., & Schredl, M. (2016). Effectiveness of motor practice in lucid dreams: A comparison with physical and mental practice. *Journal of Sports Sciences, 34*(1), 27-34.

Woody, R. H. (2006). Musicians' cognitive processing of imagery-based instruction for expressive performance. *Journal of Research in Music Education, 54*(2), 125-137.

Appendix A

Consent Form

Consent Form

You are invited to participate in a research study conducted by Tressa Solovy, a student in the PsyD. program at Northwest University. The study is being conducted as a requirement for graduation. The purpose of this study is to understand the effects of lucid dreaming on athletic performance.

If you agree to participate in the study you will be automatically placed into a raffle for a $300 Visa gift card, the winner of which will be determined at the end of the study.

If you participate in this study, you will be put into one of three groups. One of these groups will focus on keeping the same routine and schedule that you currently have for 30 days, another group will practice mental imagery 5-10 minutes four days a week, and another group will practice techniques to induce lucid dreaming 5-10 minutes four days a week.. You will be asked to try your best not to exercise for more than 75 minutes per week..

There are minimal risks associated with participation. This study involves the physical activity of sprinting for 40 yards, which might be tiring or uncomfortable for some participants. The participants also need to have their sprinting time recorded twice in the study, and this may make some individuals uncomfortable. You may choose not to participate in this research study. The benefit of taking part in this study is the opportunity to participate in the research process as a research subject.

Please do not participate if any of the following applies to you:
-You are currently injured
-You have high blood pressure
-You have cardiovascular disease
-You have any type of heart condition
-You have been advised by your doctor not to jog, run, or sprint

Participation in this study is voluntary. You may choose not to participate in this study at any time and for any reason. If you choose to drop out of the study, you will no longer qualify for the $300 Visa gift card. Apart from no longer qualifying for the raffle, there will not be any negative consequences for you if you refuse to participate. You may refuse to answer any questions asked. All responses and sprinting times are anonymous. You may request a copy of this consent form for your records. By completing this online questionnaire you are giving permission to use your results in this research study.

The results from this study will be presented in an academic and professional presentation. All data forms will be destroyed June 1, 2021.

If you have any questions about this study, contact Tressa Solovy at tressa.grummer12@northwestu.edu. If you have further questions, please contact my faculty advisor Kristin Mauldin, PhD at kristin.mauldin@northwestu.edu.

Thank you for your consideration of this request.

Tressa Solovy

tressa.grummer12@northwestu.edu

Faculty advisor, Kristin Mauldin, PhD

Appendix B

Control Group Instructions

Control Group Instructions

Thank you for your participation in this study. This is your instructional guide as to what you will be doing for the next two months while involved in this study.

Step 1 (Pre-Test):

Watch the video on sprinting. This video is a short tutorial about the proper form to use when sprinting 40 yards. The video can be found at this link:

https://www.youtube.com/watch?v=5cnVAgk3G7o

After you watch this video, you will sprint 40 yards one time. You will need to find someone to time your 40 yard sprint before you start the study. They may use any kind of stopwatch to time you, including the stop watch feature on an iPhone. Keep in mind that this person will need to be the same person who times your 40 yard sprint one month from now, so make sure it is someone who can measure you again at that time.

Go to a nearby track or field where you can accurately measure out 40 yards (ideally on a football field). Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Pre-Test Time"

Step 2 (One month study):

For the next 30 days, keep the following instructions in mind:

-Try not to exercise or play in any sports regularly (More than once every other week).

-Try to maintain the same diet and sleep pattern that you normally maintain.

-Try to maintain your usual routine in terms of extra-curricular activities and daily schedules.

Step 3 (Post-Test):

At the end of the 30 day period, do the following on Day 31: Watch the same video on sprinting that you watched at the beginning of the study (The short tutorial about the proper form to use when sprinting).

After you watch this video, you will sprint 40 yards one time. Try to keep your appearance the same as when you ran your first sprint before the start of the study (ie: same outfit, same shoes, same hair style, etc...). Use the same designated timer that you

used in the beginning of the study to record your sprinting time. Have them use the same type of stopwatch that they used in the first sprint.

Go to the same track or field where you timed your first sprinting activity and measure out the forty yards in the same place as you did before. Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Post-Test Time"

Thank you, again, for your participation in this study. Please feel free to contact the researcher, Tressa Solovy at any time if you have any questions or concerns.

Tressa Solovy
(425)281-1278
Email: tressa.grummer12@northwestu.edu

Appendix C

Inducing Lucid Dreaming Instructions

Lucid Dreaming Instructional Guide

Thank you for your participation in this study. This is your instructional guide as to what you will be doing for the next month while involved in this study.

Step 1 (Lucid Dreaming):

Stage 1:

Before you go to sleep watch this five minute video titled, "A Beginner's Guide to Lucid Dreaming." Pay particular attention to the "MILD" dreaming technique, since this is the technique you will be using to lucid dream. The video can be found at the following link: https://www.youtube.com/watch?v=grf4PJ4-QUI

Stage 2:

After you watch this video, decide what reality checks you will use in order to determine whether or not you are lucid dreaming. Watch the short video below and choose from one of the five reality checks listed in the video.

https://www.youtube.com/watch?v=mtDV3j__oh0

Stage 3:

After you have watched the second video, get completely ready to go to sleep (whatever your typical bedtime routine is). Once you are lying in your bed and ready to close your eyes and go to sleep, make sure you are as relaxed as possible. Take three deep breaths in through your nose and out through your mouth in order to help you relax.

Close your eyes and think to yourself, "I am going to lucid dream tonight." Think this sentence to yourself 10 times. As you think this sentence to yourself, try to truly believe this sentence and think of it as a fact that is definitely going to happen. Think about the reality check you decided to do and think about this while you are saying these words to yourself. (Example: If I have decided to use the reality check of looking at a clock or a watch during my dream, I will think about looking at a clock or a watch as I'm thinking "I am going to lucid dream tonight.")

Repeat Stage 3 each night for one week. You do not need to repeat any of the other stages, unless you need to refresh your memory on some of the information.

Appendix D

Lucid Dreaming Group Instructions

Lucid Dreaming Handout

Thank you for your participation in this study. This is your instructional guide as to what you will be doing for the next month while involved in this study.

Step 1 (Pre-Test):

Watch the video on sprinting. This video is a short tutorial about the proper form to use when sprinting 40 yards. The video can be found at this link:

https://www.youtube.com/watch?v=5cnVAgk3G7o

After you watch this video, you will sprint 40 yards one time. You will need to find someone to time your 40 yard sprint before you start the study. They may use any kind of stopwatch to time you, including the stop watch feature on an iPhone. Keep in mind that this person will need to be the same person who times your 40 yard sprint one month from now, so make sure it is someone who can measure you again at that time.

Go to a nearby track or field where you can accurately measure out 40 yards (ideally on a football field). Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Pre-Test Time"

Step 2 (Lucid Dreaming about Physical Activity):

Do the following every night before you go to sleep:
Get completely ready to go to sleep (whatever your typical bedtime routine is). Once you are lying in your bed and ready to close your eyes and go to sleep, make sure you are as relaxed as possible. Take three deep breaths in through your nose and out through your mouth in order to help you relax.

Close your eyes and think to yourself, "I am going to dream about sprinting for 40 yards tonight." Think this sentence to yourself 10 times. As you think this sentence to yourself, try to truly believe this sentence and think of it as a fact that is definitely going to happen.

When you go to sleep, and you dream about sprinting for 40 yards, practice the sprinting in your dreams as many times as you can. Sprint the 40 yards in your dream, and then give yourself 30 seconds of rest before your next sprint. Then, sprint the 40 yards again in

your dream, and rest for 30 seconds again. Do this as many times as you can while dreaming.

Repeat this step every night of every day for 30 days.

Try your best to do this step every night, but if you every have any nights where you do not dream about sprinting, please document the day(s) this occurred, and report these dates to the researcher at the end of the study.

Step 3 (Post-Test):

At the end of the 30 day period, do the following on Day 31: Watch the same video on sprinting that you watched at the beginning of the study (The short tutorial about the proper form to use when sprinting).

After you watch this video, you will sprint 40 yards one time. Try to keep your appearance the same as when you ran your first sprint before the start of the study (ie: same outfit, same shoes, same hair style, etc...). Use the same designated timer that you used in the beginning of the study to record your sprinting time. Have them use the same type of stopwatch that they used in the first sprint.

Go to the same track or field where you timed your first sprinting activity and measure out the forty yards in the same place as you did before. Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Post-Test Time"

Thank you, again, for your participation in this study. Please feel free to contact the researcher, Tressa Solovy at any time if you have any questions or concerns.

Tressa Solovy
(425)281-1278
Email: tressa.grummer12@northwestu.edu

Appendix E

Mental Imagery Group Instructions

Mental Imagery Handout

Thank you for your participation in this study. This is your instructional guide as to what you will be doing for the next two months while involved in this study.

Step 1 (Pre-Test):

Watch the video on sprinting. This video is a short tutorial about the proper form to use when sprinting 40 yards. The video can be found at this link:

https://www.youtube.com/watch?v=5cnVAgk3G7o

After you watch this video, you will sprint 40 yards one time. You will need to find someone to time your 40 yard sprint before you start the study. They may use any kind of stopwatch to time you, including the stop watch feature on an iPhone. Keep in mind that this person will need to be the same person who times your 40 yard sprint one month from now, so make sure it is someone who can measure you again at that time.

Go to a nearby track or field where you can accurately measure out 40 yards (ideally on a football field). Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Pre-Test Time"

Step 2 (One month study):

Every day, for the next 30 days, do the following:

1. Sit or lie down in an area where you can feel relaxed and not bothered for five to ten minutes.

2. Close your eyes and visualize yourself sprinting the forty yards activity five separate times, with a thirty second rest period in between each sprint (Example: Imagine yourself sprinting 40 yards, then rest for 30 seconds. Then, imagine yourself at the same starting point sprinting the same 40 yards again, then rest for 30 seconds, etc...)

3. Do this once a day for the next 30 days.

4. Try your best to do your visualization once a day for 30 days, but if you happen to miss any days, write down which days you missed and report it to the researcher at the end of the study.

Things to keep in mind while visualizing and imagining yourself sprinting the 40 yards:

-Visualize yourself from an out of body perspective, rather than a first person perspective. So, imagine you are watching yourself sprint the 40 yards, rather than seeing yourself sprinting through your own eyes.

-Try to utilize all five of your senses in the visualization (ie: imagine the air temperature, the feeling of the grass/turf under your feet as you run, the smell of the air, the colors of the field/track, any sounds you might hear while sprinting, any tastes you might have in your mouth)

- Stay physically still as you visualize yourself sprinting, but try to imagine what it actually feels like in your body when you sprint the forty yards. Try to imagine the feeling of your legs and arms moving during your visualization, without actually moving them.

Step 3 (Post-Test):

At the end of the 30 day period, do the following on Day 31: Watch the same video on sprinting that you watched at the beginning of the study (The short tutorial about the proper form to use when sprinting).

After you watch this video, you will sprint 40 yards one time. Try to keep your appearance the same as when you ran your first sprint before the start of the study (ie: same outfit, same shoes, same hair style, etc...). Use the same designated timer that you used in the beginning of the study to record your sprinting time. Have them use the same type of stopwatch that they used in the first sprint.

Go to the same track or field where you timed your first sprinting activity and measure out the forty yards in the same place as you did before. Line up your front foot right behind the starting line. Have the designated timer count you down to your sprint by saying "Three, Two, One, Go" and begin sprinting on the word "Go." When the timer says, "Go," they will begin the stopwatch. Sprint as fast as you can for forty yards, and have the timer stop the stopwatch as soon as you cross the forty yard mark. Record your time and email it to tressa.grummer12@northwestu.edu with the subject "Post-Test Time"

Thank you, again, for your participation in this study. Please feel free to contact the researcher, Tressa Solovy, at any time if you have any questions or concerns.

Tressa Solovy
(425)281-1278
Email: tressa.grummer12@northwestu.edu

Appendix F

Warm Up Exercises

Sprinting Warm Up Exercises

Step 1:
Jog from the 1 yard line to the 40 yard line and then jog back to the 1 yard line. Jog fast enough that you can feel your heart rate increase and your body temperature increase slightly, but not so fast that you are profusely sweating or warn out at the end of your jogging. Repeat this twice. Therefore, you should have jogged a total of 160 yards when you are finished.

Step 2:
Loosen your hamstrings and calf muscles by performing a modified hurdler's stretch. Sit on the ground with your left leg straight out in front of you. Bend your right knee so the sole of your right foot is pressed against your left thigh. Keeping your back straight, bend at the waist and try to touch the toes of your left foot. Hold the position for 20 seconds. Repeat this stretch twice for each leg.

Step 3:
Stretch your foot muscles and ankles with heel-toe drills. Take a step forward, landing on the heel of your front foot. At the same time, raise yourself up on the toes of your back foot. Use a rolling motion to transfer your weight from heel to toe for each step. Perform the heel-toe drill for 20 yards.

Step 4:
Extend the range of motion in your hips with “A” marches. Walk with exaggerated steps, bringing your knees up high toward your waist. Bring your arms up with elbows bent and your fingertips pointing toward the sky each time you raise your knee. This drill will also help you practice and maintain the proper sprinting position and form.

Appendix G

Post-Experiment Questionnaire

Post-Experiment Questionnaire

1. Name
2. Gender
3. Age
4. Did you participate in athletics growing up? If so, what?
5. What is the highest level of athletics you have reached?
6. Do you typically exercise over 80 minutes per week?
7. During the study did you exercise less than 80 minutes per week or more than 80 minutes per week?
8. During the study, how often were you able to practice your assigned technique?
9. If you were unable to practice your assigned technique four times per week, what was the reasoning? (Example: forgot, sick, too busy, injured, etc...)
10. Did you lucid dream at all during the study? If so, roughly how many times?
11. Did you lucid dream about sprinting at all during the study? If so, roughly how many times?

Table 1

Participants' Pre and Post Sprint Times

Name	Group	Sex	Pre	Post	% Change
2	C	F	11.18	10.96	0.0197
3	C	M	5.19	5.21	-0.0039
4	C	M	5.39	5.65	-0.0482
5	C	F	6.95	6.68	0.0388
6	C	M	10.67	10.62	0.0047
7	C	M	6.13	5.34	0.1289
8	C	F	10.26	10.18	0.0078
9	C	M	5.37	5.278	0.0171
10	C	F	7.46	8.23	-0.1032
11	C	M	5.9	5.84	0.0102
12	C	M	8.03	7.3	0.0909
13	C	F	7.36	6.56	0.1087
14	C	M	6.1	5.4	0.1148
15	LD	M	6.9	6.93	-0.0043
16	LD	M	5.8	5.07	0.1259
17	LD	F	5.91	5.78	0.0219
18	LD	F	6.93	6.79	0.0202
19	LD	F	6.93	6.12	0.1169
20	LD	M	7.22	5.62	0.2216
21	LD	M	5.58	5.5	-0.7641
22	LD	F	8.19	8.11	0.0098
23	LD	F	8.18	8.14	0.0049
24	LD	F	6.25	6.12	0.0208
25	LD	M	5.4	5.33	0.0129
26	LD	M	5.6	5.76	-0.0286
27	LD	M	6.96	6.23	0.1049
28	LD	F	6.8	6.6	0.0294
29	LD	F	7.23	7.01	0.0304
30	LD	F	6.7	5.75	0.1418
31	LD	F	7.35	7.82	-0.0639
32	LD	F	4.27	4.58	-0.0726
33	LD	M	7.06	6.92	0.0198
34	LD	F	14.1	9.57	0.3213
35	LD	F	6.09	6.07	0.0033
36	LD	F	7.43	7.37	0.0081

Name	Group	Sex	Pre	Post	% Change
37	LD	F	7.74	7.71	0.0039
38	LD	M	6.1	5.8	0.0492
39	LD	M	5.53	5.47	0.0108
40	MI	M	7.42	7.35	0.0094
41	MI	F	13	12.6	0.0308
42	MI	M	6.27	6.24	0.0048
43	MI	F	6.79	6.62	0.025
44	MI	M	5.56	5.62	-0.0108
45	MI	M	5.1	5.1	0
46	MI	F	5.92	6.08	-0.027
47	MI	F	7.06	6.63	0.0609
48	MI	M	5.77	5.5	0.0468
49	MI	M	6.68	6.31	0.0554

Table 2

Means, SD, SE, Confidence Interval, Effect Size Estimates

Group	Control	Mental Imagery	Lucid Dreaming	Entire Sample
Average % of Change	0.0297	0.0195	0.0449	0.0355
Standard Deviation	0.064	0.0278	0.084	0.072347
Standard Error	0.018563	0.008358	0.01694	
Confidence Interval	[-0.00509, 0.06449]	[0.00227, 0.03673]	[0.011973, 0.077827]	
Effect Size Estimates	0.08	0.29	0.12	

Table 3

Control and Experimental Group Data Tables

Control Group	Mental Imagery Group	Lucid Dreaming Group
% of Change	% of Change	% of Change
-0.1032	-0.027	-0.0043
-0.0482	-0.0108	0.1259
-0.0039	0	0.0219
0.0047	0.0048	0.0202
0.0078	0.0094	0.1169
0.0102	0.025	0.2216
0.0171	0.0308	0.0143
0.0197	0.0468	0.0098
0.0388	0.0554	0.0049
0.0909	0.0609	0.0208
0.1087		0.0129
0.1148		-0.0286
0.1289		0.1049
		0.0294
		0.0304
		0.1418
		-0.0639
		-0.0726
		0.0198
		0.3213
		0.0033
		0.0081
		0.0039
		0.0492
		0.0108

Table 4

Average (Mean) Percentages of Change Table and Bar Chart

Group	Average % of Change	Standard Deviation	Standard Error
Control	0.0297	0.064	0.018563
Mental Imagery	0.0195	0.0278	0.008358
Lucid Dreaming	0.0449	0.084	0.01694

Figure 1

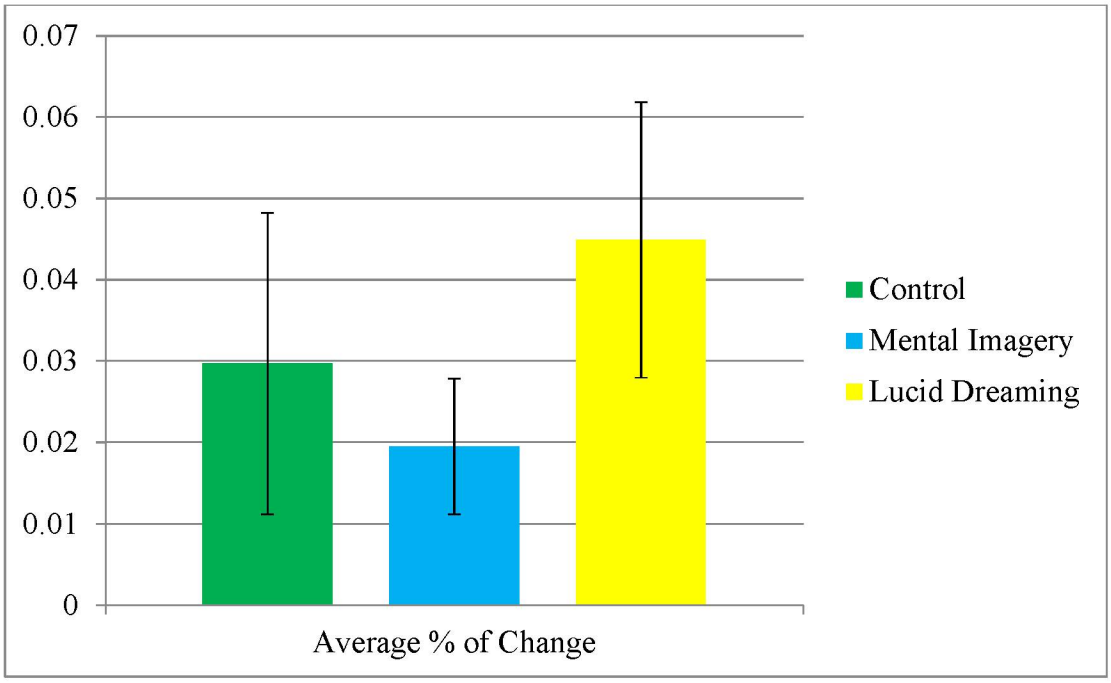

Figure 1. Average (mean) percentages of change among different groups. The y axis represents the average percentage of change that participants experienced between the pretest and posttest in the form of tenths of a second. The x axis represents the three different groups into which participants were divided in the study.