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Preventing Choking Under Pressure with Hemispheric Priming:

An Experimental Study of Vibration Stimulation for Priming

By

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The present thesis is submitted as Partial Fulfillment of the Requirements for the Degree of European Master of Sport and Exercise Psychology at The University of Thessaly in 2023

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Christopher Sebastian Bruntsch

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Abstract

The phenomenon of choking affects athletes across all sports. A simple definition of choking is when an athlete is unable to perform under pressure; even more, they are unable to perform under expectations of their ability. There has been evidence to suggest that choking occurs when the athlete switches focus on the outcome rather than the process. Furthermore, research has shown the positive effects of hemispheric priming of the brain to offset choking under pressure. This study tested whether or not priming the right side of the brain's hemisphere will have an offsetting effect on choking under pressure. The participants consisted of archers aged between 18 to 46 years ($M = 28.5$, $SD = 8.83$). All participants were male and shot right-handed. The experience of each participant ranged from national to international competition and 1 to 40 years of competition experience. The testing was done using a modern compound bow, and all of the setups were virtually identical. The study compared the performances of the archers in a pressure-free situation with that performed under pressure. The results indicated that hemisphere-specific priming extenuated a performance decrease after pressure induction when compared with a control condition ($t(30) = -4.945$, $p < .001$). This suggests that hemisphere-specific priming may prevent motor skill failure. For a real-world application, hemispheric priming can be used as a regulatory technique, much like breathing techniques. More information should be collected on the subject.

Introduction

What defines a champion? Many factors can contribute to answering this question, things such as natural talents, genetic advantages, unique skills are assets, or the ability to perform under pressure. An athlete can practice day and night non-stop when the moment comes for them to perform under pressure they are unable to. All that effort is now useless. The inability to perform under pressure is part of what makes competition so thrilling; no matter how advanced or novice one is in their sport, this inability to perform can affect anybody at any level. What contributes to this inhibition of having elite performance or minimal performance at the athlete's average level, whether genetic or social factors? Many things can contribute to the failure of performance. Let us take as an example scenario, the archer steps up on the shooting line; he is tied with this competitor going into the end of the tournament. His competitor has already shot his arrows and hit his bullseye all but once. The archer draws back, takes aim, and shoots his first shots bullseye; a sigh of relief comes over the archer. The archer loads up an arrow, draws back, and takes aim for a second shot. Twang goes the string, and again the arrow finds the middle; the archer exhales deeply. Now the archer thinks for a moment as he is loading up his third and final arrow; he is looking around the situation; he notices that the wind is picking up from the East slightly, his palms have become sweaty, and the crowd noise has come to a complete silence he knows that everybody is watching him for this final shot thinks about it. He knows with this shot if he makes a good shot, he can win the tournament; however, if he makes a worse shot he can lose the tournament altogether. He draws back, and the bow itself feels almost 5 kilos heavier than it had been just the shot before. The bow almost slipped out of his sweaty palms, and he can feel his heartbeat through his chest; he takes aim, and he notices that his side pin is not sitting still like it normally does it's bouncing along with the same rhythm as his heartbeat just as much as his front half is shaking his back after shaking too he's feeling the oxygen leave his body losing out, he sees one glimmer of the ideal side picture and releases the arrow. And with the sound of the arrow hitting the target, he could hear the crowd gasp and sighs looking at the target, the archer notices that he has missed his mark and has lost the competition. What led to the archer fall under the high-pressure situation, the weather, was it the crowd? Or was it a combination of all these things?

Situations such as this have bedeviled many athletes throughout all sports. Choking is what it is called when an athlete is unable to perform under pressure; even more, they are unable to perform under expectations of their ability. This thesis aims to help illuminate some factors that contribute to choking. It will then dive deeper into some possible interventions that can be used to help offset choking and some mechanisms that an athlete can use by themselves given that specific moment. Finally, the main purpose is to test whether or not priming the right side of the hemisphere will have an offsetting effect on choking under pressure. It is with hope that after this study, researchers and practitioners will have a better understanding and contribute to the growing amount of research it may help an athlete one day overcome perceived pressure to perform at their level or even beyond.

Dating back to the mid-1960s there has been a growing amount of research attempting to understand the effects of choking in a sports setting (Morton, 1969). Since then, various definitions and philosophies in research methodologies have been taken. More modern research has offered a more varied opinion and choking in sports; however it also lacks a consensus within this community regarding its mechanisms and moderators. There are few directly based interventions that have been designed for choking, and the ones that have become available may not be specifically geared towards a sports setting. It is with the hope that this research and future research may address these conceptual and methodological concerns. Although there is extensive evidence demonstrating the efficacy of psychological skills training with athletes under pressure in sport, its effects on those vulnerable to choking have yet to be fully proven conclusive. This specific research will offer interventions based on neurological principles and are supported by evidence given in neurological image imagery. This will offer more concrete data for coaches and athletes to use in a sports setting.

Definitions

Attentional Control Theory (ACT)

Based off of Eysenck and Calvo's *Processing Theory* (1992); attentional control theory is an approach to anxiety and cognition. It is assumed that anxiety impairs the goal-focused attentional network and increases the extent to which functioning is influenced by the stimulus-driven attentional network. In addition to decreasing attentional control, anxiety increases attention to threat-related stimuli. Anxiety's adverse effects on processing efficiency depend on two central executive functions involving attentional control: inhibition and shifting. However, anxiety may not impair performance effectiveness (quality of performance) when it leads to compensatory strategies (e.g., enhanced effort; increased use of processing resources). Directions for future research are discussed (Eysenck et al., 2007).

Attentional Threshold Hypothesis (ATH)

The attention threshold hypothesis argues that the mean latency of discovery latency can be minimized by selectively attending paying attention to one stimulus type at a time and switching to a more generally general receptive state when the rate of discovery rate falls below a threshold value. The model accounts for the fact that the response rate was highest toward samples containing a single grain type and decreased as the relative proportions approached equality (Bond, 1982).

Bilateral Stimulation (BLS)

Bilateral Stimulation is the use of alternating right, and left stimulation such as tapping on the knees, legs or shoulders, tapping toes or feet on the floor, or eye movements. Bilateral stimulation activates and integrates information from the brain's two hemispheres ("Definition of Terms," n.d.).

Choking

Choking is, understood to mean reduced performance under pressure (Baumeister, 1984, p. 610) and, more precisely, the occurrence of inferior underperformance despite striving and incentives to achieve maximum performance (Baumeister & Showers, 1986, p. 361).To classify a performance as a choke, it must be clear that the athlete has the ability to perform at a higher level and was motivated to perform during the competition. Choke cannot be looped into a random fluctuation of skill level but a negative reaction to perceived pressure (Beilock, 2007). Other researchers have stated that these definitions listed may not accurately show the full choking experience and argues that choking is a complete deterioration of skill rather than a poor performance (Gucciardi & Dimmock, 2008, Hill, Hanton, Fleming, & Matthews, 2009). This has left a divide in the data produced in the current literature and has added confusion amongst practitioners.

Broca's Region

Responsible for language production plays an important role in language comprehension. Brocas' area is also associated with movement and action, and is active in planning movements, mimicking movements, and understanding another's movement (Know Your Brain, n.d.).

Consciousness Processing Hypothesis (CPH)

Attention is focused inward in which an athlete is attempting to perform a task, consciously, processing explicit knowledge of how it works. The effect is a disruption of the automaticity of the task, which will lead to failure. It follows that disruption of automatic processing will be avoided if performers have little or no explicit knowledge of their skill (Masters, 1992).

EMDR (Eye Movement Desensitization and Reprocessing)

EMDR is a specific therapeutic technique used to treat individuals with Post Traumatic Stress Disorder (PTSD). The technique involves a therapist exposing the patient to bilateral stimulation (BLS), that involves alternating bilateral visual (eye movement), auditory, or sensory (e.g., tactile) stimulation. The techniques involve two main stages: desensitization of traumatic recollections and development and installation of a "resource," like safe and pleasant thoughts. The second is termed resource development and installation (RDI). Each stages use alternating BLS whereas at the same time having the person plan to recall the worst image of the trauma and therefore the installation of the resource. RDI has become a strong psychotherapeutic tool for relaxation and encompasses a large variety of resource development interventions throughout the stabilization section of posttraumatic stress disorder treatment (Amano & Toichi, 2016).

Functional Magnetic Resonance Imaging (fMRI)

Functional magnetic resonance imaging (fMRI) monitors little changes in blood flow connected to brain activity. Used to examine the brain's functional anatomy (it determines which elements of the brain are handling important functions). Functional magnetic resonance imaging might discover abnormalities inside the brain that can't be found with different imaging techniques (Radiology (ACR), n.d.).

Positron Emission Tomography (PET)

Positron emission tomography (PET) a kind of medical specialty procedure that measures the metabolic activity of the cells of body tissues. PET is a combination of nuclear medicine and organic chemical analysis. Used largely in patients with brain or heart conditions and cancer, PET helps to ascertain the biochemical changes happening within the body, like the metabolism (the method by that cells amendment food into energy when food is digestible and absorbed into the blood) of the heart (Positron Emission tomography (PET), n.d.).

Peripheral Nerve

Peripheral nerves are a significant a part of the nervous system. The nervous system consists of: Central System (brain and spinal cord), Peripheral Nervous System. Peripheral nerves reside outside your brain and spinal cord. It sends info from your brain to the remainder of your body. The peripheral system is split into two main parts: the autonomic nervous system (ANS): controls involuntary bodily functions and regulates glands, and somatic nervous system (SNS): controls muscle movement and relays info from ears, eyes and skin to the central system. Once we move, the brain sends a message to the spinal cord. The nerves carry the message to the required muscles to make them contract and manufacture movement. Similarly, once we make contact with object, sensory info is carried through the nerves to the spine then to the brain to create sense of that info (About Peripheral Nerves at UC San Diego Health, n.d.).

Sympathetic Nervous System

The sympathetic system is a component of the autonomic system, an in depth network of neurons that regulate the body's involuntary processes. Specifically, the sympathetic system controls aspects of the body associated with the flight-or-fight response, like mobilizing fat reserves, increasing the center rate, and releasing adrenaline (Editors, 2017).

Delimitations, Limitations, and Assumptions

One possible limitation to the application of hemisphere-specific priming would be the incapability with sports that focus on strength and stamina. Reason is that the movement is based on rather simple motor action (running, squatting, cycling), which does not necessarily comprise complex motor sequences that have become automated (Baumeister, 1984). This co-insides with an inverted U-Hypothesis which states the more perceived pressure introduced to an athlete, the great the performance ability until it reaches a point where pressure is too great and physical performance decreases, an exception this hypothesis has been strength sports due to the nature of extra stimulation may aid in simple motor movement. According to a meta-analysis performed by Bond and Titus (1983), performance supported strength and stamina wasn't worse in fact, even better under pressure. Therefore, the result of hemisphere-specific priming applies to performances focused on accuracy, as shown within the analysis. Such performances more a lot of advanced motor sequences (Ehrlenspiel, 2006) and are performed less well under pressure (Bond & Titus, 1983). Hence, enhancing right-hemispheric activity by compressing the left-hand helps the performance of advanced motor tasks. However, the performance of an easy motor action needn't be affected. This allowed a more precise method check the impact of hemisphere-specific priming on preventing motor ability failure based on the self-focus mechanism. However, during a true pressure scenario for example a competition, people don't seem to be given such self-focused directions before performing a motor task. An inferior performance might result from exaggerated self-focus and focusing attention on task-irrelevant stimuli (Mesagno & Mullane-Grant, 2010). Therefore, the result of hemisphere-specific priming is proscribed to alleviating self-focus solely, however it might in all probability not stop the distraction-based performance decline.

Literature Review

The acquisition of new knowledge is acquired over a lengthy process of consistent repetition. After some time, the knowledge becomes automatic; we can build effortless mechanics through practice and consistency. However, these automatic skills can fail an athlete at the most inopportune time. Many factors can influence an athlete's performance, such as environmental equipment failure. However, this paper will outline the psychological aspects of performance during sports competition and why failure occurs, and how it can be prevented or, at the minimum, negated.

A term used mostly to refer to an athlete's performance breakdown at a critical moment is called *Choking* (Baumeister, 1984). An example of this would be a basketball player who has practiced free throw shooting thousands of times, and the process itself is completely automated; however, when it comes time to shoot the game-winning free throw, the athlete shoots an air ball and misses the net. Athletes, coaches, and professionals would consider this phenomenon as a sign of choking where automatic processes fall short during critical moments. Pressure could be defined as any type of external factor or combination of internal-external factors that increases the perceived importance of optimal performance; this can include situations during competition or even in the presence of an audience or a system of reward or punishment contingency (Baumeister & Showers, 1986).

This literature review proposes the hypothesis that vibration is a viable stimulation for right hemispheric priming, and with the priming, an offset will negate the negative effects of choking in a high-pressure situation. The review will be broken down into four parts; first, it will introduce the theory of choking, give it a precise and cohesive definition, its relation to choking in sports and review the literature on the phenomenon. Second, it will dive into the various models of choking. Afterward, the section is going to cover quartic hemispheric responsibility. This will highlight the different regions of the brain and their respective duties concerning motor functioning. The third section that will be reviewed is hemispheric priming. This section will outline the various mechanisms at play when it comes to priming the brain and how this is a useful phenomenon to offset choking's negative effects within sports. Lastly, the final section will cover the use of vibration and its relation to cortex stimulation.

Choking

Athletes are praised for their physical attributes, such as speed, power, and agility. The physically dominant athlete will often come out as the victor; however, pressure can become a great equalizer. It is not uncommon to see a superior athlete on the field succumb to pressure and perform under their abilities. This phenomenon is known as choking. Choking repeatedly under pressure can lead to an athlete having the stigma of being a choke artist. Although choking may not present any physical harm to the athlete, it can lead to negative emotional and psychological effects such as anxiety, depression, low self-esteem, and burnout. A frustrating aspect of choking is that it can occur despite high motivation and strong work ethic, and maximal effort from the athlete. This section will define what choking is and how it pertains to sports; it will also cover various choking theories and the different models that apply to each theory, such as the self-focused model and distraction theory. In the last part of this section, the paper will outline neurological processes during choking, what parts of the brain become activated, and what inhibitions to learning motor functions occur during a high-pressure situation.

When discussing sports, the origin of the term choke seems to originate in the sport of baseball shortly after World War Two by famed St. Louis player Jackie Robinson one of the vital pennant battles in St. Louis, Robinson grabbed at his throat to signify that Bill Stewart, the umpire, was "choking up." Stewart threw him out of the game. Robinson suggested that the umpire was blowing calls throughout the game (The Random House Historical Dictionary of American Slang 1994).

Baumeister connected the first psychological investigation of choking and sport (1984), in which he simply defined choking as the "performance decrements under pressure circumstances" (p. 610). Baumeister and colleagues developed an initial choking model (e.g., Baumeister & Showers, 1986), which included pressure manipulations, manipulation checks, and measuring independent variables with self-report questionnaires, which are still widely used in choking research. This definition of choking is evolving and changing as more and more researchers are attempting to expand the definition to offer more precision and uniformity. Masters (1992) stated that choking is "the failure of normally expert skill under pressure."

More recent definitions that have become the new standard for researchers are proposed by Wang (2002), who had highlighted the perception of pressure and the level of performance degradation and learned skills are necessary components of a choking definition. Wang stated that choking was a deterioration in the execution of habitual processes of performance under pressure. Furthermore, Wang explained that deterioration meant a clear interruption in performance quality characterized by the performer trying too hard. Even more recently, Mesagno, Marchant, and Morris (2008) defined choking as "a critical deterioration in the execution of habitual processes as a result of an elevation in anxiety under perceived pressure, leading to substandard performance (p. 439)." For Mesagno et al. l choking is the combination of the failure of the athlete's perceived sense of control and skill of execution; pressure is the main culprit of discord, which explains the altercation of the athlete's performance process, which is cyclically resulting in choking. The habitual process that was referred to deals with the performance levels the athlete is used to (Routledge, 2014). Hanton, Fleming, and Matthews (2009) offered an alternative to choking "as a process whereby the individual perceives that their resources are insufficient to meet the demands of the situation and concludes with a significant drop in performance." The most recent clarification of choking when pressured happens once a competitor exhibits an acute performance decrement in an exceedingly competitive pressure scenario, which is attributed to a rise in anxiety and once acknowledged by the competitor that self-expected standards would otherwise be achieved (Mesagno & Beckmann, 2017)

The specificity of the definitions of choking in sports can vary amongst researchers; there are core elements consistent throughout the 35 years of study. The first element for choking is the athlete's perceived pressure; the second is anxiety, which can be attributed to the first factors, but the interpretation of anxiety can vary from person to person. Lastly, loss of attention at the task at hand, which results in performance substantially below the normal level, occurs and constitutes a choke. The term choke is a common sporting vernacular that has been used for 80 years; however, as researchers, caution should be used when saying choking under pressure. This is because of the various definitions that we had stated for choking to occur, pressure must occur, and if the athlete does not perceive pressure, then choking cannot happen. In the following passages choking in sports will be more closing explored and how researchers have been able to reproduce pressure to induce a choking situation.

Research Methods in Choking

As stated above, being able to research and fully understand the phenomenon of choking in sports can be rather difficult for researchers—the main reason being the recreation of pressure. If an athlete does not perceive pressure, then choking cannot occur and is a sort of tautology. So, what are some of the methods that researchers have used to induce and recreate pressure and how to better understand and explore this phenomenon? It is the aim that these studies will give further illumination as to how we can create and reproduce pressure for our experiment moving forward.

Beckmann and colleagues (2013) conducted three experiments to test the effects of right hemispheric activation and its ability to offset choking's negative aspects. The researchers had compared the performances of experienced athletes in soccer, taekwondo, and badminton. They first had a pretest analysis of the pressure-free situation and then a post-test of performance under pressure. To reproduce perceived pressure, the experimenters had done several steps. The induction of pressure included combinations of features such as competition, an audience's presence, ego relevance, and reward contingency. These methods are like a previous study conducted by Baumeister & Showers (1986). In the first two experiments, a baseline test was measured and the performance under pressure and compared the effects of hemispheric priming. The third experiment had consisted of two test phases under pressure; the first examined the main effect of pressure on performance (i.e., the occurrence of choking), and then used hemisphere-specific priming to test its effect. Researchers used the WettkampfangstInventar-State (WAI-S; Ehrlenspiel, Brand, & Graf, 2009) to test perceived pressure, which is an instrument based on the multidimensional model of competitive state anxiety by Martens (Martens, Vealey, & Burton, 1990). Like the Competitive State Anxiety Inventory-2 (Martens, Burton, Vealey, Bump, & Smith, 1990), it has often been used to check the effectiveness of pressure induction, comprised of 3 subscales questions that are answered on a 4-point liker type scale. It should be noted that only somatic and the cognitive subscales for the analyses represent the central aspects of anxiety. The WAI-S has sufficient internal consistency ranging from Cronbach's .72 for cognitive state anxiety to .88 for somatic state anxiety; its validity has also been well established (Ehrlenspiel et al., 2009; Strahler, Ehrlenspiel, Heene, & Brand, 2010).

There are several ways researchers have attempted to recreate pressure; competition, performance in front of an audience, and reward contingency, to name a few. A meta-analysis was conducted to determine the most common ways to induce pressure in athletes during practice. The results had shown that out of 47 studies, 91%, the pressure was induced artificially with a combination of reward contingency (K = 29), ego relevance (K = 23), videotaping (K = 19), simulated competition (K = 18), the presence of an audience (K = 9), performing at height (e.g., from a climbing wall; K = 4), and a math task (K = 1) (Mesagno & Beckmann, 2017). Previous researchers (e.g., Butler & Baumeister, 1998; Heaton & Sigall, 1991; Kurosawa & Harackiewicz, 1995; Lewis & Lindner, 1997) have successfully used financial inducements, audiences, and video cameras as pressure manipulations to induce performance pressure.

Qualitative research has offered several other theories as to why an athlete might perceive pressure during competition. In his earlier work, Baumeister (1984) reported that self-conscientiousness was a predictor of athletes being at a higher risk of choking. This was further supported by more recent research (Dandy, Brewer & Trotman, 2001; Wang, Marchant, & Gibbs, 2004; Wang, Marchant & Morris, 2004). Mesagno, Harvey, and Janelle (2012) had sought to understand what some athletes tend to self-monitor under pressure. They had proposed that trying to promote a positive self-image will minimize the effects of social anxiety. On the other hand, when athletes doubt they will be successful, self-presentation becomes a priority, increasing anxiety because of the possible negative effect of poor performance on the self being viewed by others. Furthermore, the concept of fear of negative evaluation (FNE) can precipitate choking Mesagno, et al. (2012).

Another factor associated with choking is trait anxiety (Baumeister & Showers, 1986), self-confidence (Baumeister, Hamilton, & Tice, 1985), skill level (Beilock & Carr, 2001), task properties (Beilock & Carr, 2001), stereotypical threat (Chalabaev, Sarrazin, Stone, & Cury, 2008), public status (Jordet, 2009a), dispositional reinvestment (Masters et al., 1993), fear of negative evaluation (Mesagno et al., 2012), audience effects (Wallace, Baumeister, & Vohs, 2005), and coping style (Nicholls, & Polman, 2007, 2008; Wang et al., 2004). Understanding what factors can create pressure for athletes gives researchers the ability to replicate and study the phenomenon of choking even more. The next section introduces two main concepts of choking the self-focus model and the distraction model and how researchers and coaches alike can use them to help athletes in the field.

Models of Choking

Self-Focus Model

Within the past 40 years of literature, two predominant models of choking have emerged: self-focus and distraction; each model helps practitioners highlight some common problems athletes face in high-pressure situations. When discussing the Self Focused model, otherwise known as explicit monitoring or automatic execution, numerous examples can be found in the early sports psychology literature where theorists subscribe to the importance of focusing on the performance process. Baumeister described his understanding of the self-focus model; under pressure, an individual realizes that it's necessary to properly execute the behavior. Consciousness makes an attempt to confirm the correctness of this execution by observation of the method of performance (e.g., the coordination and preciseness of muscle movements); however consciousness doesn't contain the information of those skills so it ironically reduces the dependability and success of the performance once it makes an attempt to manage it (p. 610)

Further examining the self-focus model, Lewis and Linder (1997) stressed the importance of self-awareness and competition amongst peers, performing in front of audiences, ego-relevance, and reward and punishments heighten the effects of self-awareness. Other theorists proposed that self-focus is simply pressure raising self-consciousness and anxiety about performing optimally; thus, this increases the attention to the processes and their complete control of their skill Beilock and Carr (2001).

Further literature of self-focus theories supports the notion that increased self-awareness will lead to an athlete focusing attention inwardly. There is a contingent factor of how well a Self-Focus model applies to an athlete, which is the athlete's overall experience (Hill et al., 2010b; Masters & Maxwell, 2008). A beginner, for example, during a competition, will focus on an explicit rule-based aspect of a skill as opposed to an automated task is outside working memory and breakdowns in performance resulting in reinvestment in well-learned skills and conscious processing through working memory.

The explicit Monitoring Hypothesis (EMH; Beilock & Carr, 2001) and the Consciousness Processing Hypothesis (CPH; Masters, 1992) are the more popular of the self-focus theories. The key difference is that Beilock and Carr, in describing EMH, state that by focusing step-by-step on mechanics causes the interruption in the completion of skills, whereas when Masters describes

CPH, he states that conscious controlling of the performance is detrimental. This raises the interesting and seemingly counter-intuitive possibility that as athletes become increasingly skilled and their level of explicit skill execution knowledge increases commensurately, they become increasingly vulnerable to performance degradation under stress (Papaioannou, 2014).

To counter the CPH theory, Hardy et al. (2001) had proposed the Attentional Threshold Hypothesis (ATH), which states that performance degeneration is the combined factor of thoughts of anxiety and explicit instruction that overrides the ability to remain focused. Anxiety requires attention, which is typically used for performance. This results in a detrimental effect on overall performance when an athlete has both anxiety-provoking thoughts and explicit instruction (Mesagno & Beckmann, 2017, Hardy et al., 2001).

Distraction Model

An alternative to the Self-Focused model is called a distraction model. Simply stated, a distraction model is created on the idea that a decrease in performance while under pressure happens because of the inability to concentrate on the task at hand instead of focusing on a task-irrelevant stimulus (Lewis & Linder, 1997). For example, during a high-pressure situation, an athlete will start to focus on external factors such as crowd noise, the game's score, etc. An effect of this is increased arousal, which will cause the player to hyper-focus on the external stimuli and not on the task itself, resulting in a decrease in performance (Sanders et al., 1978). Some athletes have found a solution to counteract being distracted by external factors is an overall increase in their technique (Murray & Janelle, 2003; Wilson, 2008; Wilson, Smith, & Holmes, 2007). Increasing effort does have its limitations during pressure situations because attentional abilities may become overwhelmed due to the high levels of anxiety (Williams, Vickers, & Rodrigues, 2002; Hill et al., 2010b).

A sub-theory of the Distraction model is Attentional Control Theory (ACT) Eysenck, Derakshan, Santos, & Calvo, 2007). The ACT model conceptualizes the fact that there are two main attentional systems at work, first one is a stimulus-driven system in which it is very reactive to external forces (scores, crowds, weather etc.). The second system is a goal-driven system that determines which attention is going to be selected. Anxiety will jeopardize the efficiency of the goal-driven system. It will decrease the overall ability to have attentional control through focusing of the attention honest demonstration system but the use of specific interventions, an athlete, will be able to avoid the denigration of performance and becoming hyper-focused on external stimulation and be more goal-driven oriented (Moser, Becker, & Moran, 2012; Wilson, 2008).

Self-focused and Distraction model

When a practitioner is attempting to develop an effective intervention that will help the athlete combat the negative effects of choking, it is important to select which model will apply because the interventions' nature is different. For example, a therapeutic intervention might emphasize reducing the athlete's distractions and refocusing on task-relevant features while performing. However, when using a self-focus model, there should be an effort to take away attention to certain technique steps during competition. Beilock and Carr stated that distraction theory is most applicable when skill execution relies on working memory to store decision and action-relevant information. In contrast, distraction models may be more applicable for strength and endurance dominant tasks and for novice and medium ability performers who have not fully automated their skills (2001). Other studies have discovered that self-focused theories were the main cause of choking but were dependent on technique complexity, the number of steps that needed to be carried out to complete the task Beilock, Kulp, Holt and Carr (2004).

Consequently, non-sensorimotor tasks, such as challenging mental arithmetic problems distraction theories, explain poor performance under pressure. Jackson, Ashford, and Norsworthy (2006) proposed that process goals may activate attentional focus that helps in cognitive tasks and prevent a step-by-step on the processes governing skill execution. It is also widely recognized that distraction theories offer a better explanation for poor performance under pressure for novice performers (e.g., Beilock et al. 2004).

Recent students have shown that elite-level athletes completing complex motor tasks show they tend to perform better in a dual-task situation. Reason begin, experts can do techniques on the autonomous level resulting in better performance under pressure when introduced with an extra task such as counting or playing a song in your head. This additional task prevents the athlete from over-analyze autonomous learned techniques (Beilock & Carr, 2001, 2004; Beilock, Wierenga, & Carr, 2002; Gray, 2004). On the other hand, when a beginner is asked to function with multiple tasks under pressure, they typically perform worse than in a single task condition because they require their working memory to assist with step-by-step task execution (Papaioannou, 2014).

To offer a more comprehensive understanding of both choking self-focus and distraction models. Babiloni and colleagues had begun to test a neural efficiency hypothesis using several electroencephalograms (EEG) high-resolution machines on elite and amateur karate athletes. The concept of neural efficiency states that more experienced athletes tend to have less critical or brain activation while conducting various techniques within their sport as compared to amateur athletes. This is supportive of the idea that elite-level athletes tend to perform better in a dual-pass situation simply because they are using less cortical activity in a high-pressure environment Beilock & Carr, 2001). More recent evidence has shown that the neural efficiency hypothesis can apply to athletes from kendo (Kita et al., 2001), rifle and gun shooters (Fattapposta et al., 1996) and fencing (Percio et al., 2009).

Choking has a long history within sports; starting back 80 years, the definition has expanded and altered greatly in the past 45 years. When an athlete chokes under pressure, there is a significant performance decrease during competition; this is attributed to an increase in anxiety when an athlete acknowledges that self-expected standards would otherwise be achieved (Mesagno & Beckmann, 2017). To research and fully understand the phenomenon of choking, researchers have gone into various techniques to induce pressure under competitive situations without the introduction of pressure, and choking cannot occur. Some of these various methods are competition amongst peers, financial incentives, videotaping, and performance under an audience (Beckmann et al., 2013). We introduced the two main models for choking first one is a self-focused model, which occurs when a person realizes consciously that it is important to execute behavior correctly. The focus is now shifted to ensure the technique's correctness by overanalyzing their coordination and movements. This, however, negatively affects the overall ability to perform at once on standard because consciously controlling your movements will stifle any preprogrammed learning behavior (Baumeister & Showers, 1986). The second common model for choking is known as the distraction model, and this is simply when the athlete becomes focused on a stimulate that is irrelevant to the test that needs to be performed usually this is external factors such as score, crowd size, tournament situation, weather etc. (Baumeister & Showers, 1986). The next section will highlight which part of the brain holds certain responsibilities regarding test management and attentional focus on particular stimuli.

Cortex hemispheric responsibility

For an athlete to learn a new technique, two things need to happen; the athlete needs time and repetitions. To learn a new skill, there must be a certain amount of time; a number that has been used in literature is 10,000 hours for an athlete to reach mastery in a skill (Avanzini et al., 2016). The second factor at play is repetitions of the technique; thousands of repetitions are typically required for an athlete to function in a consistent manner (Baumann et al., 2005). This section will give an overview of the neurological process at work when an athlete executes that specific technique, cortical responsibility, and application in the sporting field.

The two previous models mentioned offer practitioners an insight into the reasoning behind choking. However, there is still another aspect that, until recently, had remained in the dark. Recent advances in neuroimaging have given researchers access to brain activity in athletes while conducting experimental techniques. Certain neural pathways are engaged in attentional control, performance monitoring, mood regulation, reward processing, and motivation, according to an increasing body of data (Yu, 2015). This enables current research to support current models of choking under pressure. Each theory makes a prediction about how the brain works. The distraction concept, for example, proposes that choking under pressure is linked to activity in the executive function region of the brain. If the distraction theory is right, activity in attention control regions should be lowered when people choke, and the degree of choking should be predicted by the reduced engagement of attention control regions.

Conversely, a self-focus model would hypothetically show hyperactivity in attention control regions, and this overstimulation would be associated with individuals' propensity to choke. The over-arousal theory would hypothesize the involvement of reward-sensitive regions in choking effects. Reward itself is central to emotion, motivation, learning, and uprising. Our brains have specific pathways efficiently specializing in processing rewards (Frank et al., 2014, (Kim et al., 2011).

Neurological perspective

Using a functional magnetic resonance imaging (fMRI), Mobbs et al. developed a study within which a participant played a video game; they controlled a blue triangle (the predator) to capture an AI prey to win either small reward (£0.5) or a high reward (£5) (Mobbs et al., 2009). The results showed that participants were less able to catch the high reward prey than the low-payoff prey and created additional errors within the high- than within the low-reward condition. Information from the functional magnetic resonance imaging showed that once participants were closer to the prey, activity in reward regions escalated within the orbitofrontal cortex. Apparently, the constant impact of distance within the left middle effect was considerably stronger in high-reward vs. low-reward conditions, theorizing that these regions inscribe reward incentive as a function of goal distance. Activities within the right prefrontal cortex showed the alternative patterns and were related with higher performance and reduced susceptibility to incentive-induced errors within the high-payoff condition relative to the low-payoff condition. The information shows that increased motivation registered within the mid-cortex produces choking, whereas increased cortical management could reduce it, supporting the over-arousal theory.

As a result of the midbrain is sufficiently made in dopaminergic cells and is the key part of the dopamine system, the results imply that neurotransmitter dopamine plays a major role in choking under pressure. To offer support for this position, a positron emission tomography (PET) study found that dopamine secretion was correlated to poor performance during a cognitive management task (i.e., the Stroop task) once incentives were high (Aarts et al., 2014), suggesting that financial bonuses could impair cognitive management via over-exciting the dopaminergic system (Silston and Mobbs, 2014). More research has shown that individuals show a significant increase in a tendency to activate and deactivate in motor performance when incentives are increased (Chib et al., 2014). These studies show the importance loss avoidance has on whether an athlete chokes under pressure or not. Nevertheless, it is still difficult to discern the relationship between the excitement of success (reward sensitivity) and fear of loss. They do, however, provide some support for a distraction model theory.

The studies that used neuroimaging equipment have shown that certain brain regions are vital to emotional regulation and motivation, which relate to choking under pressure and how the brain responses differ during the anticipation and execution stage. A key factor is where the source of perceived pressure is coming from, depending on where certain brain regions are activated during the anticipatory stage. If the pressure originates from a reward (reward sensitivity), neural networks that are connected to rewards are activated, which can signal the "excitement" of achieving the reward (Mobbs et al., 2009; Chib et al., 2012). When the pressure rises from fear of failure, neural pathways connected to negative valence are fired (Lyons & Beilock, 2012). Perceived pressure or excitement may influence performance and affect the mechanisms responsible for encoding the type of pressure itself.

Dual Neural Networks

A recent paper discussed the theoretical involvement of two distinct brain networks. Frist is the salience (emotional reactivity and attentional awareness); the second is, the executive control network (working memory and decision making) during stressful situations (Hermans et al., 2014). The two networks have different functions in performance under pressure. The sympathetic nervous system's emotional, physiological reaction results in sweaty palms, elevated heartbeat and can become exasperated when attempting to perform under pressure. Compared to the executive network could improve performance under pressure, al be it task specificity. It can be assumed that a balanced of the salience network vs. execute control network is needed for proper performance under pressure (Hermans et al., 2014).

Further neurological tests need to be conducted to solidify a dual network theory that affects performance under pressure. Choking has been linked to increased activity in motivation-related regions such as the midbrain, striatum, and insula (Mobbs et al., 2009; Chib et al., 2012, 2014; Lyons and Beilock, 2012b), as well as decreased anterior activity (Lyons and Beilock, 2012a; Lee and Grafton, 2015), supporting the dual-system theory of stress and performance. When people are stressed, the cortical region's activation is inhibited, whereas neural responses in the subcortical brain areas increase. In terms of neuroimaging, further research is needed to better understand what distinguishes "chokers" from those who excel under pressure. More data is needed to establish a causal relationship.

Hemispheric Priming

While learning a basic motor task, there are highlights of activity in the left side of the brain's prefrontal cortex region (Blefari et al., 2015, Ungerleider et al., 2002). Language centers are also associated with the left frontal cortex; researchers Zhu and colleagues had shown that giving learners explicit instruction about golf putting resulted in an activation of both the left hemisphere and motor regions while under pressure (Zhu, Poolton, Wilson, Maxwell, & Masters, 2011). Further evidence suggests that practice has a negative link with prefrontal activation; the more an individual repeats a task, the lower its prefrontal activation becomes and the activity moves to the basal ganglia (van Mier et al., 1998, Seidler & Meehan, 2015). The left hemisphere becomes less active, while the right hemisphere's visual-spatial activities become more dominating

(Salazar et al., 1990). According to new research, the front motor areas of the left hemisphere are engaged in initiating skilled motor action, but these areas become inhibited after the behavior is initiated. A shift from left to right hemisphere activity was observed in exceptional rifle shooters (Hatfield et al., 1984), and comparable results were observed in archers (Salazar et al., 1990) and golfers (Salazar et al., 1990). (Crews & Landers, 1993).

The effect of altering neural networks is more dominant in expert athletes than novices (Haufler, Spalding, Santa Maria, & Hatfield, 2000), this also provides the notion that experts can operate on a sub-conscious level in performing their task. Further data shows a correlation between left-hemispheric inhibition and better performance; in a study that sought to understand what factors lead to poor putting accuracy in elite golfers. The results showed that greater activity in the left hemisphere, as opposed to golfers who were able to experience left-hemispheric inhibition, had shown more accurate putting skills (Crew, 2004).

The previous study of golfers (Crew, 2004) had shown that left-hemispheric deactivation could increase performance; there has also been shown a positive correlation with right hemispheric activation performance (e.g., Hatfield et al., 1984; Hillman et al., 2000; Salazar et al., 1990). Right activation is associated with visual-spatial processing (Et & F, 2008) and the generalized process of motor task execution (Lusebrink, 2004). Among semi-elite archers' motor performance was increased with the use of neurofeedback that targets right-hemispheric activity. Compared to archers who showed a greater amount of left-hemispheric activity showed poor results (Salazar, & Crews, 1991). To summarize, this research shows that right hemispheric activity should be enhanced for a good performance, and left-hemispheric activity should be reduced. Both Crews (2004) and Salazar and colleagues (1990) have shown that poor performance among elite athletes has been linked to increased left-hemispheric activation. It is not an overstatement to propose that asymmetrical cortical activity negatively reflects the cognitive phase of motor learning, which happens under pressure, thus choking.

The perception of pressure can cause an athlete to focus on the proper execution of motor action (Baumeister & Showers, 1986). The shift of attention to one's movement can activate Broca's region of the brain. This region is associated with language (Liberman, 1996). This results in increased cognition involvement with motor processes (Deeny et al., 2003; Zhu et al., 2011), which disrupts the automatic execution of a skilled behavior, leading to performance breakdown. To show occurrence, elite golfers were verbally instructed to think about the specific steps to putting, this showed a dip in performance when presented with additional pressure. Compared to another group of golfers who had focused on task-irrelevant verbal cues showed an increase in performance (Gucciardi & Dimmock, 2008).

Intervention/Priming

Along with providing sound evidence of a connection between performance under pressure and hemispheric brain activation, there is an indication of interventions that can you bused to offset the negative effects of choking. A common theme to the published research is a positive effect of the hindrance of left-hemispheric activity and performance. A neuroimaging study had shown an increase in performance after the inhibition of the left-temporal lobe by transcranial magnetic stimulation (Snyder, 2009). A growing body of work seeks to better understand what effects "Priming" the right hemisphere can have on performance.

One of the early definitions of Hemispheric Priming is in facilitating stimulus processing induced by prior exposure in a related stimulus (Morton, 1969). More current studies (Bardouille et al., 2010, Baumann et al., 2005, Beckmann et al., 2013, Cottone et al., 2004, De Martino et al., 2019, Hirao & Masaki, 2018), focused on if prior stimulation usually a word or a picture, facilitates subsequent processing of that stimulus or a related stimulus. The evidence proposed that stimulating a specific hemisphere of the brain will increase performance.

The upper half of the body is cross-laterally connected to the brain, implying that the left hemisphere of the brain controls the right side of the body (Hermans et al., 2014, Onishi et al., 2010, Porcaro et al., 2009, Ra & Lt, 1989, van Ede et al., 2014, Wolf et al., 2015). Using a functional magnetic resonance imaging (fMRI), Kim and colleagues (1993) investigated hemispheric asymmetry in the functional activation of the motor area during contralateral and ipsilateral finger motions. When comparing ipsilateral and contralateral finger movements, they discovered significant right-hemispheric activity. Right-hand finger movements had a comparable but weaker effect on left-hemispheric activation. Schiff et al. (1998) found that unilateral muscle contractions in the right hemisphere amplified left-hemispheric activation. (For example, compressing a softball.) After left-hemispheric priming, determination in attempting to tackle insoluble difficulties was found to be higher. Baumann et al. (2005) used this method to test the theory that activating the correct hemisphere could diminish self-infiltration, or the incorrect self-ascription of assigned goals. They discovered that left-hand muscle contractions activated the right-hemispheric process, which was confirmed by a line bisection test, and protected individuals from mistaking assigned goals for self-selected goals in memory, whereas right-hand muscle contractions did not. Neuroimaging with the use of an EEG has shown an effect on left- and right-hand contraction on hemispheric activation. A greater left hemispheric activation was when the right hand was contracted and vice versa with the left hand (Petersen et al., 2008).

These findings suggest that a basic stimulation is effective in hemisphere-specific-priming, stimulation of the left hand is activated, then there will be an increase in the performance in the visuospatial process, which will offset the negative effects of choking under perceived pressure. While the right hemisphere is creased in its activation, the left hemisphere is becoming suppressed; this aid in reducing verbal-analytic processing, which results in greater susceptibility of choking under pressure (Beckmann et al., 2013). Although performance strain may increase the likelihood of skilled performance declines by stimulating dominant left-hemispheric activation, activating the right hemispheric may reduce left brain dominance and, as a result, mitigate choking. As a result, this article hypothesizes that applying vibrational tactical stimulation to the left hand before performing a skilled motor task under pressure will alleviate performance deficits.

Vibration stimulation

This review has defined what choking under pressure is and what factors can decrease performance. Afterward, the paper highlighted the frontal cortex's responsibilities regarding motor movement and task performance under perceived pressure. Following this, a deeper analysis of hemispheric activity and what effects priming has on overall performance. The last section will outline the uses and benefits of vibration stimulation regarding priming each hemisphere.

Research in vibrational tactical stimulation ranges from pain management (De Martino et al., 2019), sleep activity (Cottone et al., 2004) and in a clinical setting for treating trauma patients (Keller et al., 2014, Nieuwenhuis et al., 2013, Pagani et al., 2012). Although there is a wide range of data about the use of vibrating stimulation, little has been done in the way of sports. The science supports the notion that stimulation influences cortical activity (Onishi et al., 2010), and a there is a neuromuscular connection between the left and right hemispheres of the brain and the extremities of the body (hands, arms, legs etc.). This connection is crossed wired in the body (Ansado et al., 2010, Avanzini et al., 2016, Blefari et al., 2015) the right side of the body is connected by the left hemisphere and vice versa. To prime one hemisphere of the brain, researchers have used several methods such as hand contractions (Baumann et al., 2005) and ball squeezing (Schiff et al., 1999). Other ways hemispheric stimulation has been used effectively in a therapeutic setting is in EMDR (Eye Movement Desensitization and Reprocessing) (Bardouille et al., 2010), (Nieuwenhuis et al., 2013), (Pagani et al., 2012), (Claus et al., 1988), (Amano & Toichi, 2016).

The American Psychiatric Association recommends eye movement desensitization and reprocessing (EMDR) as a standard treatment for PTSD (APA, 2021). When a therapist introduces a patient to bilateral stimulation (BLS), which involves alternating bilateral visual (eye movement), auditory, or sensory stimulation (e.g., tactile stimulation), and the approach entails a strategy (Amano & Toichi, 2016). Desensitization of traumatic memories and the construction and installation of a "resource," such as safe and pleasant thoughts, are two steps of an EMDR procedure (Keller et al., 2014). Both stages of the conventional protocol use BLS. BLS is performed in conjunction with the patient's unique information being recalled.

There are eight phases to the EMDR procedure. The first phase entails gathering information regarding the patient's medical history and symptoms. Phase 2 establishes a reasonable degree of expectation. Phase 3 emphasizes a thorough evaluation of trauma-related symptoms, which includes strong visual imagery linked to traumatic memories, positive and negative self-perceptions, and associated emotions. The key therapy step is Phase 4, during which alternative BLS is employed to treat traumatic reactions. BLS can be achieved using a variety of ways, but one of the most frequent is the employment of a set of vibrating paddles. The client would alternate vibrations between two paddles. This alternating vibration stimulates both the left and right sides of the brain, allowing memories to be recalled (Keller et al., 2014). Phase 5 comprises cognitive change, which entails the installation of positive cognition. Phase 6 entails a physical examination to detect pain or unusual sensations. Phases 7 and 8 are utilized to wrap up the session and prepare for the next one (Amano & Toichi, 2016).

Vibration stimulation and cortical activity

Along with therapeutic uses such as EMDR, vibration stimuli have also been used in sensory-motor rehabilitation, with positive effects such as bone formation, hormone production improvement and in a whole-body functional ability such as strength and balance (Magalhães et al., 2013, Lau et al., 2011, Sá-Caputo et al., 2014). Further research has sought to understand the effects vibration has on gross motor unity synchronization and cortical activation (Pozo-Cruz et al., 2012). The research shows that vibratory stimulation first travels through the muscle through the peripheral nerve, finally arriving in the responsible cortical area for the motor movement (Luft et al., 2002). Furthermore, the vibration itself seems to enhance the peripheral nerve's effect on the cortical areas (Christova et al., 2011, Chan et al., 2012, Silva et al., 2014). These findings support the notion that vibration can be used as a valid stimulation for hemispheric priming.

One factor missing in this area is the use of neuroimaging techniques, such as electroencephalography (EEG). An EEG can be used effectively to provide inconclusive evidence of the vibrational effects on the peripheral nerve. This tool allows researchers to record electrical activity in the brain cortex and further aid in understanding the dynamics of cortical activity and responses to external stimuli. If a machine were obtained, these finding would be easy to collect; however, this is not the focus of this research.

Seo and Colleagues (2019) had referenced the previously listed data and added it to the application methods of vibration stimulation. They had done this by introducing vibration stimuli through wrist bands on healthy adults in a grip strength task. Participants have been designated to test their grip strength, one trail with vibration on the rest and one without. The results showed that when participants had the wrist band activate vibration, their grip strength significantly increased compared to the non-vibrational trial. The results support previous data with the activation of the peripheral nerve and the notion of vibration having a relationship to motor function.

Purpose of the study

This literature review's main intention was to show support for the hypothesis that vibration is a viable stimulation for right hemispheric priming, and with that priming will show offset on any negative effects of choking in a sport setting. The first section of the review described what choking means and its historical definitions, and then it offered two common choking models. First being a distraction model in which any stimulus or response required irrelevant to the individual's primary task, whether it is an external or internal stimulus (Sanders, Baron & Moore, 1978.) The second model is also a focused model in which an athlete well hyper analyze pre-learned motor movements, thus affecting the athlete's overall performance (Baumeister & Showers, 1986).

The second section had identified specific cortex hemispheric responsibility and how the mechanisms at work correlate with choking models. There seems to be a viable correlation between incentive reward and the effects of punishments; this would solidify the distraction model. It also introduced the concept of a dual neural network hypothesis. In which two specific neural pathways are connected to motor function and abstract thinking. One network is activated when trying to learn a behavior, and the other is activated when trying to perform the learned behavior in each situation.

The third section discussed hemispheric priming, and this is the notion that priming one specific hemisphere of the brain will have an offsetting effect on the other. Research has shown that the left hemisphere was responsible for linguistic and abstract thought, which Davis supports the notion that an increase in left-hemispheric activity leads to poor performance under pressure. Vice versa, right hemispheric activity tends to lead to better performance while under pressure. Studies have been showing that priming the right hemisphere can have an offset effect on negative sport performance. Various methods such as hand contractions squeezing a ball have been shown effective.

The 4th section introduced the concept of vibratory stimulation and its effects on motor function and cortical activity. Vibrational stimulation has been an effective tool for rehabilitating four injured individuals, helping in sleep performance, and helping treat traumatic clients with psychological issues. EMDR is a professionally researched technique used to help treat individuals with past traumatic experiences, and one of its main proprietors is called BLS bilateral stimulation, which is used to activate both left and right sides of the brain hemispheres. There are several different ways of enacting bail less, but one common way is vibrational paddles. One study has shown that the use of vibration in a wristband has been effective in improving grip strength in healthy individuals. The literature highlights the use of the peripheral nerve and its connection to motor function and cortical activity. Further neuroimaging studies could help add inconclusive evidence to the mechanisms at work with vibrational stimulations in cortical activity; however, there seems to be ample evidence to propose that vibration is an effective tool to stimulate or prime the left hemisphere results in better performance under pressure.

Methods

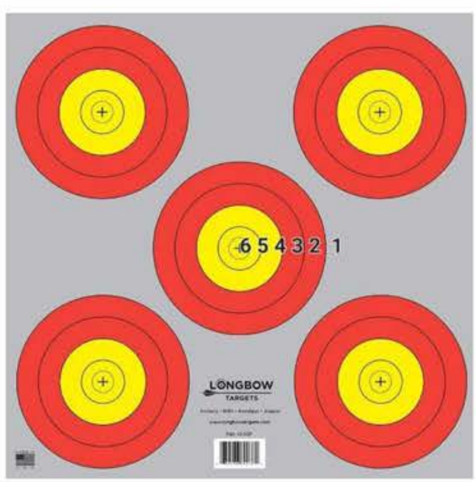
Participants

For this research study to conduct, 20 male archers consented to participate in. These archers were drawn from the area of Spokane, Washington, United States of America and the research project took place in a local archery shop based in Spokane Valley, Spokane Valley

Archery. The participants who completed this study aged between 18 to 46 years (M = 28.5, SD = 8.83). They had 2 to 40 years of archery experience (M = 12.65, SD = 10.09) and 1 to 30 years of competitive archery experience (M = 8.75, SD = 8.41). Twelve of the people indicated that the highest level they had competed was in national competitions, while the other 8 indicated that the highest level they had competed was international. The amount of days that they dedicate per week to train varies between 2 to 6 days (M = 4.35, SD = 1.31) and the amount of hours they dedicate per week to training varies between 4 to 36 (M = 16.85, SD = 9.06). All of the participants shot right handed and they all used a modern compound bow (all of the setups where virtually identical).

Performance assessment

The measure of accuracy of the shots was made as a dependent variable. Five shots in a pressure-free situation (i.e., pre-pressure) and another five shots after pressure induction (i.e., post-pressure). The participants' task was to shoot their compound bow from the standard indoor distance (i.e., 18 m; into a 5 spot target). Archers were instructed to make five shots. Their performance was measured by scoring each shot on a 6-point scale: 6 for a clean shot in (X), 5 for outer ring (10), 4 for nine ring, 3 for 8 ring, 2 for 7 ring, and 1 for a 6 ring. After the five shots the data were collected and that's how we measured the effects of priming pre and post pressure.



Procedure

Before the research study began, the 20 male semi-professional archers were gathered and informed about the purpose of the study, and that they would be participating in a research project that its main intention was to understand the effects priming has on the brain before a high-pressure situation. Also that the experiment would be conducted in a single session and that the winner with the best score would receive a $100 gift card. Prior to their arrival at the location they were given the consent form to sign which also included in detail the whole procedure.

Upon the arrival the researcher conducted an initial session to explain one last time the procedure, received the signed consent forms from all participants and administer the questionnaire regarding demographic information such as age, years of archery experience, years of competitive archery experience, highest level of competition, training hours per week and training days per week. The archers started the session with a warm-up (shot 5 arrows). After completing the warm-up then the pretest was conducted in order to establish a baseline of performance. The pretest consisted of each archer shooting five arrows. There was not any additional pressure during the baseline test. After the first round of data was collected, another test was conducted where the perceived pressure was introduced. The archers had to compete in head-to-head shoot off to enhance pressure, moreover, the archers performed their shots in the presence of a large audience. Before the shoot off the archers wore a vibrating Fitbit wrist band on their left wrist (i.e., left-hand vibration condition, which they set to vibrate for about 30s. The shoot off consisted of each archer shooting one arrow alternating back and forth totaling five arrows. After each arrow the score was called out. Comparing the experimental condition with no vibration might confound the interpretation of assumed benefits of left-hand vibration, as we would not be able to decide whether reduced choking occurred because of enhanced activation of the right hemisphere or optimized concentration. The duration of the test lasted 2 hours.

Results

A paired samples t-test was used to examine changes in performance between the non-primed and the primed condition. The analysis yielded a significant effect, $t(19) = -4.945$, $p < .001$), showing that performance in the primed condition improved. The descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics for accuracy

	Mean	Standard Deviation
Non-Primed condition	27.30	1.42
Primed condition	28.45	1.36

Discussion

This study sought to answer whether or not hemispheric priming can offset the adverse effects of choking within sports. The results showed that in the primed condition participants performed better than the non-primed condition. This finding is congruent with past works that studied the hemispheric priming effect (Beckmann et al., 2013). The primary inquiry that this thesis sought to understand is whether or not vibration would act as a viable option for hemispheric priming, and other studies had used various methods such as squeezing a ball or making a fist. In addition, there is a large body of research in other fields (counseling and neural anatomy) that show the effectiveness of vibration as a stimulus for brain activity (Amano & Toichi, 2016; Claus et al., 1988; de Moraes Silva et al., 2015; Nieuwenhuis et al., 2013; Oliveira et al., 2018).

Hemisphere priming is a technique used in sports psychology to help athletes overcome the negative effects of choking under pressure. This technique involves priming the brain by directing attention to one hemisphere of the brain, either the left or right, depending on the athlete's dominant hemisphere. This type of priming is based on the idea that each hemisphere of the brain is associated with different types of processing, with the left hemisphere being more analytical and the right hemisphere being more creative.

There have been several studies on the effectiveness of hemisphere priming in sports psychology, as well as other techniques for offsetting the effects of choking under pressure.

One study published in the Journal of Sport and Exercise Psychology compared hemisphere priming to visualization and a control condition in a golf putting task. The study found that hemisphere priming was more effective than visualization in reducing anxiety and improving performance under pressure (Masters, Ogles, & Jolton, 1993).

Another study published in the Journal of Applied Sport Psychology compared hemisphere priming to relaxation training in a basketball free throw shooting task. The study found that both techniques were effective in reducing anxiety and improving performance, but hemisphere priming was more effective in reducing anxiety (Hardy, Mullen, & Jones, 1996).

A third study published in the Journal of Sport and Exercise Psychology compared hemisphere priming to a cognitive-behavioral intervention in a tennis serving task. The study found that both techniques were effective in improving performance, but hemisphere priming was more effective in reducing anxiety (Wilson & Eubank, 1993).

Other techniques for offsetting the effects of choking under pressure have also been studied. For example, a study published in the Journal of Applied Sport Psychology compared imagery, self-talk, and a combination of both in a basketball free throw shooting task. The study found that the combination of imagery and self-talk was more effective in reducing anxiety and improving performance than either technique alone (Suinn & Richardson, 1971).

Another study published in the Journal of Sport and Exercise Psychology compared a goal-setting intervention to a relaxation intervention in a soccer penalty kick task. The study found that both techniques were effective in improving performance, but the goal-setting intervention was more effective in reducing anxiety (Singer, 1985).

Simply, there is evidence to support the effectiveness of hemisphere priming, visualization, relaxation techniques, goal setting, and mindfulness training in offsetting the effects of choking under pressure in sports. The choice of technique may depend on the athlete's individual needs and the specific demands of their sport. Overall, each of these techniques can be effective in helping athletes overcome the negative effects of choking under pressure. The choice of technique may depend on the athlete's individual needs and preferences, as well as the specific demands of their sport.

The test results showed a strong correlation between the archer's pre and post-test ($p=.720$). To hypothesize why the results were so conclusive first, we must look at the nature of placebo. If there were another attempt at this study, multiple tests over a longer period of time would be required to prove the change is viable. However, the limitation of this proposal is that the archer might improve performance under pressure because he or she is practicing more pressure situations.

While there is evidence to support the effectiveness of hemisphere priming in sports psychology, there is still much research to be done to fully understand how this technique works and how it can be optimized to prevent choking in sports.

One area of future research could focus on individual differences in hemispheric dominance and how these differences may affect the effectiveness of hemisphere priming. Some athletes may have a stronger left hemisphere dominance, while others may have a stronger right hemisphere dominance. Understanding how these differences affect the effectiveness of hemisphere priming could help tailor this technique to individual athletes. As an example, for archery the determining factor if a archer should be shooting a right handed or left handed bow is more dependent on eye dominance rather than hand dominance.

Another area of future research could focus on the optimal timing and duration of hemisphere priming. Currently, it is not clear how long the effects of hemisphere priming last, or how close to competition the priming should be done. For the study the archers utilized the fit bits in between each arrow during the shoot off, this was convenience for the test however in a tournament setting where you do not alternate it would be difficult to implement. Further research could help determine the optimal timing and duration of hemisphere priming for different sports and situations.

In addition, more research could investigate the use of combined interventions, such as combining hemisphere priming with visualization or relaxation techniques, to further enhance performance under pressure. This study solely focused on priming intervention through the use of vibration. Understanding how different interventions can be combined to maximize their effectiveness could have important implications for sports psychology.

Future research could explore the use of hemisphere priming in other domains beyond sports, such as in academic or professional settings. Understanding the generalizability of this technique could help extend its usefulness beyond sports psychology.

This study did offer a unique insight to the use of vibration as a stimulation technique for the brain during sports competition is a relatively new area of research. The underlying principle of vibration is that it can activate sensory receptors in the body, leading to changes in muscle tone, blood flow, and neural activity. Theoretically, this can improve performance by enhancing muscle activation, reaction time, and focus.

There is some evidence to support the effectiveness of vibration as a stimulation technique in sports. For example, a study published in the International Journal of Sports Physiology and Performance found that vibration improved power output and jump height in basketball players (Kubota et al., 2019). Another study published in the Journal of Strength and Conditioning Research found that vibration improved sprint times and jump height in track and field athletes (Gonzalez-Badillo et al., 2014).

However, the evidence is not yet conclusive, and more research is needed to fully understand the effects of vibration on sports performance. For example, a study published in the Journal of Sports Sciences found no significant effects of vibration on reaction time or power output in soccer players (Costello et al., 2015). Another study published in the Journal of Strength and Conditioning Research found that vibration had no significant effects on maximal strength or power output in weightlifters (Lau et al., 2011).

In addition, there are some potential drawbacks to using vibration as a stimulation technique in sports. For example, excessive vibration can cause muscle fatigue and reduce performance, and it may also interfere with balance and proprioception. While there is some evidence to support the effectiveness of vibration as a stimulation technique in sports, more research is needed to fully understand its effects and limitations. Athletes and coaches should use caution when using this technique and consider the potential risks and benefits on a case-by-case basis.

In conclusion, while hemisphere priming has shown promise in preventing choking in sports, there is still much research to be done to fully understand and optimize this technique. Future research could focus on individual differences in hemispheric dominance, optimal timing and duration, combined interventions, and generalizability to other domains. Ultimately, this research could help enhance our understanding of how to prevent choking under pressure and improve performance in a wide range of domains.

Still there are many questions that need to be further researched, the data from this test supports the notion that vibration is a viable stimulation for hemispheric priming and that hemispheric priming seems to have an offsetting effect when it comes to choking in a pressure situation. Hopefully, other research will attempt to repeat these results in many other types of sports in hopes to give athletes tools to counter the choking effect.

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