External Factors and Athletic Performance

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Abstract

The science behind athletic performance has progressed significantly with the advancement of technology and research of sport. The current review examines further the effects of several external factors on athletic performance. Factors were deemed external if they involved either variables out of the athlete's control or an athlete's conscious decision. Addressing playing environment, voluntary consumption of alcohol, sleep, a variety of emotions, and team environment contributes to a better understanding of the wide variety of factors that may influence athletic performance. The conclusions reveal ways in which awareness of external factors may impact overall performance.

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External Factors and Athletic Performance

Humans have participated in sports since the earliest days of existence. Perhaps not as sports are viewed currently, but running during a hunting brigade or jumping over a stream involved motions that are still used today. With the introduction of competitive sports, most notably from the Greeks and Romans, scientists began looking for ways to improve athletic performance and, ultimately, to win. Anatomists and kinesiology professionals have discovered many internal factors that contribute to sports performance such as muscle fiber type, genetics, and VO_2 max. In addition to these, external factors such as playing environment, voluntary alcohol usage, sleep, emotions, and the team environment may also influence sports performance. These specific external factors will now be discussed in greater detail.

Playing Environment

Hot Environment

As an athlete exerts energy when exercising in hot environments, his or her core temperature will rise greater than if the individual was exercising at a moderate temperature. This effect may be a possible explanation for decreased athletic performance when environmental temperatures continue to rise, due primarily to excessive fluid loss and impaired thermoregulation in extreme environments (Siegel & Laursen, 2012). In warm environments, exercising induces a rise in core temperature, sweating rate, and progressive dehydration (Özgünen et al., 2010). The ability of an athlete to thermoregulate adequately depends on his or her body type. Athletes with a smaller body size will produce and store less heat than their heavier counterparts (Marino et al., 2000). When a player exercised in an environment that created a core temperature greater than his or her accepted body temperature, the player's body innately anticipated an undesirable rise in core temperature. To counteract that response, the player slowed down before a critical temperature was reached in an attempt to forego a possible crisis should the critical temperature be exceeded. In this way, the effect of hot temperatures caused an athlete to show a decrease in performance by about 2-3% in order to account for a possibly dangerous rise in core temperature (Dugas, 2010). Performance reduction was confirmed in another study in which soccer players covered 15% less distance when the combination of air temperature and water vapor pressure created a perceived environment of 49°C (Özgünen et al., 2010).

In an attempt to combat this phenomenon, researchers have investigated the effect of pre-cooling an athlete before performance. The idea of pre-cooling is to lower an athlete's body temperature purposely in order to increase the time it will take for the athlete to reach his or her critical temperature, allowing improved performance and less stress on the body from heat (Wegmann et al., 2012). Common methods of pre-cooling include ice baths, ice jackets, and ingestion of cold water. A review of pre-cooling methods, showed that the effects of pre-cooling have consistently shown an enhancement in performance under hot weather conditions (Siegel & Laursen, 2012).

However, playing in dry, hot weather does not present the added problem of humidity. In hot and humid conditions, the ability of the body to extract heat through sweating is impaired because sweat cannot evaporate off the body. Hot and humid environments are characterized by temperatures greater than 18°C and when the amount of water vapor in the air exceeds the ability of water to be evaporated from land surfaces back into the atmosphere (Hue, 2011). This may hinder the body's ability to thermoregulate, especially in endurance events. Humid environments also affect an athlete when swimming, even though he or she is submerged in water. The silicone cap that is typically worn during competition places stress on the hypothalamus, which is in charge of sudation, by not allowing body heat to escape because the head is covered. When the process of removing heat from the body is interrupted, overall performance is decreased as core temperature rises (Hue & Galy, 2012).

Cold Environment

Just as the hot environment can negatively impact performance, exercising in the cold environment has been found to influence performance as well. One major concern of exercising in the cold is the effect cold air has on the pulmonary system. Exercised induced bronchospasm can lead to a higher ventilation rate due to the constriction of the airways as a result of the dry and cold air being breathed in. This leads to a higher exertion and a decrease in performance (Lindberg, Malm, Hammarström, Oksa, & Tonkonogi, 2012). Unlike in warm environments, heart rate decreases in cold weather, due to the body's attempt to retain heat through vasoconstriction (Lindberg et al., 2012). The nerve conduction decreases which in turn decreases the electrical impulses at the sinoatrial node, the heart's pacemaker (Wilmore, Costill, & Kenney, 2008). This can create inaccurate intensity level reading if athletes are trying to reach a certain heart rate, in which case studies suggest that they would be exercising at a greater intensity in the cold compared to normal temperatures when trying to reach the same heart rate. This extra exertion leads to decreased performance (Nimmo, 2005).

Cold wind also plays a role in the decrease in body temperature through the process of convection (displacement of heat by motion of gas or liquid). Additionally if the wind is high, heat from the body will be displaced. The clothing an athlete wears can increase body temperature through conduction (transfer of heat from one solid to another). If the athlete's clothes are not appropriate for cold, heat may actually be removed from the body via that method as well (Wilmore et al., 2008). Prolonged exposure to cold temperatures reduces core body temperature. This is pronounced in athletes with small body size, as heat is able to escape more readily due to less body surface area (Nimmo, 2004). Other factors that are reduced in cold weather are muscle power, force production, muscle shortening velocity, and an increase in fatigue rate (Wilmore et al., 2008).

High intensity exercise is especially affected as many studies have shown a reduction in dynamic performance of about 10% when the temperature of working muscles drops (Sargeant, 1987). VO_{2sub} and VO_2 peak tests in cold environments have also revealed reduced performance in athletes due to multiple factors such as fast-twitch fiber recruitment, thermogenesis, and higher contribution of anaerobic glycolysis (Lindberg et al., 2012). Interestingly, performance was actually increased in marathon runners when the race was performed at a temperature of approximately 14°C. The slightly colder temperatures provided an environment that kept runners from getting too hot, but did not create a detrimental response from the body trying to stay warm (Peiser, Reilly, Atkinson, Drust, & Waterhouse, 2006).

Synthetic Grass vs. Natural Grass

An increasing number of athletic fields are being installed as artificial or natural turf to take the place of regular grass fields. According to the Synthetic Turf Council, in 2009 more than 1,000 fields were being installed each year (Kennedy, 2009). While sports complexes are doing this to increase the durability and variability of fields (Dragoo & Braun, 2010), there are some significant detriments to athletes playing on synthetic grass. Most of the concern over the switch to artificial grass is focused on injury rates and types of injury as will be reviewed in the next section. Other variations seen when comparing different playing fields are how the surfaces affect ball movement and control as well as overall player preference.

In a study done by Andersson, Ekblom, & Krustrup (2007), male and female soccer players were surveyed about their opinions of the field surface after playing a match. The survey revealed that male soccer players found artificial turf to be more physically demanding and decreased the effectiveness of plays such as controlling, passing, and shooting the ball. In complete contrast, the female players surveyed stated that the playing surface had neither positive nor negative effects on physical demands, ball control, or ball movement.

Additionally, they quantified movement patterns and ball control differences by comparing number of passes, types of passes, accuracy of passes, and player movement. The authors found that players tended to stand, walk, and run the same amount of time, and they covered approximately the same distance when moving. In that respect, performance remained the same between the two playing surfaces. Ball control presented a different opinion. On artificial turf, more short passes were completed in the midfield zone, causing more passes to be made overall than on natural grass. For long low passes, the accuracy was worse on artificial turf than on grass (Andersson et al., 2007). These findings support the notion that pitch properties can impact the pace and style of play (Dragoo & Braun, 2010).

A study by Zanetti (2009), found through surveying, that amateur soccer players in Italy preferred artificial turf surfaces except in the case of abrasions from turf or hot playing environments. Hot air temperature can in fact play a crucial role in the comfort and safety of players. On a ninety-eight degree day, the University of Missouri's turf expert recorded a temperature of 173 degrees on the synthetic field, compared to 105 degrees on the natural grass. When the temperature was taken at head-level, the synthetic grass still measured 138 degrees (Adamson, 2012). High temperatures associated with artificial playing surfaces could lead to heat stress repercussions if the appropriate safety measures are not taken (Kennedy, 2009).

Injuries between playing surfaces, on the other hand, have been studied and analyzed extensively. Keeping players injury-free is a top priority among the athletic population because an injury could prohibit an athlete from playing at full potential, in every game, or the remaining games in a season. Although the properties of synthetic fields have improved, the high stiffness and grip of artificial turf remains the main cause of injury (Stiles, James, Dixon, & Guisasola, 2009). Friction is important for quick changes in direction, but too much can place an overload of forces on bones, muscles, and joints (Steffen, Andersen, & Bohr, 2007). Although the rate of injury in soccer players remains the same, there is a significant difference in the types of injuries that are sustained. Incidence of ankle injuries, concussions, and abrasions were found to be significantly greater on artificial surfaces. Knee ligament injuries, however, were found to occur more often on natural grass surfaces (Wright & Webner, 2010). Dragoo & Braun (2010) concluded that many factors including surface type, surface condition, surface shock absorbency, and environment temperatures play a significant role in a player's risk of being injured.

Pollution

Many large cities receive criticism for producing high volumes of air pollution. Concern is especially relevant when large metropolitan areas such as Beijing, China host competitive sporting events such as the Olympics. High quantities of air pollutants can have a deleterious effect on athletic performance (Qing Wen & Brimblecombe, 2008). Pollutants that have received the most attention regarding negative effects on athletic performance include oxides, particulate matter (PM), and ozone. The pollutants are of concern due to their ability to impair the effectiveness of the pulmonary and vascular systems, which would in turn impair performance (Rundell, 2011).

One of the most common sources of pollution is car exhaust. Nitrogen oxide and carbon monoxide are the largest by-products of motor vehicles, although nitrogen oxide has not been shown to have a significant effect on exercise (Bonini et al., 2006). Carbon monoxide, however, has a significantly greater affinity for binding with hemoglobin in the blood than oxygen does. With an increased concentration of carbon monoxide in the blood, oxygen is not able to be sufficiently transported and released to the working muscles. Lack of oxygen reduces the volume and intensity of exercise an athlete is able to achieve. Other performance effects caused by an increase in carbon monoxide levels include an increase in submaximal heart rate, an earlier onset of angina, and a decrease in maximal exercise time. Compared to other pollutants, carbon monoxide had the most negative effect on athletic performance (Frykman, 1988).

In the same group of primary pollutants as carbon monoxide and nitrogen oxide is another pollutant: particulate matter. Particulate matter (PM) is made up of all the small or large, solid or liquid particles that float around in the air. The most influential particles are those less than 10 micrometers in diameter, also referred to as PM_{10} (Weather, 2013). These particles are associated with deteriorated lung functioning and damage to the respiratory system. They are also known to interact with allergens to trigger allergy symptoms in athletes susceptible to allergies (Bonini et al., 2006). Rundell (2011) investigated PM and observed a statistically significant decrease in exercise performance three days after an initial six-minute exercise bout. The author concluded that while affects may not be noticeable acutely, performance could be inhibited three days later.

A second category of pollutants, known as secondary pollutants, are formed through the interaction with other pollutants, water, salts, and ultraviolet rays from the sun (Frykman, 1988). The most notable of these pollutants is ozone. Ozone affects pulmonary function by causing inflammation of the air passageways (Rundell, 2011). Studies performed on cyclists concluded that exercise performed at higher ozone concentrations combined with hot temperatures, induces a greater negative effect on athletic performance. Based on the study, the authors associated ozone with the symptoms of coughing, difficulty in breathing, headache, and eye irritation (Florida-James, Donaldson, & Stone, 2004). Athletes in particular are more susceptible to the effects of pollutants due to an increased respiratory rate, inhaling larger volumes of air, and deeper concentrations of pollutants in the body because of increased air flow velocity when exercising (Borresen, 2008).

Altitude

High altitude can significantly influence the performance of an aerobic athlete. Although the amount of oxygen available does not change as altitude increases, the partial pressure of the oxygen (PO_2) decreases. Normal PO_2 at sea level is 159 mmHg, climbing up to 2,000m the PO_2 drops to 125 mmHg, and at 4,000m it drops even farther to 97 mmHg. This drop in the partial pressure of oxygen creates a hypobaric hypoxic environment. A hypobaric environment has a reduced barometric pressure, while a hypoxic environment shows a compromised delivery of oxygen to the tissues. Physiologically, a hypoxic environment causes a decrease in the pressure gradient across cell membranes, making it harder for the tissues of the body to take up and utilize oxygen (Wilmore et al., 2008). A lack of oxygen throughout the body leads to physiological changes that have been shown to decrease prolonged athletic performance.

The response of the body to a change in altitude over a two to three week time frame is collaboratively called acclimatization. The athlete will immediately experience an increase in ventilation, heart rate and cardiac output in order to make up for the decrease in utilized oxygen (Derby & deWeber, 2010). This results in the athlete fatiguing earlier because the athlete has to work harder to get enough oxygen to the working muscles to achieve non-altitude results. This is most notable in maximal aerobic activities such as endurance running or in multiple maximal anaerobic activities such as repetitive sprints. While one maximal sprint may actually show an increase in performance due to its usage of the glycolytic energy system, multiple repetitions without an adequate recovery period (such as in soccer) will show a decrease in ability and performance. However, without proper acclimatization the athlete may face health risks that would impair performance before they even step on to the field (Levine, Stray-Gunderson, & Mehta, 2008).

The cumulative manifestation of symptoms associated with the body's reaction to a hypoxic environment is known as High Altitude Illness (HAI). Acute Mountain Sickness (AMS) is the most common form of HAI and involves the onset of headache and one of the following other symptoms: insomnia, dizziness or light-headedness, nausea or vomiting, fatigue or weakness, and anorexia (DaRosa, Jotwani, &Valentine, 2012). These symptoms usually disappear within three days (Derby & deWeber, 2010), but if a team arrives to a high altitude destination without allowing the proper time for athletes to acclimate, altitude sickness may debilitate performance or prevent athletes from playing altogether. Two to three weeks is the accepted amount of time for athletes to acclimate at one mile above sea level; an extra week is required for every additional 2,000 feet of elevation. The physiological changes during this adaptation include increased oxygen carrying capacity, increased hemoglobin, and increased red blood cells. Decreases in body weight and muscle mass have also been shown (Wilmore et al., 2008).

While most athletes are well versed in how altitude may impact personal physiological performance, most may not be aware of altitude's effect on techniques such as throwing, kicking, or even reacting to an approaching ball. The reduction in air density that accompanies increasing altitudes translates into a decrease in the drag and lift forces in the air acting on a ball. On the sports field, this would allow a ball to travel farther, but any curve put on the ball would be diminished (Levine et al., 2008). The difference in air density may affect teams who ascend to a higher altitude as well as teams who descend to a lower altitude. For athletic teams traveling to a higher altitude, the ball will deviate, or curve, about .4m less at 1000m and about .8m less at 2000m, making for a significant difference when a soccer player calculates how much curve to give the ball when aiming for a corner (Levine, et al., 2008). The distance a ball will travel is also greatly affected by the altitude. According to Levine et al. (2008), "a ball that carries about 30m through the air at sea level will carry about 2.95m further at 1000 m, 5.9 m further at 2000 m." Since sports depend on a player's ability to accurately hit the target, these changes in ball travel could be the difference between a caught pass and a dropped ball. Thus, while altitude can affect a player's performance based on physiological changes, it may also affect the player's physical performance concerning the player's ability to adapt to the aerodynamic differences in ball movement.

Alcohol

Although technically a depressant, alcohol is often associated with the celebratory activities before, during, and following a sporting event. Alcohol is also the most consumed drug among the athletic community (O'Brien & Lyons, 2000). With that commonality, it is important to understand the substantial effects that alcohol has on athletic performance. Due to ethics subjects consuming large volumes of alcohol, the majority of research studies have been performed with athletes consuming low to moderate quantities. In a study performed on archers who consumed up to .05 per cent blood alcohol level, it was determined that reaction time and extended arm stability declined as alcohol content increased. Performance was especially hindered at the highest blood alcohol level (Mottram, 2005). Although these effects are noteworthy, consuming alcoholic beverages is most commonly associated with athletes who participate in team sports whose performance relies on aerobic and anaerobic capabilities (Wichstrøm & Wichstrøm, 2009).

Alcohol's depressant effect on body systems results in a reduction in neural activation therefore affecting coordination and speed of appropriate limb movement. Thus it would be expected for athletes experiencing the repercussions of alcohol to demonstrate detrimental effects in reaction time, highly skilled movements and movement decisions (Shireffs & Maughan, 2006). These effects are supported by research in the 1980s. In 1983, it was found that time to exhaustion during cycling was reduced. In 1985, researchers noticed that inotropicity, the pumping force of the heart, was reduced. Lastly, in 1987, performances in athletes who competed in a five-mile treadmill run after consuming .44mL of alcohol per kg of body weight were approximately twenty-eight seconds longer compared to previous trials performed without alcohol consumption (Houmard, Langenfeld, Wiley, & Siefert, 1987). Important to note, however, is that research is inconclusive on whether or not alcohol affects anaerobic performance (Vella & Cameron-Smith, 2010). The effects stated above pertain to alcohol consumption approximately 45-minutes before athletic activity when the effects of alcohol are at their peak, yet performance consideration should also be given when drinking occurs the day before an event.

The hangover effect of alcohol can last for up to twenty-four hours, as well as its negative consequences on athletic performance (Mottram, 2005). Although anaerobic performance has been shown to remain unaffected, aerobic performance showed a significant decrease. O'Brien & Lyons (2000) quantified the effect, saying that aerobic performance was decreased by 11.4% when alcohol was consumed within 24 hours of activity. These findings are of concern for those athletes who choose to drink the night before competition (Mottram, 2005).

With a more dangerous style of play due to the influence of alcohol, an athlete's chance of being injured also increases. An impaired judgment, reduced reaction time, and an inability to perform complex moves quickly puts an athlete in danger of executing a movement incorrectly, making them more prone to injury. In a study done by O'Brien & Lyons (2000), it was discovered that athletes who consumed even half a pint of alcohol at least once a week had an injury rate of 54% while nondrinkers revealed a 23% injury rate. It is not uncommon for an athlete to acutely injure his or her muscle during regular training or performance. This results in an inflammatory and increased blood flow response in the body. The vasodilation effect of alcohol as well as inappropriate behaviors that may occur while influenced could compound the effects of an injury and hinder recovery–causing the athlete to underperform for longer than necessary. The effects of alcohol on performance can be significant, but seem to be dependent on the type of activity, the amount of alcohol consumed, and an athlete's tolerance level for alcohol (Shireffs & Maughan, 2006).

Sleep

It is no secret that the body needs sleep in order to function at its highest level. Athletes tend to be especially limited on sleep time due to competition schedules, prolonged training days, and work demands (Fischer, Nagai, & Teixeira, 2008). It is during the period of sleep that the body discards unnecessary information from the brain, heals, and gains energy for the next day's activities. A good night's sleep is imperative to enhancing performance (Willis, 2009).

The central nervous system controls every aspect of athletic performance, from firing the correct sequence of muscle contraction to reflexes and reaction, exact biomechanical movements to function of skills (Underwood, 2010). When athletes do not receive a full night of sleep, athletic performance decreases due to sleepiness. Researchers that studied ballet dancers found that health also deteriorated when sleep deprivation patterns were continuous (Fietze et al., 2009). In another study, after thirty hours of sleep deprivation, running performance during a five-mile run on a treadmill was reduced. An interesting finding during this same study was that the perceived effort remained the same; athletes ran a shorter distance because the perceived effort was the same as that for five miles. The deleterious effect of thirty hours of sleep deprivation impaired performance as much as nine percent. Thus, loss of sleep may result in a significant reduction in aerobic performance (Oliver, Costa, Laing, Bilzon, & Walsh, 2009).

Athletes in particular require more sleep than the average relatively sedentary individual (Davenne, 2009). Researchers who performed a study in 2005 found that when athletes were allowed to sleep as much as they could, players experienced enhanced performances, better moods, and a decrease in fatigue compared to when customary sleeping habits were instilled (Dement, 2005). This data is consistent with Dement's later study that found that the first factors to decline in performance are mood, cognitive function, and the ability of the brain to perform motor skills (Davenne, 2009). According to Underwood (2010), the muscles need an appropriate amount of sleep in order to meet the demands of reflex and reaction impulses. Evaluative tasks, visual tracking, and focus also depend on adequate rest. Lack of sleep also reduces blood flow to the brain resulting in confusion and physical inabilities seen in individuals who are sleep deprived (Underwood, 2010). Additionally, these symptoms peek during the mid-afternoon, pre-disposing athletes to poor performance in games performed at this time or later that evening (Fietze et al., 2009).

It is not only the amount of time spent sleeping that affects performance. The quality of sleep received is also paramount to an athlete's ability to perform well. Deep sleep is essential for the release of growth hormones, which allow for the growth and repair of muscles, fat burning, and bone strengthening. The release and consequential effects of this hormone allow for an athlete to recuperate after an intense workout or competition and continue working toward better results. Sleep and physical activity have direct influences on each other (Davenne, 2009).

Emotions

Anxiety

The budding field of sport psychology has led to multiple studies on the effect of emotions or mood on athletic performance. An athlete may experience a wide range of emotions prior to competition that can affect his or her performance. A well-known pre-game emotion is anxiety. Anxiety among an athlete is a feeling of perceived imbalance in his or her abilities and the demands placed upon them (Craft, Magyar, Becker, & Feltz, 2003). While moderate levels of anxiety about an approaching competition can actually improve skills and abilities, too much may comprise performance (Mottram, 2005). In an in-depth study of anxiety in fifteen ballet dancers, the dancers agreed that a certain amount of anxiety was important to increase concentration and energy. Furthermore, the dancers interviewed believed there an anxiety threshold, above which anxiety would negatively impact performance. The dancers also believed that cognitive anxiety, the mental component of anxiety, had a greater effect on performance than the physiological somatic component (Walker & Nordin-Bates, 2010).

In sports where interactions with the opponent before competition are greater, anxiety is believed to grow and become more detrimental (Craft et al., 2003). In a study focusing on penalty kicks in soccer, anxiety tended to cause the athlete to focus on the opposing goalkeeper. Results confirmed that a more centrally located fixation point led to a more centralized shot, making it easier for the goalkeeper to block (Wilson, Wood, & Vine, 2009). Anxiety may also be exacerbated from other sources such as feeling underprepared, the size or type of audiences, fighting to maintain or win a position, or receiving negative criticism (Walker & Nordin-Bates, 2010).

Anger

Anger is usually thought of as a post-performance emotion for circumstances such as performing poorly and/or losing a game. However, anger may also influence an athlete before performance and carry over into competition. A 2004 literature review on mood responses in sport concluded that negative emotions, such as anger, associated themselves with poor performance. The lower an athlete’s level of anger, the better they tended to perform (Lane et al., 2004). However, there is an argument that depending on the task, anger may actually enhance performance. Utilizing the cognitive-motivational-relational theory, Woodman et al. (2009) correctly hypothesized that anger would increase performance on a physical task. The study suggested that because anger’s action tendency is to lash out, there was a greater peak muscle performance for angry subjects than happy subjects, whose action tendency is to do nothing in order to maintain satiation. These results lead to the conclusion that while anger is typically recognized as an unfavorable emotion before performance, if the task demands relate to the action tendency performance may actually be enriched.

Hope and Happiness

In two studies (Lane et al., 2010; Woodman et al., 2009), the positive emotions of hope and happiness were placed against performance results. In the Lane et al. (2010) study, the emotions of vigor, calmness, and happiness were associated with successful performance. Pleasant emotional states correlated to the attainment of performance goals. The Woodman et al. (2009) study found that both effort and performance for soccer-related reaction time tasks increased under the emotion of hope. Strong emotional intelligence, as well as a player's ability to determine and feel the correct emotion for the task at hand, suggests that acquiring the most beneficial emotions for a specific task lead to enhanced performance (Lane et al., 2010).

Stereotypes and Pressure

During major competitions such as the Olympics, Super Bowl, World Cup, or even local championship games, the pressure on the players to perform well is excessively high. Part of this pressure can come from widely held ideas about the expectations of the player. If the player feels expected to perform well, he or she experiences a positive stereotype. Conversely, if a player feels expected to perform poorly, he or she experiences a negative stereotype. Going into a game with a positive stereotype, will help an athlete to perform better; however a study found that once under observer pressure, performance decreased for those acknowledging positive stereotypes. In contrast, athletes primed with negative stereotypes performed worse both with and without pressure from observers (Krendl, Gainsburg, & Ambady, 2012). Stereotyping may cause a player to play better or worse in a self-fulfilling prophecy based on the stereotypes that pertain to him or her. The pressure to rise to a positive stereotype may cause an athlete to overthink rudimentary concepts and thus not be able to devote his or her full attention to the unpredictable aspects of competition (Beilock & McConnell, 2004). As observed by Otten (2009), one way to decrease the chances of an athlete choking under pressure is to introduce pressure scenarios in order to increase confidence. Coaches need to know that the players can handle the pressure and still perform at optimal levels.

Stress

Stress comes in many forms, not all of which are directly related to competition performance. Many of the stressors an elite athlete faces do not come from the competition but rather come from the organization of the team he or she plays for (Mellalieu, Neil, Hanton, & Fletcher, 2009). This could be due to the possibility that athletes are acquainted with stressors that come within competition and because those stressors remain fairly constant. Organizational stressors, however, can vary and remain inconsistent to both type and timing (Hanton, Wagstaff, & Fletcher, 2012). Mellalieu et al. (2009) concluded that multiple organizational stressors affected athletes. One of the major stressors involved the playing environment and the organization of that environment. The athlete’s role within the organization of the team and the cohesiveness among players were also revealed to be stressors. In addition, the level of involvement from team management was found to add to an athlete’s perceived stress (Mellalieu et al., 2009). Even though organizational stressors may not continually worsen, they are regularly present and affect the athlete (Hanton et al., 2012).

Mellalieu et al. (2009) also investigated the competition stressors faced by athletes. These included stressors such as being adequately physically prepared, internal and external expectations, an athlete's image, and the current opponents. Sustaining an injury was also a stressor to athletes as they have expressed concern over incurring a new injury, worsening an existing one, or feeling unstable at the site of an injury (Walker & Nordin-Bates, 2010).

Team Environment

Coaching

In regards to performance stressors, coaches can play a critical role in preparing athletes with the ability to overcome mental obstacles. Coaches have the greatest amount of influence and responsibility for every aspect of the athletic program (Johnson et al., 2011). Differences among coaching styles through the characteristics of personality, knowledge, experience, communication skills, team leadership, and motivation methodology, can directly influence the same characteristics in the athletes (Barić & Bucik, 2009). Coaches who show sufficient knowledge in the technical skills of sport movements are better able to teach athletes correctly and decrease the amount of injuries from improper form and technique (Johnson et al., 2011). Another important factor in overall team performance is the ability of the coach to communicate. Coaches who do not communicate with the players, or who demonstrate poor communication skills, are more likely to mold athletes who feel less competent on the playing field. The athletes of these coaches also tend to maintain a business relationship rather than growing a personal, dynamic relationship with the coach (Barić & Bucik, 2009). Supporting and assisting with mental preparedness for game time is essential to the success of the team. An area of great interest concerning mental preparation is how a coach's leadership style influences self-talk in athletes. A 2010 study (Zourbanos, Hatzigeorgiadis, Tsiakaras, Chroni, & Theodorakis) found that positive coaching environments correlated positively with positive self-talk. Positive self-talk is known to incorporate confidence, anxiety control, and competency. Positive self-talk–cultivated by positive coaching relationships–also correlates with improved individual performance. As leaders, coaches are the primary facilitator in enhancing program effectiveness, team relations, and group and personal performance.

Mental Toughness

When teams may be quantitatively matched in performance abilities, the deciding factor in winning a game may come down the mental toughness of the players. Research has shown that the team with the greater mental toughness triumphs more often compared to a mentally weak team (Gucciardi, Gordon, & Dimmock, 2008). Coaches have a direct ability either to catalyze or thwart the development of mental toughness among athletes. A coach can positively develop mental toughness in many ways including, "developing and maintaining positive coach–athlete relationships… creating training environments that continuously challenge and expose players to various challenges… and employing specific techniques that include coaching behaviours and game awareness" (Gucciardi, Gordon, Dimmock , & Mallett, 2009, p. 1493). When emphasis is placed on performance or criticizing players' weaknesses, the coach has a debilitating effect on mental toughness (Gucciardi et al., 2009). A 2010 study (Butt & Culp) found that athletes believed practicing physically difficult or challenging situations among a positive practice environment helped to increase mental toughness. This is consistent with results that showed a proportional relationship between physical condition and mental toughness. The athletes surveyed also expressed how important teammates could be to the development of mental toughness.

Player Cohesion

The support of teammates is not only integral to gaining mental toughness but is also essential to performing well (Butt & Culp, 2010). Group cohesion and performance are found to be positively correlated (Evans & Dion, 2012). Further, team cohesiveness influences player mood, which then influences individual performance and could affect group performance as well (Lowther & Lane, 2002). Thus teams with positive player and team mood in regards to team cohesiveness are also predicted to be more successful. Improved group cohesion is found in teams who set goals and work to attain the goals together (Johnson et al., 2011). Often for one player to reach his or her performance goals, he or she relies on the contribution of other players on the team. When multiple individual goals are being met, the team is cohesively working together and improving performance (Lowther & Lane, 2002).

Pre-game Speeches

Sports movies such as *Miracle* bring the audience into the locker room and provide even non-athletic viewers the chance to experience that emotionally driven moment before the underdog steps out onto the playing field and wins it all. Pre-game speeches are not just for movies, however; they are for real game situations as well. More than half of the players on the soccer team studied reckoned that the team's performance was positively affected by the pre-game speech. These speeches can incorporate a wide range of information deemed necessary by the coach to optimize performance. Most speeches contain either strategic information concerning plays or the opposing team's strengths and weaknesses and/or emotionally charged messages aimed at motivating the players. However, the timing and content of a coach's advice to his or her team can significantly alter the performance of the team. The effectiveness of these speeches also depends on the personality of the player and what motivates him or her (Vargas & Short, 2011).

In Vargas-Tonsing & Bartholomew's (2006) study, it was revealed that athletes in an imaginary championship game situation were more motivated by the passionate, inspirational pre-game speech than by the informative speech. When the same study was taken to the field, the question "Did the speech your coach gave immediately prior to the game impact your performance?" was posed to the players. The results of the questionnaire showed that 65.5% of athletes responded in support of the pre-game speech because the speech facilitated effort, influenced mental condition, and supplied game knowledge. Therefore, pre-game speeches may be essential in pumping players up and giving them the information they need in order to improve performance.

Conclusion

Athletic performance is one of the most researched topics in the field of exercise science. As athletes are constantly trying to get better to beat out the competition, much thought goes into all aspects of performance that could enhance or debilitate execution. Although this literature review is not a comprehensive collection of all external factors affecting performance, or represent the entire scope of every factor that can influence athletic performance, major factors were discussed. However, studies that were included in this thesis pertained to the most common type of study done on the respective factors; with results consistent among other results and hypotheses.

A prominent weakness of this literature review is an inability to account for all sports in each factor. For instance, most performance studies are tested on soccer players. However, factors discussed that affect soccer performance would also affect sports played under similar conditions such as lacrosse, rugby, and field hockey but in different ways due to different types of balls and different equipment. Most studies are also performed on team sports, which is also the main focus of the factors investigated here. Individual sports such as fencing, ping-pong, and gymnastics may have a whole other set of factors specific to the individual sporting aesthetics as well as the specific sport itself.

Another shortcoming is that most research studies did not differentiate between male and female subjects. Most studies were looking for general trends, not gender-specific trends. Therefore, some information may be more accurate for males than females and vice versa. A consistent limitation of the research cited for the discussion on emotions was the focus on investigating differences between elite and non-elite players rather than comparing athletes within these groups. Elite athletes may experience different factors and effects that relate specifically to being in a well-funded organization where they are treated like celebrities.

The future for exercise science is great. As technologies become more advanced and more precise, researchers will be able to conduct studies on factors that have never been studied before. As more research is completed, a more rounded set of results may become available. Further studies should look to investigate sports that have not been given much attention. While some of the information learned from studies performed on more popular sports can be adapted to fit the lesser known sports, there are some aspects which just cannot be duplicated. For instance, the impact of a hot environment created by the equipment worn for fencing may affect the fine motor skills of athlete differently than the hot environment created by the equipment worn during hockey, which requires larger motor movement patterns. In order to continue increasing the competitive edge in sports, each sport would benefit from having its own set of research investigations in order to provide the most accurate results and to enhance performance in each specific sport.

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