Fatigue, Complexity and Technical Execution in Cheerleading

Abstract

Cheerleading is a technical, explosive and physically demanding sport. Currently there is very limited knowledge or specific research in regard to both routine fatigue and technical execution of skills at different levels of cheerleading performance. This review investigates the potential impact of fatigue on the performance of the technical back handspring manoeuvre and suggests avenues for future research. Four phases of movement are identified within the completed handspring. At each phase the variation in biomechanical factors of velocity, trajectory, angular momentum are examined as crucial determinants to successful skill execution.

Keywords: dynamic systems, strength and conditioning, velocity, trajectory, angular momentum, back handstand.

Review

Competitive cheerleading is a growing sport in New Zealand and all over the world with 6 competition levels. A cheerleading routine consists of stunts, tumbling, jumps, dance and motions (Lopez, 2003). Athletes are required to be in optimal anaerobic condition to perform a 2 minute 15 second routine that involves many high impact, technical, explosive and physically demanding skills (Goodwin, Adams, Shelburne & DeBeliso, 2004). In the tumbling section, a standing back handspring is a fundamental skill used from level 2 all the way through to level 6. As the levels progress more complex skills are added to the end of a back handspring to increase difficulty. This is why it is very important that proper execution and technique is used when performing a back handspring (Lopez, 2003). It is critical that individual basic elements are mastered before progression of skills (Heinen, Vinken & Olsberg, 2010; Penitente, Merni & Sands, 2011; Sawczyn et al., 2016). Furthermore, the anaerobic high intensity routine may lead to fatigue. There is no research on cheerleading in regards to both routine fatigue and technical execution of skills. This review aims understand the knowledge on the technical execution of a back handspring and the potential impacts of fatigue. With limited research on cheerleading, fatigue will be broken down in relation to other sports. The biomechanical aspects of the basic back handspring will also be identified to help further understanding. Finally the review will identify the need for further research relating to these two aspects in cheerleading.

Fatigue

There is vast research on the impacts of fatigue on sports performance. Knicker, Renshaw, Oldham and Cairns (2011), studied the multiple symptoms of fatigue in sports competition and determined that fatigue is an exercise induced impairment of performance. The concept of performance is very different for each sport. However, it often depends on an athlete's neuromuscular, aerobic and anaerobic systems to accurately endure high levels of physical, tactical, technical and psychological skills during a competition (Knicker et al., 2011). Over differing periods of time, the ability to sustain performance decreases as symptoms of fatigue set in. Measuring the various symptoms of fatigue can be very complex. The use of Rate of Perceived Exertion (RPE) measured by the Borg scale is a very cost effective way of measuring fatigue (Knicker et al., 2011). RPE incorporates the whole body, muscles and breathing as symptoms of fatigue. The primary motor cortex influences the perceived exertion based off internal feedback and motor unit recruitment (Knicker et al., 2011). The Borg scale relies solely on an athlete's perceptions and feelings of exhaustion, this may not accurately represent the full fatigue, or over-estimate the fatigue that is actually occurring at the muscular level. Furthermore if the athlete does not fully understand each level on the scale then they may have difficulty selecting the level of fatigue. There are also many aspects in which fatigue can impact performance.

From a technical perspective, two outcomes occur as a result of fatigue. The dynamic systems theory is the concept of a deviation in technique followed by a deterioration (Knicker et al., 2011). These two outcomes have differing effects on performance. Often technique deviation will create the same outcome as well executed technique, it will just be accomplished differently. On the other hand technique deterioration will cause poorer performance. However there is no specific evidence in regards to the length of time it takes for technique to move from deviation to deterioration. In contrast to this, a study on player time on rugby performance found no significant effect of fatigue on technique (Tierney, Denvir, Farrell & Simms, 2016). This study did not specifically look at deviation in technique just deterioration. A study analysing punt kicking technique after fatigue also found deviation in technique but not deterioration (Coventry, Ball, Parrington, Aughey & McKenna, 2015). A further explanation is that elite level athletes have a much higher resistance to fatigue effects (Spencer, 2016). More relevant sports that may translate better to cheerleading would be a high intensity style sport. Sprints in both cycling and figure skating found after fatigue there were decreases in technical aspects of performance (Stoter et al., 2016). The most specific article that could be found for cheerleading was the effects of fatigue in elite level gymnasts. Van Dieen, Luger and Van der Eb (2012), studied the impacts on trunk stability of high training loads. In gymnastics core stability, maximum force, power and muscular strength is very important for performance. Similarly in cheerleading power, endurance and strength are critical to perform stunting and tumbling skills (Goodwin et al., 2004). Van Dieen et al., (2012), found that fatigue had negative effects on maximum force, slowed down muscular response, and resulted in a loss of trunk stability. Furthermore fatigue was also linked with respiratory challenge that is associated with high intensity trainings. Brief high intensity exercise can lead to a 5-15% reduction in peak force (Knicker et al., 2011). This is a fairly similar sport however, it does not create strong correlation evidence that the same would be found in cheerleading. This reinforces the need for more research on changes in technique after the fatigue of a cheerleading routine. Developing research in this area may also help form strategies on how to avoid the impacts of fatigue.

Conditioning Requirements

A common strategy used to negate the impacts of fatigue is strength and conditioning. Changing strength capabilities is very important to ensure correct technique is used. Both in Gymnastics and cheerleading, conditioning has been found improve technique in skills (Goodwin et al., 2004; Sawczyn et al., 2016). Having a good foundation to allow correct technique is very important in development and performance of skills. By improving strength, the technique of skills become more accurate and are less likely to be impacted by fatigue. The execution quality of a skill is dependent on strength endurance (Sawczyn et al., 2016). Good strength endurance is what prevents faults in performing skills. Strength training can also have a positive effect on the hormonal effect of fatigue in strength endurance (Spencer, 2016). Increasing the research of fatigue on technical execution of skills can further develop training plans to improve performance in cheerleading. The technical execution of a back handspring is very complex.

Biomechanics

There are many different factors and ways of measuring the biomechanics of a back handspring. The most common biomechanical indicators that were identified amongst the literature was the velocity, trajectory, and angular momentum of the body alongside the length of the back handspring. It was also commonly broken down into four phases. Significant differences included elbow flexion, power and work, and time structure as alternative key performance indicators.

Velocity was one of the most commonly referred to areas of technique. Velocity is the speed and momentum of the body during the back handspring (Davidson, Mahar, Chalmers & Wilson, 2005; Hars & Calmels, 2007; Niznikowski et al., 2007; Penitente et al., 2011; Prassas, Kwon & Sands, 2006; Sands, Alumaugh, McNeal, Murray & Stone, 2014). In particular the ability to generate vertical momentum during take-off to allow enough time and height to complete the skill is very important (Heinen et al., 2010; Prassas et al., 2006). It was also found by Penitente et al., (2011) that in elite level gymnasts the average time it took to complete a back handspring was 0.78 seconds. Generating high velocity is imperative during a back handspring to allow enough force to flip the body over.

The second most commonly referred to technique was the trajectory of a back handspring. The trajectory is the flight path of the athlete during the skill (Heinen et al., 2010; Niznikowski et al., 2007; Penitente et al., 2011). The purpose of trajectory in a flic-flac (back handspring) is to optimise the centre of mass to gain height that allows time to complete the skill (Heinen et al., 2010; Prassas et al., 2006; Sands et al., 2014). By gaining sufficient height during the launch phase, an athlete has enough time to flip their body over and land on their hands without risk of falling on their head. In contrast to this Penitente et al., (2011) emphasised the importance of a back handspring being long and low. The length of the trajectory was also supported to create a large flight distance (Niznikowski et al., 2007). Research was even conducted in relation to the length of a flic flac in comparison to body height. This exposed that highly skilled gymnasts covered the distance of close to 50% of her height (Penitente et al., 2011). Trajectory is another important biomechanical aspect to determine height and length of a back handspring.

Angular momentum was a factor identified in three of the studies as important to correctly perform a back handspring. Angular momentum can be determined by the angles of the body's sagittal plane in regards to the horizontal angle (Heinen et al., 2010; Penitente et al., 2011; Prasses et al., 2006). During the flight phase of a back handspring, the centre of mass needs be as close to 100 degrees as possible, to accurately complete the movement (Penitente et al., 2011). This stretching out of the body allows a straight centre line of gravity to form a handstand in the middle of the flip. If the athlete has complete control over the angular momentum then achieving the handstand is a good indicator that the back handspring should continue flipping (Prasses et al., 2006). Post launching phase, the muscles in the body must remain tight in order to attain good control over the angular momentum, which allows the body to flip and finish in an upright position. However there is limited evidence on the exact angles required for each phase to perform the perfect back handspring.

Technical Phases

A flic flac is often separated into four key phases. The first phase identified by Niznikowski et al., (2007) and Potop (2014) is the launching position during the preparation stage. Penitente et al., (2011) similarly identified the first stage as feet support, although this wasn't explained in as much detail as the first two. One of the two key phases found in Prasses et al., (2006) was the ability to take off with the correct angular momentum. In general the first phase is related to the jumping position in which the athlete takes off from. The second phase is identified as the multiplication of body posture with a straight body position (Niznikowski et al., 2007; Potop, 2014). In contrast to this Penitente et al., (2011) breaks the skill down even further into two flight phases, with the second phase being the first flight from feet to hands. Although there is no complete agreement in the second phase, the overarching theory is the flipping phase. There were many inconsistences around what the third phase was. One article recognised the third point as the final position to ensure a safe and accurate landing (Niznikowski et al., 2007). The second study's third stage was at the maximum flight height (Potop, 2014). As Penitente et al., (2011) broke the skill up more, their interpretation of this was the hand support in the middle of the back handspring. The final phase is the landing posture which allows a dynamic link between acrobatic exercises (Niznikowski et al., 2007; Potop, 2014; Prasses et al., 2006). The only opposing theory to this was in Penitente et al., (2011) whose final stage was the second flight phase from hands to feet. However there was consistent evidence in many studies of the importance of a rebound or final launching phase to allow other skills to follow out of the back handspring (Heinen et al., 2010; Niznikowski et al., 2007; Potop, 2014; Prasses et al., 2006; Sands et al., 2014).

There are also some ideas that only single studies found important. One compared a standing back handspring with a round off back handspring and found that although significant amount of work and power is needed for both, power plays a much more important role in a round- off back handspring (Watkins & Nicol, 1985). Time structure during the different phases is critical for good performance (Heinen et al., 2010). Lastly, elbow flexion should not occur during the skill to protect the head (Davidson et al., 2005).

Coaching Implications

Research shows that a back handspring is a very complex skill, with many factors affecting it. Regardless, the technical execution is essential for both safety and performance. In cheerleading, performance of this basic tumbling skill is also significant for the development of connecting skills. Fatigue can have substantial effects on technical performance. There is a wide gap in literature on fatigue impacts of technical execution of basic tumbling skills in cheerleading. Understanding if there is an impact and the level of significance this may have on a back handspring will determine the required strength and endurance training for competition. Furthermore this research would not only benefit the coaching sport of cheerleading, but may have significant positive impacts on parallel sports such as gymnastics, tumbling and trampolining.

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