Developing Physiological Adaptations to Enhance an Individual’s Performance: Analytical Essay

Introduction

This study looks at evaluating training programmes and their application when developing physiological adaptations to enhance an individual’s performance. When undertaking a training programme, individuals aim to achieve specific goals that are structured with the intent to increase the individual’s physiological, psychological and sociological performance (Bompa & Haff, 2009).

Training aims to develop specific qualities associated with certain tasks, these attributes consist of multilateral physiological development, sport-specific physical development, technical skills, tactical abilities, physiological features, health maintenance, injury resistance, and theoretical knowledge (Bompa & Haff, 2009). The main purpose of this study is to evaluate training programmes when developing physiological adaptations and therefore, multilateral physiological development (MPD) is the main focus of this study in addition to sport-specific physical development (SSPD), as the client is participating in a sport at University level so the programme needs to link to the needs of the sport. MPD is also commonly known as general fitness and targets the development of specific components of fitness; health and skill (Clark, Lucett, McGill, Montel, & Sutton, 2018). Health-related components: cardiovascular endurance, muscular endurance, muscular strength, flexibility, body composition as well as skill-related components: agility, balance, coordination, power, reaction time, speed.

Adaptation to any training programme is correlated to the physical demands placed upon the neuromuscular system and the associated physiological systems needed to execute a training session; where the body is continuously exposed to stressors of volume and intensity of exercises. The physiological process by which the body reacts to training and exercise is called adaptation (Fleck & Kraemer, 2014). However, adaptation can depend heavily on the stimulus of the session, the greater the degree of adaptation to the training process, the greater the prospective for high levels of performance (Brown, 2017). This improvement is only possible if the programme follows a sequence of increasing stimulus, resulting in adaption, whereas a lack of stimulus will lead to a lack of improvement. If the stimulus is excessive, maladaptation will occur and there will be a substantial decrease in performance (Swain & Leutholtz, 2007).

One training concept that was described by Falbort in 1941 was super-compensation, which identifies the advantage of progressive overload and touches upon the importance of it being used correctly to limit excess levels of undesirable stress (Clark, Lucett, McGill, Montel, & Sutton, 2018). It was later discussed by Seyle (1956), who called it the general adaptation syndrome (GAS) in which it is now commonly known as. They go on to suggest that for the best chances of training adaptation to occur, a stimulus such as training loads, training volumes and bioenergetics specificity will have to be altered. This is done by altering low, medium and high intensities within the programme, allowing for the essential recovery and rest periods between exercises and training sessions, if this is done correctly, alongside sequenced training phases, it will lead to the management of critical levels of fatigue and overtraining; this is commonly known by the term, periodization (Ansell, 2008).

Pre-training Analysis

The participant being used within this study is a 26-year-old male student who plays rugby at University level for the 1st team as a prop. Throughout the training programme, rugby physiology papers were used to gather information about the performance level at which the participant should be working at. Rugby union is a highly intermittent sport that involves periods of high-intensity exercise that includes: running, tackling, and static exercise combined with periods of low-intensity activity (Blair, Elsworthy, Rehrer, Button, & Gill, 2018). Nothing out of the ordinary came from the client's needs analysis which can be seen in appendix 9. The weight and height of the client correlate with normative data when comparing against other University league rugby players (Gabbett, King, & Jenkins, 2008).

Within the game of Rugby Union, a large amount of research has been undertaken to outline the physiological effects of the game on the player (Blair, Elsworthy, Rehrer, Button, & Gill, 2018). There is some evidence to suggest that the physiological abilities of a rugby player may deteriorate as the season advances, with reductions in muscular power output and maximal aerobic power as well as an increase in skinfold thickness taking place towards the end of the rugby league season, when training loads are lowest, whereas match loads and likelihood of an injury occurring is at it’s highest (Gabbett, King, & Jenkins, 2008). As shown, there has been research on the types of movement patterns and the physiological demands of rugby league competition in this study. Therefore, having a greater understanding of how the training programme can imitate the competitive environment as well as a firm understanding of the physiological demands of the specific individual positions within a game, would allow for the correct stimulus to be placed on the individuals training programme. This resulting in developing the necessary components of fitness to meet the requirements on that specific position that the individual plays (Borges, Doering, Reaburn, & Scanlan, 2017).

FMS

The initial pre-training assessment that was completed was the functional movement screen (FMS). This was completed as this assessment was designed to assess joint mobility and stability in a variety of different movements (Swain & Leutholtz, 2007). This is a fundamental test to conduct with an athlete, as it may uncover some of the neuromuscular control and muscular imbalance risk factors that can cause injury. However, FMS may only be able to expose these risks that will contribute to a non-contact injury. Trewartha, Preatoni, England, & Sokes (2013), discussed that 80% of injuries in rugby union are a result of contact events like tackles and collisions and are unavoidable because of the nature of the sport and forces involved. They later went on to discuss that previous research suggests these injuries occur from technique based movements and FMS can be used to assess the mobility of the individual and their ability to perform these discussed techniques efficiently, therefore affecting the player’s injury risk. The participant completed an FMS which consisted of seven different tests that focus on balance, stability and mobility. Each exercise is scored between zero and three, three being the maximum score for perfect execution (Bompa & Haff, 2009). The maximum total score is 21 and the participant scored 16 which means they do not have an increased risk of injury. Comparing this against the norm shows the participant is at the right stage as evidence suggests rugby players should have an FMS score of >14 (Brown, 2017). FMS scores can be seen in table 1. It did, however, show that shoulder mobility exercises may be beneficial for the client to improve their mobility.

Table 1 –Table 1 - Fundamental Movement Skills Score

Test Score

Deep Squat 2

Hurdle Step 2

In-line Lunge 2

Shoulder Mobility 1

Active Leg-Raise 3

Trunk Stability Press-Up 3

Rotary Stability 3

Total 21 Total 16

Power

The vertical pump has been commonly employed as a measure of lower body explosive power output and regardless of questioning in respect to its validity due to it only measuring the lower body, studies support this measure as biomechanically, it is similar to various acceleration and game-related dynamic movements within the game of rugby (Trewartha, Preatoni, England, & Sokes, 2013). Therefore, the vertical jump test is valid to use with a battery of over tests (Brown, 2017). The assessment scores can be identified in table 2. The game of rugby requires a specific level of power to be able to perform certain movements within the game, for example, performing a tackle, lower body power is vital to drive the player back and perform the tackle efficiently (Blair, Elsworthy, Rehrer, Button, & Gill, 2018).

Table 2 – Vertical Jump Scores

Test Participant Score Normative Data Elite Score Reference

Vertical Jump 18.5inches 16-20inches 25-28inches (Darmiento, Galpin, & Brown, 2012)

YO-YO

The Yo-Yo intermittent tests evaluate an individual’s ability to repeatedly complete intense exercise. The Yo-Yo IR level 1 (Yo-Yo IR1) test focuses on the capacity to carry out intermittent exercise leading to a maximal activation of the aerobic system, whereas Yo-Yo IR level 2 (Yo-Yo IR2) determines an individual’s ability to recover from repeated exercise with a high contribution from the anaerobic system (Bangsbo, Laia, & Krustrup, 2008). The yo-yo test used within this study however, has had a few modifications from the original test as changes to the protocol were made for a specific purpose of testing rugby players. This specific yo-yo test conducted, requires the participant to lay on the ground in a prone position, before each 40-metre shuttle (Krustrup, et al., 2003). The format of this test can be seen in appendix 2.

Literature shows that by adopting the prone position during this test it increases the blood lactate and rate of perceived exertion (RPE) responses, which places a larger emphasis on metabolically demanding actions that can be mirrored within a game (Krustrup, et al., 2006). The literature used was from a football study, however both football and rugby are high-intensity invasion games with similar characteristics. Therefore, that is the reason this specific test was conducted to measure the participant's aerobic capacity.

Table 3 - Yo-Yo Test Results

Test Participant Score Normative Data Elite Score Reference

Yo-Yo 17.6 17.3-18.6 22.2 (Bangsbo, Laia, & Krustrup, 2008)

Strength Assessment

One commonly used strength assessment is the one-repetition maximum, which requires the participant to lift the highest weight possible through the full range of motions of that specific lift (Gamble, 2013). Although, conducting a 1-RM strength test is slightly critical, especially when looking at an athlete in recreational sports. The 1-RM strength test is connected with high stress for muscles, connective tissue, and joints (Brown, 2017). Also, studies show that the 1-RM is inappropriate for specifying load in strength training (Swain & Leutholtz, 2007). Even though this strength assessment is commonly used, limited research has been conducted into the reliability of multiple repetition maximum strength assessments until Gail, (2014), conducted a study looking into this limited area of testing and the reliability when comparing it to recreational sports. The study found that the 5-RM strength assessments in recreational sports were reliable and a simple measurement method to undertake, with no need for extreme preparation before the assessment. Whereas the 1-RM does. Gail, (2014), found that there was a very high intra-class correlation coefficient (ICC>0.90; pTable 4-5-RM Results

Test Participant Score Normative Data Elite score Reference

5-RM Squat 1.01kg per kg body weight 1.00-1.14kg per kg body weight >1.60kg per kg of body weight (Fleck & Kraemer, 2014)

From the information gathered from the pre-assessments, it shows that the athlete is either within or exceeding normative data which doesn't cause any concern. However, the lowest score was recorded on the strength assessment so therefore, this component of fitness will be the main focus of this study as it will also improve power and speed (Ansell, 2008). The main type of training used will be resistance training as the client enjoys that the most and it allows a specific programme to be designed around that area. The athlete’s main goal is to get into the above category (>1.14kg per kg body weight) by the end of the twelve weeks.

Training Proposal

In order to support the client in reaching their long term goal, training sessions will mainly revolve around resistance training methods which focus on the body's musculature to move against an opposing force which is commonly done by a piece of equipment (dumbbell, etc.). The phrase ‘resistance training’ encompass’ a variety of training modalities which include:

body weight exercises, elastic bands, plyometric as well as free weights or a weight training machine (Clark, Lucett, McGill, Montel, & Sutton, 2018). This can be seen in appendix 4 and 6. Throughout this section of training, certain adaptations would be expected to occur; these are: muscular endurance, muscular hypertrophy and muscular strength (Hong, Hong, & Shin, 2014).

Muscular endurance is the ability to harvest and uphold force production for an extended amount of time (Clark, Lucett, McGill, Montel, & Sutton, 2018). Improving muscular endurance is an integral component of this training programme as within rugby, the ability to harvest force production throughout the duration of the game efficiently is of the upmost importance for performance success (Hong, Hong, & Shin, 2014). In addition, an improved muscular endurance will aid in improving core and joint stabilization which is the foundation on which, strength, speed and hypertrophy are built upon by recruiting all those muscles responsible for postural stabilization, namely, slow-twitch fibres (Clark, Lucett, McGill, Montel, & Sutton, 2018). Previous literature indicates the most efficient way to gain muscular endurance is through high repetitions within sets and (Bompa & Haff, 2009), found that training 20-28 reps with 2 sets with one minute rest periods, starting at two days a week, increased muscular endurance and hypertrophy in men after an 8-week training programme when working at 70% of their 1RM..

An additional adaptation to occur is muscular hypertrophy. Muscular hypertrophy is defined as the enlargement of skeletal muscle fibres when reacting whilst being employed in developing increased levels of tension that can be seen in resistance training (Abe, Kojima, Kearns, Yohena, & Fukuda, 2003). Hypertrophy characteristically stems from an increased number or size of contractile elements within the muscle fibres when responding to a heavy training stimulus, causing a growth in the cross sectional area of the muscle fibres and consequently the entire muscle construction (Schoenfeld, 2010). When a skeletal muscle is placed under tension that disturbs the integrity of the muscle fibres, myogenic actions occur which cause an increase in the number of contractile proteins, actin and myosin within the myofibril (Abe, Kojima, Kearns, Yohena, & Fukuda, 2003). As this occurs, sarcomeres (striated muscle tissue) are added in parallel, causing a reaction to occur where the muscle fibres expand, creating the muscle cross sectional area to enlarge (Schoenfeld, 2010). Gamble (2013), discussed that 24 weeks of training, 3 days per week with 3 sets of 8-12 repetitions per exercise saw the most improvements in muscular hypertrophy when working at 75% of their 1RM.

Muscular strength is defined by the ability of the neuromuscular system to produce internal tension to overcome an external force (Brown, 2017). Depending on the degree of internal tension will determine the strength adaptations. Using heavier loads will increase the neural demands and recruitment of additional muscle fibres until a plateau is reached. As strength training is designed to match characteristics of type 2 muscle fibres, acute variables such as, sets, reps and intensities, need to manipulate the stimulus to take advantage of the characteristics of the muscle type (Clark, Lucett, McGill, Montel, & Sutton, 2018). Literature suggests a rep range of between 3-8 with 3-4 minutes rest in between sets at 90%+ of the athletes 1RM to improve strength (Gamble, 2013).

The exercise selection was conducted from client information gathered from their needs analysis as well as the requirements for strength gain. The client enjoys free weights and cable machines more than resistance machines, which is why the majority of exercises are not machine based. In addition to this, I have positioned the compound lifts earlier on within the workout as they're the most demanding and therefore fatiguing exercises such as the barbell squat or barbell deadlift. We then have the isolated or unilateral exercises later on within the

programme as they're less demanding on the client's muscles (Fleck & Kraemer, 2014). The frequency of the sessions start to climb as the week's progress, starting with three and building to four as literature suggests that you need to train at least three times a week to see adaptations occur (Bompa & Haff, 2009). The initial two weeks are used as a general conditioning/stabilization phase and the following weeks conclude the strength phase, focusing on the three key elements; strength, endurance and hypertrophy, finishing the programme with power sessions. This follows the Optimum Performance Training (OPT) model designed by NASM (Clark, Lucett, McGill, Montel, & Sutton, 2018).

This all needs to fit within the FITT principle to obtain maximal performance enhancement. The frequency of the session/sessions needs to correlate with how much of the training the client needs to do to see adaptations. For example, for this study, the client would need to train at least 2-3 times a week on strength to see those adaptations occur. Additionally, the intensity the client is working at needs to be within the correct range, when training strength, you need to be working at a higher percentage of their repetition maximum (85%+). Following on from the intensity of the session, the duration of the session is vital for optimum adaptation, also known as time. The duration of the sessions need to be long enough for the training to work but not too long where you start to overload the muscle groups which can cause reversibility effects. Finally and potentially the most vital principle, type of training. Dependent of the main goal of a client will depend on the type of training that is required; for this client, their main goal is to increase their overall strength, to do so, they need to be completing resistance training whereas if they were on a cardiovascular programme, it would not get the adaptations we require (Clark, Lucett, McGill, Montel, & Sutton, 2018). Additionally, sessions were given enough time between one another to ensure the most recovery time, recovery of ATP store, needed for optimum performance in the next session.