EXPLORING PSYCHOLOGICAL STRATEGIES TO MANAGE FATIGUE IN ENDURANCE SPORT

BY

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Abstract

The purpose of the study is to examine psychological interventions and their contextual validity in endurance-based sporting events. Over the course of three studies the work examines interventions for coping with fatigue in both laboratory and real-world settings. Participants range in ability and experience from novice to sub-elite competitors. The two cycling-based studies explore pacing strategies and goal directed self-talk. The final study delivers brief interventions to sub-elite runners in repeated trials at their local parkrun. Results throughout were mixed and often it was not clear the extent to which the intervention had been effective. The studies highlight the complexity and challenge involved in trying to teach and then measure psychological interventions in this context. Many factors influence performance, and more work is needed in understanding and highlighting the impact of training, experience, competitive conditions, belief effect and so on. In particular the motivation levels of athletes are critical when trying to assess a maximal performance. Case studies will be a useful model in future research to understand the complexities of individual athletes. Finding creative ways to examine athletes in environmentally valid settings, where there can be a high degree of confidence in athlete effort levels, will be valuable. The relationship between belief effect and the athlete's choice of coping strategy is worthy of further research.

Table of Contents

Chapter One: Introduction

1.1 Introduction

"'Scientists come and tell us we should have this special system, but we know it's based on some half-bent study on students… The thing that grates more than anything is that scientists seem to think they know best and have no respect for what we've learned over the years.'" (Sir Steve Redgrave, cited in Ingham 2016, p.35)

This quotation is credited to Sir Steve Redgrave, who famously won gold medals at five consecutive Olympics between 1984 - 2000. The quotation was selected by Dr Steve Ingham who provided support in performance for both the British Olympic Association and the English Institute of Sport. Early in his career, Ingham worked with athletes including Redgrave and recounts some of the scepticism with which Sports Scientists[1] in general were greeted when working with elite athletes. Sports Science is inherently a discipline which conducts research aimed at producing applied value. However, some of the challenges presented in conducting contextually accurate research are highlighted when such recommendations are made based on studies where participants are not equivalent to the group or individual to whom it is delivered. In short, Redgrave offered a valid description of some research (in that research is often conducted on students), and Ingham, in using this quote, sought to raise the importance of having evidence that a practitioner can use to inform their work and enhance their credibility. Elite athletes such as Redgrave will often have powerful beliefs supported by a proven track record of success and so will hold knowledge of what helped them achieve. An athlete's belief is an important factor in the adoption of an intervention. Robust evidence and sound reasoning are two ways in which this belief can be cultivated. As Ingham

[1] "Sports Scientist" is used throughout as the focus of the present studies is on competitive sport.

acknowledges, the timing and style of communication are important factors (Lane, Godfrey, Loosemore, & Whyte, 2014). Ingham recounts consciously attempting to build trust among the rowing squad and with Redgrave in particular by volunteering for mundane tasks, thereby trying to show he was part of the team. He reports that he deliberately avoided making bold, large claims about the potential of his own impact. These seem unusual acts when comparing a Sports scientist to what a GP, Dentist, physiotherapist, or other health professionals might do in order to gain the trust of their clients, where trust that the practitioner will have a positive effect is taken from the outset. As many science-based practitioners highlight (Ingham, 2016; Lane, Godfrey et al., 2014), the evidence to show interventions will work is hard to find; it requires an evidence base showing the size of the effects on an intervention, that it works with the population you wish to use it with, it works reliably, and you know why it works. Designing and running such studies is challenging, but is a motivating factor driving the present programme of study along with looking at how science is translated to practice.

Recent research has focused on the influence of placebo or belief effects on performance in sport (Hurst et al., 2017, Beedie, 2007). A key factor in the studies that follow is the challenge of identifying the impact of any placebo or belief effect from that of an intervention - that is to know why the intervention worked. The present programme of research was interested in assessing the effectiveness of interventions rather than the study of the placebo effect per se, but unlike a great deal of previous research, accepts that placebo beliefs can be both positive and negative (Beedie, 2007). A positive belief effect can follow through and make an intervention work, and a negative belief can lead to an intervention failing. For example, if you hold strong beliefs that an intervention such as self-talk will not be effective, using self-talk is likely to be seen as an annoyance rather than a help. Carrying out this kind of research is very challenging. Designing studies which isolate the intervention from belief effect is not straightforward given the practical implications of research conducted with suitable ethical approval and informed consent.

As demonstrated clearly in the quotation from Steve Redgrave above (Ingham, 2016), the importance of the athlete's perception whenever a practitioner is involved. Studies where brief online training has been imparted, that is the way the different interventions have been controlled, have shown that the deliverer can influence to a considerable degree (Lane et al., 2016a). The study which follows, of repeated parkrun trials, examines some of these issues in detail.

As Sports Science has developed as a discipline, researchers, particularly those with applied interests, have become aware of the challenges which translating research into the field provide. Ingham's career path is not atypical as practitioners in professional sport have increasingly turned to Sports Science to provide performance gains. In offering support researchers will attempt to be specific to both the sport and the athletes in question. Set against this are the practical constraints of academic ethics and the environment in which much of the research is necessarily conducted. It is obvious that the laboratory is a very different environment to the field of play (Davids, 1988). Likewise, athlete motivations will be different when participating in a study as opposed to competing, even where the athlete might value the research and perceive benefits.

In endurance sport, and specifically endurance sports such as distance running and cycling, the context for the present study, athletes by necessity carry out large volumes of aerobic training in environments akin to their competitive setting. Endurance or distance running are terms relating to events where aerobic capacity is the key physiological determinant of performance. In the case of marathon runners this can mean many hours of running on the roads. The increasing availability and convenience of technology, even within a wrist-based device, coupled with widely available training advice from physiologists (for example, see https://support.garmin.com/en-GB/?faq=o21H5a4cSU52FwFAy0R6Z5; https://www.trainingpeaks.com) means that many athletes will now inform their training using heart rate, and even more recently by power. Some of these "training zones" are even suggested within the software accompanying the device and are refined as the athletes training data is recorded. As such many athletes are familiar with and hold positive beliefs towards using data to inform their training. This is not universally the case however. Many athletes prefer to train "to feel" or what a Sports Scientist would consider Rate of Perceived Exertion (Borg, 1998). Many training programmes deliberately avoid specifying paces but instead focus on setting sessions of training based on time and effort. This is in keeping with the philosophy that running is a simple sport and that excellent results were achieved before the aforementioned technology was widely available. Translated to the laboratory, it is clear that athletes are likely to have differing views on and investment in the value of Sports Science support. Mark Cavendish is a well-known example of a highly decorated athlete who at times showed little faith in Sports Scientists and perhaps at least in part for this reason performed poorly in their tests (Ellingworth, 2013, p. 63-64). Despite his reluctance to engage with Sports Science his abilities were recognised and the subsequent results, including a world championship and a record number of stage wins at the Tour De France, spoke for themselves.

As Ingham's experience suggests, Sports Science should consider contextually relevant support to increase their credibility with athletes and coaches. Understanding the demands of the sport and even the event or role within that sport is crucial to achieving this. An ability to communicate this understanding effectively and with empathy will be beneficial. For example, if a researcher displays an understanding of the specific demands on a domestique in a professional cycling team, that cyclist should be more likely to be more receptive to suggestions based on research.

Sports Scientists, out of practical necessity to gather accurate and reliable data, carry out much of their research in the laboratory. The application of this research takes place in the field, in training and competition, where it is known that motivational conditions differ from the research environment (Davids, 1988). In research involving physiological and psychological factors methods often rely on self-reporting which rely on accurate recollection and inner knowledge. It quickly becomes apparent then that carrying out research with the intention of producing recommendations for practitioners provides complex challenges which vary between sports and disciplines.

Endurance athletes seeking to optimise their performance, particularly those competing at an elite level, do large volumes of training. Distance runners for example typically train up to twenty hours per week and are often reported to cover in excess of one hundred miles. Full-time athletes can view around the clock activities, including eating and sleeping as an extension of their training (Wellington, 2012). There is a limit to the amount of time which can actually be spent training, and so the full-time job involves recovering well to allow adaptation to take place. If motivation is seen as the selection, intensity of persistence of behaviour, then this shows they are highly motivated individuals who undergo rigorous training regimens. Evidence shows that such training volume associates with fatigue, with overtraining being an unwanted consequence (Saw, Main, & Gastin, 2016). Therefore, what is clear is that fatigue is a major factor not only in competition but in their day to day lives.

Competitive endurance sport presents a number of challenges to the athlete and their support team. Optimising performance involves operating at high levels of intensity relative to the duration of the event. The psychological demands on the athlete are considerable. They must execute their best performance whilst managing increasing physiological symptoms of fatigue and the accompanying desire to slow down. Additionally, they must cope with the influence of competitors, perceived pressure to perform well and in the case of elite athletes, the potential impact of performances on their career.

The common demands of endurance events have been usefully grouped into three categories (McCormick, Meijen et al., 2019). Firstly "exercise-related sensations" such as burning muscles and breathing discomfort, secondly, skill-based factors such as pacing and thirdly, a range of other stressors both before and during the event (McCormick, Meijen et al., 2019). These might include competitive and personal stressors which could impact performance. The following literature review into endurance performance reveals shifting emphases between these factors culminating with an increasingly holistic approach to the challenges of improving performance.

The psychology of in-event fatigue and its contribution to performance has been an area of increasing interest to sport scientists in recent decades. In 1997, Tim Noakes renewed A.V. Hill's previously disregarded argument, from as far back as 1922, that a "Central Governor" exists which regulates exercise intensity to protect the body from harm (Noakes, 1997). Central Governor Theory has become synonymous with Noakes despite the previous work of Hill.

The large volume of research by Noakes and others challenged the notion that performance was limited by the failure of muscles due to inadequate oxygen supply.

More recent research has included a "psychobiological model" (Marcora, 2008) which has stressed the importance of motivation and perception of effort in providing the limits to performance. All of this has meant that increasingly in competition settings athletes looked to sports science disciplines including sport psychology and physiology to improve their performance. In most cases, competitive athletes are carrying out physical training at high volume and intensity. Athletes have for many decades recognised the importance of psychology. The idea that structured psychological skills training can form part of an athlete's preparation is attractive as it provides an additional opportunity to enhance performance.

The recruitment of suitable participants is a challenge for all researchers but particularly so in this area. (Swann et al., 2015). In seeking to provide advice to elite and competitive athletes, researchers must be sure that their work is relevant to those groups. Ideally this would mean carrying out studies involving athletes competing at a high level. By definition the number of available athletes is limited, an issue which is compounded by the difficulties which their training and competition schedule provide in recruiting them to studies. Additionally, it is likely that such athletes would need to perceive a tangible benefit to their performance from agreeing to participate in a study. Researchers have on occasion identified participants of varying ability as an elite group (Swann et al., 2015). Similarly, other descriptions such as "highly-trained" are problematic as they are by definition relative terms. An athlete could be described as highly trained relative to the general population but might not be considered such in the context of competitive sport. Standardising these terms is not straightforward. Within the elite field of a major marathon for example there will be a wide variety of training volumes and intensities reported by the athletes. Even when assured of anonymity, athletes may be reluctant to participate in research which compromises what they perceive to be competitive advantage by revealing training techniques and other elements of their preparation.

Another of the challenges for researchers is conducting contextually relevant studies which can validate effective interventions. An athlete's performance in a laboratory setting may not be analogous to their competition performance for a number of reasons. Environmental conditions differ. There can also often be considerable variation in the motivation level of athletes carrying out physiological or other forms of testing. Their belief in the value of the testing might influence this, as could the availability of the data to a governing body or selection panel for example. Recommendations to coaches and athletes need to be appropriately qualified and put into context. Field testing can be an alternative option to the laboratory but can often be more logistically challenging, particularly in respect of controlling conditions. In-competition research faces many more obstacles, particularly with regard to psychological interventions. Athletes will be very reluctant to endanger a competitive outcome by trialling a psychological strategy, the effects of which are unknown.

In summary there are challenges in this area of research in terms of participant recruitment, logistics and making the research contextually relevant. In reality understanding the limitations of a study, rather than trying to remove all of these issues becomes key.

The aim of the present programme of studies is to explore challenges facing researchers in gathering meaningful data to inform the application of psychological strategies in endurance sport. Varying populations were recruited with the goal being to identify further areas for research which could produce meaningful recommendations for practitioners.

1.2 Aims

The aims of this study are: -

(i) To identify and examine issues around the selection and delivery of psychological interventions in endurance sport for athletes with a range of experience and abilities.

(ii) To examine interventions intended to manage the specific symptoms of fatigue in the latter stages of intense exercise.

(iii) To suggest appropriate avenues for future research to develop interventions that are effective, easy to learn and accessible.

1.3 Outline of the present programme of study

The present programme of study sought to develop, and test interventions designed to help competitive participants in endurance sports improve performance. The research aimed to examine ways in which athletes are assessed and the use of data collated, the efficacy of interventions, and the usefulness of those interventions. Given the broad range of participants in endurance running and other events, the research aimed to look at how competitors learn about interventions and use them, with an aim to be able to have interventions that work and are easy to learn and make accessible for wide scale adoption. The approach to conducting the research, with so many possible starting points was to begin by joining and synthesising existing research that was conducted in the area by the author's research team. Lane has published widely in endurance sport (Lane 2015, Lane et al., 2014, Lane et al., 2004, Lane et al. 2019), often in an applied context including providing sport psychology support to the London Marathon for 5 years and running a large-scale project with Runner's World (Lane, Devonport, et al., 2016; Lane, Davis, & Devonport, 2011). At the outset I was able to participate in a funded project by the British Psychological Society called Resisting the Urge to Stop (RESIST) which brought in expertise and highly published authors in endurance sport. Further, Lane was part of a research team with colleagues in Girona including Latinjak, the co-author of the paper presented in Chapter 4. All of the above researchers were conducting research and the aim was to synthesise these findings and further collaboration. The author's role varied in the four articles used in this thesis, but it is worth noting that he led both the parkrun study and the attention focus study. The thesis begins with a literature review, on which should be noted that the RESIST research team produced a narrative review of literature for publication in Sports Medicine. This narrative review informs the general discussion also. Three studies are reported and whilst they are presented in an order, this order is for the convenience of writing the thesis, and so they are not sequential. The findings from one study did not inform the design of the next study and this is an important point to emphasise. Each study has limitations, which are highlighted, and inform the general discussion where the contribution to new knowledge comes from the integration of findings. The three short studies each looked at a different aspect of endurance performance.

Chapter 3 deals with the ability of novice athletes to adopt and implement pacing strategies. The ability to pace with and sometimes without external feedback is an important skill for endurance athletes. In addition to this the study looks at some issues around how successfully people unfamiliar with the conscious implementation of psychological strategies are able to learn these strategies in a short period of time.

Self-talk (Hatzigeorgiadis et al., 2011, Van Raalte et al., 2016) is much discussed in the literature, having as it does an influence in a number of psychological strategies and interventions. The study looks at goal directed self-talk, its effectiveness and how learning effects occur for psychological strategies such as this impact performance.

The final study examines brief online interventions and their impact on highly trained and experienced athletes. A number of psychological strategies were involved and were assessed in the semi-competitive setting of parkrun, a weekly community led 5km time trial. Athletes were in training for targeted competitions and as such motivated to improve their performance during the study.

1.4 Delimitations

- Where possible a contextually relevant environment was selected for the study (such as parkrun) to ensure motivated participants invested in optimising performance.
- Participants were recruited with an understanding of their experience, training schedule and level of competition.
- In so far as possible, conditions of field testing were controlled with the same course being used.

1.5 Limitations

- Effects of weather conditions and interpersonal competition
- Motivation levels of participants
- Recall and self-reporting of participants

1.6 Definition of Terms

Endurance Running - in this context relates to distances where work is carried out primarily by the Aerobic energy system. The first distance in athletics competition generally regarded as “long-distance” running is 3000m. The present study deals with Endurance Running in the context of events of 5 km in distance and above.

VO2 Max - The maximum amount of oxygen which can be utilised during exercise, a commonly used measure of aerobic endurance. Measured in ml/kg/min.

Lactate Threshold - The point at which lactate begins to accumulate in the muscles faster than it can be removed. In laboratory settings this level is often defined as 4.0 mmol/L of lactate. In applied settings the Lactate Threshold is spoken of in terms of the exercise intensity which can be sustained for one hour.

RPE - Rating of Perceived Exertion. Reported by participants / athletes typically using the Borg Scale (6-20).

Central Governor Theory - Proposed by Noakes in 1997 the Central Governor Theory suggests that the brain regulates exercise to protect the body by limiting recruitment of muscle fibers.

Fatigue - In the context of endurance sport, an inability to maintain a required power output at the same perceived effort. So as fatigue increases the perceived effort to maintain a given power output also increases.

Pacing - the self-regulation of effort to manage fatigue levels and optimise performance outcome.

Parkrun – Community organised weekly 5km time trial.

Running Economy – Typically described as the energy requirement to run at sub-maximal intensity, measured by oxygen uptake at a given speed.

Chapter Two: Literature Review

2.1 Introduction

Endurance sport has prompted a large volume of both academic and applied literature, with a considerable overlap between the two. This plethora of literature can be at least partially explained by a large increase in participation in endurance events. The most recent report commissioned by World Athletics (formerly the IAAF) reports a 57.8% increase in participation levels in the last decade, to 7.9 million participants. Unsurprisingly this increase has been reflected in average performance times and this more participatory group has been widely addressed in the literature, both in terms of research as well as in training guides and the like. That being said, high performance sport has increasingly adopted input from Sports Science as athletes, coaches and governing bodies seek a competitive advantage. This interest in Sports Science is certainly not limited to professional or elite athletes, however. A trickle-down effect has seen athletes competing at club level utilising support including physiology testing, gait analysis, and Sport Psychology or nutrition advice all of which has become more widely commercially available. The intention of this review and the studies that follow is to focus on aspects of Sports Science and Psychology that seek to maximise performance. In particular it will examine the relationship between physiological and psychological factors in endurance performance.

The role of fatigue and its management in endurance sports has received considerable attention in both academic research (Walters et al., 2019, Meijen et al., 2019) and more nonacademic literature and media. The latter has been brought about by a large increase in participation in endurance events such as marathons and cycling sportives (mass participation long distance cycling events). For participants of all levels there will be the necessity to cope with increasing symptoms of fatigue in races and training. For the recreational athlete there are an increasing number of options to access psychological skills training. Podcasts such as MarathonTalk and Running for Real have blossomed both in the number of podcasts being made and the size of the audience. These podcasts often provide practitioners with opportunities to give practical advice to a large audience. Likewise, other online resources are developing to provide evidence-based advice to participants (https://www.resist-stopping.com). This review will attempt to summarise the historical and recent research in this area with a particular focus on optimising performance in highly trained and highly motivated individuals with the use of psychological skills.

Firstly, we have to be clear about what we mean by fatigue in this context. Marcora (2019) describes fatigue as having three elements in the context of endurance sport, physiological fatigue, an increased perception of effort and an eventual inability to produce the necessary power or velocity. In this description, fatigue and its symptoms provide the limiter to endurance performance. The thesis will look at psychological interventions to manage the specific symptoms of fatigue during the latter stages of intense exercise. This is distinct from the cumulative fatigue which is often spoken of in terms of overtraining or adrenal fatigue. As such we are looking at the way in which fatigue is experienced in this context and the challenges which this presents. Many methods for coping with these challenges are currently proposed when advice is given to recreational and sub-elite endurance athletes. Often generic notions of mental toughness mean that verbal cues such as “dig in” and “keep pushing” are proposed. Elsewhere the focus is on energy management and efficiency such as in Chi Running (https://www.chirunning.com/danny-dreyer/). All of these methods seek to combat the central problem that during intense efforts, and particularly in the latter stages of endurance events, tiredness and fatigue can be perceived as overwhelming. Negative thoughts occur with increasing frequency and intensity and the athlete can choose to accept that they have no choice but to concede and slow down (Marcora, 2008) or is eventually regulated to do so by the Central Governor (Noakes, 2003). In order to develop interventions to help athletes resist the urge to slow down we need to understand what leads the athlete to the conclusion that the pace can't be maintained.

The traditional physiological view of fatigue and the more recent models which incorporate more psychological elements are discussed in some detail below. Regardless of which of these theories currently holds sway, a thorough understanding of the build-up and outcome of fatigue is needed before any attempt to mitigate this through psychological interventions. What are the symptoms and how do they lead to a decline in performance?

Mauger (2013) begins a paper on the relationship between fatigue and pain by accepting Gandevia's (2001) definition of fatigue, as an exercise induced reduction in muscle power, regardless of whether the task can be sustained. Importantly this paper goes on to discuss some of the issues surrounding the testing of fatigue, pointing out that laboratory tests are often to failure whilst real world performance can never be so, providing the event is completed. However, in a competitive or performance environment, completing the event in a time or position worse than planned for is often framed as failure. This might especially be the case if the athlete perceives that they have not given a best effort or given up in some respect. If, as we shall see below, the brain has a key role in the managing of effort during performance, then it follows that interventions have the potential to contribute to performance improvements.

Whilst a considerable proportion of research still focuses on the physiological impact of fatigue more recently various models have been proposed for the brain as the key limiter when it comes to pushing through discomfort and improving performance as a result. This review will look at the key models being proposed along with studies carried out to test and support them. Additionally, it will seek to contrast the manner in which this research has filtered through to general advice offered to serious amateurs and participants, particularly in marathon and distance running events. Finally, it will examine reported evidence provided from elite athletes, an inconsistently defined category across many studies. Swann et al conducted a systematic review of the definition of elite athletes and found eight separate ways of defining elite athletes using a wide range of criteria, from world class athletes to participants with as little as two years' experience in the sport (Swann et al., 2015). A classification system is suggested that includes the level of competition as well as experience and success of that level. The present intention is to look at how research can provide practical support for runners and how it compares with approaches which have been effective at the world class level.

For several decades the idea of oxygen consumption as the limiting factor in endurance performance held sway. Starting with work carried out in the 1920s by A. V. Hill and Hartley Lupton. The development of the VO_2 Max test and what Noakes called the Cardiovascular / Anaerobic Model (Noakes, 2001). Essentially this proposed that in order for the model to be validated the fastest runners would always be those with the highest VO_2 Max as oxygen utilisation would be the single determining factor in performance. Since we know that even at elite levels there can be a variation in VO_2 Max levels this model was obviously open to scrutiny. For example, Steve Prefontaine and Frank Shorter, two American elite athletes had a number of highly competitive races in the 1970s. Despite the fact that Prefontaine's VO_2 Max (84.4) was reportedly 16% higher than Shorter's, their lifetime best performances over 3 miles (a standard distance at the time) differed by less than a second. (Fitzgerald, How Bad Do You Want It? P.370 +

https://sportsscientists.com/2007/12/running-economy-part-i/). The fact that lack of oxygen to the heart (and resultant chest pain) did not appear to be present when exercising to failure in a maximal test also indicates that oxygen deprivation alone does not dictate maximum performance.

The idea that Running Economy was a contributor to maximum performance became increasingly important (Conley & Krahenbuhl, 1980, Daniels, 1985). Put simply, some athletes required less oxygen to maintain a given speed and as such had a better running economy. This concept is illustrated through the applied work of Professor Andy Jones and world marathon record holder Paula Radcliffe. Over a number of years Jones (2006) carried out physiological testing on Paula Radcliffe. Although her VO_2Max did improve over the 12 years of the study, as she moved from a junior to a seasoned senior athlete, this did not account for the dramatic improvement in her performances. Jones (2006) argues that consistent, high quality training improved her running economy considerably to account for a significant proportion of these improvements. Another contributory factor here may be an athlete's familiarity with running for prolonged periods at the required effort and / or pace. Radcliffe's training included frequent long runs at an effort and pace which replicated the demands of the marathon (Radcliffe, 2005).

It is possible that Radcliffe's improved physiological capacity could have coincided with increased self-efficacy. Self-efficacy theory proposes that an athlete's beliefs around an ability to achieve a specific task are influenced by factors such as past experience and are domain specific (Bandura, 1997). If an athlete engages in specific training over an extended period they are more likely to have high levels of self-efficacy in their ability to run a marathon at the prescribed pace. During this period Radcliffe competed at a world class level consistently and as such would have developed an increasing belief in her ability to be successful at the highest level. These beliefs would be reinforced by the data provided by Jones that her physiological capacity was sufficient to achieve world record times.

We can see that laboratory testing of physiological indicators has remained at the centre of both analysing and predicting endurance performance. Clearly tests such as the VO_2 Max are relevant in considering an athlete's potential and a general correlation exists between higher scores and better performance. However, other factors such as efficiency and other regulatory systems either in the Central Governor or Psychobiological model seem to have such an impact on performance that oxygen uptake as a measure is increasingly regarded as limited. Magness (2014) discusses at length, in an entire chapter entitled The Fallacy of VO_2 Max, what he perceives to be an over emphasis on this test and the possible shortfalls of using it as a means of prescribing training (Magness, 2014, p61-68). Magness highlights "the traditional trio" of VO_2 Max, Running Economy and Lactate Threshold (2014, p.98). We can see in the discussion of more general training literature below that these concepts have been central to the way that distance running training is designed.

Noakes (2001) examined the role of the brain as a regulator as he surmised that the brain interpreted the experience of fatigue and regulated performance accordingly to prevent heart and muscle damage from oxygen deprivation. Noakes proposed that "maximum exercise capacity is a process, coordinated subconsciously by the brain, limited by the maximum capacity of the coronary blood flow to supply oxygen to the heart, and regulated to prevent heart damage during maximal exercise." (Noakes,2001 p.35). The key word here would appear to be subconsciously because although Noakes acknowledges that in discussion that the Central Governor can be trained to an extent

(Noakes, 2003), he proposed that it cannot be overcome and that a significant safety margin will always be maintained by this regulator to avoid catastrophic physical damage.

In the Central Governor model, we can see that whilst psychological factors are allowed some influence, this will be relatively minor compared to the safety margin which the subconscious regulator is maintaining to prevent long term damage. The challenge to this view has recently come from the likes of Marcora (2008) who has revised Noakes' view with a psychobiological model. In various studies he has been able to find evidence that perception of fatigue is a limiting factor which can bring about a reduction in performance well before physiological limits are reached. The implication would be that psychological training could alter the perception of fatigue thus allowing the athlete to push harder for longer. Although the theories of Noakes and Marcora are often portrayed as adversarial closer analysis suggests that they have much in common. Indeed, Noakes contends that one or two very hard sessions provide benefit not in physiological terms but in demonstrating that hard exercise can be survived and thus reprogramming the Governor to relax the level of regulation. Noakes articulated on the podcast Marathon Talk in 2010 (https://marathontalk.com/shows/episode-47-prof-tim-noakes/) as a way to disseminate findings to runners. Clearly comments made in media like podcasts are opinions not subject to peer review. Nevertheless, there is value in an example of a researcher engaging with a broader sporting community as here. Under these models we have to consider not only the physiological training effect of any session or overall schedule but also the psychological impact that completing the training is having.

The notion that the perception of effort, and therefore psychological elements were the key limiting factor has been supported by a number of studies. In a study of 16 participants completing a cycling to exhaustion test, one group was first given a cognitively demanding task whilst the control group watched neutral documentaries (Marcora, 2009). The study found that the perception of effort was greater when mentally fatigued and it was this rather than any physiological changes which restricted performance compared to the control group. As such Marcora concluded that mental fatigue could reduce exercise tolerance.

2.2 Motivation

Once the idea of exercise tolerance being at least in part determined by controllable mental factors is established we can look at other psychological factors beyond simply mental fatigue. Motivation, and the impact of interventions such as self-talk appear to allow performance to continue deeper into discomfort and the other symptoms of fatigue. We need to consider the extent to which psychological interventions provide agency in terms of controlling and improving performance.

Understanding the motivation of elite athletes, particularly in comparison to their counterparts at a participation level, is clearly going to be key in assessing the impact of motivation on performance level. For example, in a study of domestic and international level Kenyan athletes the largest single reported motivational factor was economic (Onywera 2006). This is hardly surprising on the surface of things given poverty and unemployment levels in the country. This was a wide-ranging study however, looking at a number of variables which influenced Kenyan runners. What it does not do is consider the power, or effectiveness of one type of motivation over another. It is potentially significant not only that this reason was the most widely reported, but also that it is likely to remain a motivating force under the most difficult of physical conditions. There may be many reasons why East Africans have dominated distance running for a number of decades, but it seems extremely likely that this economic imperative is amongst them. Many studies have also suggested other contributing factors such as altitude, diet, genetic factors and so on, but none have identified a single cause which has been generally accepted. For example, Larsen suggests that Kenyan dominance is rooted in superior physiology, specifically in regard to maximal oxygen uptake, percentage utilisation of $VO_{2\ Max}$ and running economy (Larsen, 2003). Whilst physiological capacity continues to be regarded as making a crucial contribution to performance it is no longer seen as the lone limiter of performance.

Marcora's (2008) model suggests that there are two key ways to improve performance from a psychological perspective. One way is to reduce the perception of effort by being mentally rested and a second is to accept that effort needs to be high, and that is met by increasing motivation. The logical extension of this reasoning is that a greater proportion of physiological capacity can be accessed at a similar perception of effort. From that starting point, we can look at other psychological factors that feed into this model and the interventions which have been proposed to assist athletes in managing the physiological symptoms of fatigue.

Clearly alongside the interpretation of physical symptoms during high intensity endurance events, there are also emotional and mood implications, particularly as the duration of the event increases. Self-control plays a key role as individuals are likely to experience at least some periods where negative emotions can sabotage performance. The concept of self-control, in relation to endurance sport, is about preventing unhelpful habits and behaviours from derailing the athlete (Fullerton, 2016). We can see two conflicting views of the impact of exercising self-control. In the strength model (Muraven et al., 1998; Muraven and Baumeister, 2000; Baumeister et al., 2007) we see self-control as a finite resource, depleted as a result of activation. In the Resource Allocation Model of Self-Control (RAMS) (Beedie and Lane, 2012) self-control is engaged according to the importance of tasks to the individual. But this does not indicate a limited resource in the same way - if the task is sufficiently important, resources will be identified to meet the need. We can see echoes here of the psychobiological model as it relates to endurance performance. Where Marcora argues that motivation may allow athletes to push harder, so we could see self-control being exercised in a similar way. Negative emotions or thoughts might occur as later in the event as the physiological symptoms of fatigue increase, but sufficient importance is attached to the outcome for the urge to slow down to be resisted. As Fullerton summarises (Fullerton, 2016, p.204) -

> 'Emerging research suggests that energy depletion is no more than a subjective belief that one has limited resources. In contrast, those who believe they have unlimited stores of willpower are unlikely to experience ego-depletion effects'.

When we move on to some of the more popular literature below, we can see this characterised in specific performances of elite athletes where the perception at least is that willpower overcame inferior fitness to achieve a victory. There may be no better case in point than Sammy Wanjiru's victory in the 2010 Chicago Marathon where despite poor preparation he was able to withstand multiple attacks from Ethiopian Tsegaye Kebede to win, to the amazement of even his own support team. It is important to note also that at stake for both athletes was a large financial reward of $500 000 offered by the organisers of the World Marathon Majors. Fitzgerald places this performance firmly within the psychobiological model (Fitzgerald, 2015 p.39). It is obviously not advisable to retrofit theoretical models to real world performances in a speculative fashion. Individual athletes will have complicated histories and are influenced by a number of factors. To balance this though, there does seem to be value in reviewing available information, however partial, from elite competition. This environment is after all where all theories are ultimately tested and for athletes the outcome in their key competition is often all important. Whilst recognising the need to maintain the integrity of research methods, analysing and contextualizing real world practice is also essential in developing guidance for practitioners.

We can see that research has carried out a wide variety of studies attempting to understand and quantify the way in which fatigue is experienced in endurance events, the effect it has on performance and how interventions can be introduced to try and enhance performance without physiological improvement. For logistical reasons the majority of studies have been in laboratory conditions and, despite sometimes being defined otherwise, have included recreational or sub-elite athletes. This raises a number of questions, particularly when discussing the psychobiological model and the possible impact of increased motivation on tolerance of fatigue. Whilst we can undoubtedly raise motivation in artificial conditions, where motivation to do the task is likely to be low; for example, students participating in an endurance task where the result is not tied into important goals. it seems difficult to contend that we can truly replicate the levels of motivation experienced when individuals have committed to events for their own reasons and invested a large amount of time and effort in preparing for these events. Furthermore, these types of study do not allow us to see any differences which may exist in elite athletes in this respect. For example, if we look at the physiological information available on Paula Radcliffe, the marathon world record holder, we might see all of the expected indicators of an exceptional distance runner (Jones, 2006). However, her scores are not so outlandish as to suggest that she should be a kilometre ahead over the marathon distance of her competition at the time. In her world record performance her average time for each half marathon was 67:42 mm:ss an absolute world class time in its own right. It would be fascinating for research such as those carried out by Jones over an extended period could be accompanied by information regarding Radcliffe's RPE during these tests, and indeed races. A comparison between the ability of elites and sub-elites to push physiological "limits" for extended periods would surely be informative in terms of models which indicate that a level of agency exists within the athlete to control their own performance level.

2.3 Psychological Skills

So, if we now have a broad understanding of the challenges which fatigue presents to endurance athletes, the next step is to identify the contribution which psychological techniques can make in preparation and performance. Sport psychology has to deal with a broad range of demands from a wide variety of sports. In his chapter on Psychological Skills Training (PST) Thelwell (2016) gives an overview of how they can assist performance:

> What we do know, from varying laboratory and empirically based peer-reviewed research, is that employing psychological skills increases the chance of going into competition in a positive mindset, and, if this coincides with being physically ready, then positive performance experiences tend to follow (Thelwell, 2016, p. 376).

Key to the correct choice of any training or interventions will be the demands of the sport in question. Thelwell draws a clear contrast between endurance and skill-based sports, using golf and 10,000m running as an example (Thelwell, 2016). Thelwell points out the "gross motor movements" involved in the distance running event as opposed to golf as "a sport requiring precision". As with many of the studies below, the focus when it comes to endurance events is on physiological and psychological rather than technical factors. In the 10,000m event, Thelwell supposes that “the psychological priorities may be to overcome low motivation, pain and boredom-related issues” (p.369). Given the physiological demands which athletes face in maximizing their performance over this distance it seems somewhat unlikely that even over 25 laps boredom would be much of an issue. An elite level male athlete will be covering this distance in around 27 minutes, a period for which intense concentration is possible, and in this context perhaps necessary given the physical intensity achieved.

Marcora’s (2008) model allows us to understand the demands placed on athletes during endurance events. As physiological symptoms and perception of effort increase so does the likelihood of negative emotions and mood but also the potential for psychological skills to have a positive impact on performance outcome. Given that significant time is given over to physical preparation sessions for endurance events it is fortunate that athletes have the opportunity to engage in psychological skills practice simultaneously. The increasing numbers of participants in endurance events such as marathons and triathlons have in turn afforded researchers the opportunity to develop psychological interventions through self-reporting. A focus of this type of research has been to make interventions widely available and simple to deliver. Websites such as resiststopping.com[2] seek to make evidence-based skills training accessible to a wide range of participants.

[2] A research group developing resources to assist athletes in resisting the urge to stop or slow down in endurance events. Members - Dr. Noel Brick, Professor Andy Lane, Dr. David Marchant, Professor Samuele Marcora, Dr. Alister McCormick, Dr. Carla Meijen, Professor Dominic Micklewright.

A brief overview of the types of psychological skills employed in endurance sport will allow us to better contextualise the various interventions and studies that have been carried out in relation to endurance performance and fatigue management.

In terms of endurance performance, a number of strategies have been proposed (resist-stopping.com) and this group have produced a review paper (Meijen et al., 2020) addressing research into the key strategies employed when faced with a key component of endurance performance, increasing physiological and psychological feedback interpreted as a desire to slow down or abandon the event.

The following is a summary of some of the key strategies proposed to assist endurance performance.

Imagery

Imagery is a well-known and widely used psychological technique in sport. Hall et al. (1997) developed the Sport Imagery Questionnaire which suggested five basic types of imagery. The list is not exhaustive by any means but provides a useful starting point for categorisation: - Cognitive Specific, which relates to discrete skills such as a serve in tennis. Cognitive General imagery involves tactics such as staying on the baseline. Motivational Specific covers outcome goals such as winning a race. Motivational General Arousal applies to arousal control whilst Motivational General Mastery deals with motivational state. Of these, the most recognisable in endurance sports is Motivational Specific - it is often outcome based, for example targeting a personal best time or winning a particular race. However, to achieve this outcome goal athletes may well employ elements of each type of imagery in combination.

The effectiveness of imagery has its basis in what has become known as “functional equivalence”, a link between neural processes during imagery and actual performance. In a study of motor imagery and its links to motor execution the impact of mental training concluded that it “affects not only global motor performance… but also aspects of the performance normally thought to be more specific outcomes of training, such as reduction of variability and increase in temporal consistency” (Jeannerod, 1995). Interestingly there is a distinction drawn between the use of imagery in the third person, perhaps seeing oneself winning a race from the perspective of the crowd, and the first person, visualising the action of running from one’s own viewpoint. It is possible to see the former as an outcome driven approach and the latter as more process based. It is perhaps significant then that motor imagery and the subsequent link to motor execution is in the first-person category. This could be extremely relevant in considering interventions which are intended to focus on form and technique as a means of managing fatigue in the latter stages of events.

Pacing

Endurance sport often lends itself to a time-based goal. Equally one strategy to optimise the finishing position in a competition is to complete the course in the fastest possible time. Initially an athlete must select a pacing strategy and then more specifically decide on whether this is based on an outcome goal (time) or a process goal (achieve a level of effort). The selected strategy can be informed by a myriad of factors, but will carry with it elements of risk, either of failing to finish or of not achieving the desired outcome (Micklewright, 2019).

Pacing has become an issue of increasing focus in recent years with debate around the legitimacy of use of pacemakers in competition. For a period, the women’s Marathon

World Record (which involved male pacemakers) came under threat of revision by the governing body before a separate "women's only" record was established. Similarly, events like Eliud Kipchoge's two sponsored attempts to break the sub 2-hour marathon mark have utilised multiple pacemakers based on wind tunnel testing. Additionally, lasers were provided from a lead car to indicate the target pace. As these were exhibition events this pacing assistance was not subject to normal competition regulations. This did highlight the difference between a competitive race where athlete's pacing strategies might be subject to revision based on the actions of their competitors and a pure time trial. In the latter case an athlete can train very specifically to run at a single speed with maximum efficiency. As previously discussed, this is likely to increase levels of self-efficacy in regard to the particular task in addition to the physical benefits.

In addition to selecting a pacing strategy, athletes need to develop the skills necessary to execute accordingly. In particular, this requires pace judgement. A variety of external aids can assist with this including GPS watches and timing clocks and points provided by race organisers. The study in Chapter Four focuses on the impact of concentration strategies and external feedback on the ability of inexperienced athletes to pace to a plan.

Metacognition

Metacognition is an important element in the psychological approach of an endurance athlete. Deliberate engagement of cognitive strategies is commonly reported by competing athletes (Brick et al., 2019). A key issue in this area of research is methodology and data collection. Brick et al. (2019) suggest that the retrospective nature of questionnaires and career retrospective interviews are less reliable given that they involve considerable delay between performance and reporting. Metacognition and self-regulation are linked in the context of endurance performance (Swann et al., 2017) which is of particular relevance in the studies that follow.

Emotion Regulation

Athletes are presented with environments and situations which can impact their emotions. Emotions can also influence performance (Beedie et al., 2012, Lane et al., 2019). Given this it is desirable to identify which emotions might be helpful to performance and adopt effective strategies for reducing the prevalence of unhelpful emotions. A complicating factor is that emotions associated with success vary between individuals (Lane et al., 2019). A variety of cognitive strategies such as imagery and goal setting are regularly used by competitive athletes. Popular literature and online training have contributed to this more widespread awareness and subsequent use.

Attentional Focus

Attentional focus is used in a variety of formats by athletes to assist performance. Research into these strategies has developed over time moving from a simple categorisation of *associative* and *dissociative* thoughts to what Brick et al. have described as "the dynamic intricacies of cognitive activity during endurance performance". (2019, p. 114). Models for more nuanced categorisation have been proposed including a five-category model of associative thoughts as *active self-regulation, internal sensory monitoring, outward monitoring* and dissociative thoughts as *active distraction* and *involuntary distraction* (Brick et al., 2014). This provides a framework for thoughts and strategies which may be helpful to or hinder performance.

Self-Efficacy and Sport Confidence

Self-efficacy can be defined as “a self-appraisal as to what an individual believes they *can* do, not what they *will* do (an intention), or what they *have* done (an experience).” (Anstiss, 2019). As a concept it is based on specific tasks or performances. High levels of self-efficacy in one sport, or at one time of the season may not translate to similar beliefs in other contexts. Self-efficacy is distinct from but related to confidence beliefs. The latter being a more general concept and therefore, perhaps unsurprisingly, less effective as a predictor of specific performance (Anstiss, 2019). As Anstiss points out, a practitioner may often use the term confidence where perhaps self-efficacy more accurately reflects the ideas in question. He argues that this is not detrimental, and that athletes and coaches feel comfortable with the term.

A separate strand of research has looked at the concept of sport confidence, described as a complex, multidimensional construct influenced by demographic and organisational factors (Hays et al., 2016). A revised model of sport confidence (Vealey & Chase, 2008) emphasised the influence of affect, behaviour and cognition. In common with the description of self-efficacy above is the notion of specificity. That an athlete can feel high levels of confidence in one aspect of the sport but not in others. So, a runner may feel high levels of confidence in their sprint finish at the end of a 1500m race but have low levels of confidence that they have sufficient endurance to stay close enough to the front to deploy their sprint in a fast-paced race. Similarly, the definition provided by Vealey of sport confidence as “the degree of certainty individuals possess about their ability to be successful in sport” appears to be distinct from but related to the definition of self-efficacy provided above (Vealey, 2001. p556).

It is one thing to select a psychological strategy, but success will rely on the ability to train the athlete to utilise that skill effectively and at the right time. Thelwell (2016) references the seven-step approach to developing psychological skills in a sporting context as proposed by Sinclair and Sinclair (1994). This approach relies on execution and evaluation followed by repetition. It seems well suited to skills-based sports but in an endurance context would possibly be more suited to technique work where short drills are involved, rather than forming part of the more fundamental training sessions themselves.

2.4 Practical Applications

Implementing the knowledge from this research in training and competition is crucial to enhancing its value. Coaching in endurance sports has always been a combination of trial and error and the, sometimes partial or misguided, implementation of research. Traditionally the emphasis has been far more on physical rather than mental preparation which in terms of endurance sport was entirely consistent with the cardiovascular / anaerobic model discussed above. More recently the development of Sport Psychology as a discipline and the increasing investment in and rewards available from endurance sports have led to a greater emphasis on mental training. This is unsurprising in the context of a "marginal gains" culture and a perception that performance advantages can be achieved outside of physical training. The widespread use of ergogenic aids is a clear example of this.

A wide array of literature aimed at both recreational and competitive athletes has been forthcoming as participation has increased. To varying extents this literature attempts to make use of developments in Sports Science and Sport Psychology. In many cases practitioners can be asked for contributions, providing evidence-based suggestions to athletes in an accessible format. However, researchers must always be cognisant of the distinction between scientific papers and the rigour involved in this process and more general literature such as coaching texts and autobiographies. Whilst literature of this type can provide applied context as well as practical insight, the limitations of these sources must be borne in mind.

Endurance coaching has begun to utilise evidence based research, both in cycling and running, with good examples being the British Cycling programme started in the late 90s by Peter Keen and continued by Dave Brailsford and running groups in the United States such as the Oregon Track Club, Brooks Hanson and Northern Arizona Elite. This has led to a development in the way that coaches are educated from a grass roots level up and even assistant coaches at local club level encounter elements of physiology and Sport Psychology in gaining their initial qualifications.

So, we can perhaps see two categories of practical application for which a mass of literature has been produced, the recreational athlete primarily interested in participation and what we might term sub-elite and serious amateurs whose focus is performance. This is obviously a simplification and there are of course plenty of recreational athletes who are intent on improving their times but perhaps this is not the central motivation. The health and social benefits of being active and part of a wide community are often very important.

A large number of training manual style publications exist which incorporate physiology and psychology to varying extents (Lydiard & Gilmour, 2017, Noakes, 2001, Magness 2014, Brewer (Ed), 2017). These range from specific texts for beginners, to catch all guides intended for athletes of all abilities. There are also more detailed books based on a particular training philosophy or designed for sub-elites who are willing to dedicate a large portion of their lives to the sport in question. The key here is that all of them need to deal with the management of fatigue both from a physical and mental point of view.

The variety of ways in which this is done is extremely relevant to the thesis given that the eventual aim is to produce effective interventions which are widely applicable in real world performance situations.

Turning to applied settings, if we begin by looking at traditional training manuals, we can trace the way the management of fatigue has been viewed in coaching over time.

In his chapter on mental conditioning Peter Coe begins a section entitled The Will To Win by claiming that "the true winner is highly goal-oriented and has learned very early on that participation and winning are not the same" (Coe 1996 p.39). This appears to be an extremely outcome focused approach and possibly not that helpful given that running involves competing against others over whom we have no control. Interestingly though the remainder of the chapter includes a number of ideas which are not only much more process driven but also hint at some of the ideas developed in the psychobiological model outlined above. For example, Coe suggests that "*one of the secrets of sustained fast running is relaxation at speed…the ultimate test of whether or not the athlete has mastered this art is if he or she can maintain good form right through to the end of a hard-fought race*." He concludes "*ultimately successful running is a conquest of the body by the mind"* (Coe 1996 p.50-51). Coe very much developed his own training methods based on his training as an engineer. He seems here to have settled on at least some of the principles which have been developed in the ensuing decades most likely based on the success of his son, which is interpreted as evidence of effectiveness.

Other manuals from a similar period often ignored mental preparation almost completely in favour of a focus on the physiological and technical elements of training. Brook (1992) for example produced a manual on behalf of the British Athletic Federation which includes only a cursory mention of mental preparation in relation to competition. In fact, there is no real mention of psychological factors in the performance in endurance running model (Brook 1992, p.5)

Of course, one could argue that manuals of this type are designed for elite, or at least aspiring elite athletes who are already highly motivated to pursue their running goals. There has been a major growth in the last few decades in literature aimed at a more general audience, often described in terms of participation rather than competition. These texts are regularly produced by former elite athletes aiming to pass on their experience and advice to a wider running population. Here we often find a far greater emphasis on the contribution of psychological factors. Julian Goater describes psychology as "a component perhaps more important than any of the others" (Goater, Melvin, 2012 p.364). At the end of the chapter, he contextualises the fatigue as appropriate to the activity being undertaken - "So although you can expect to suffer in races, it's not really pain. You shouldn't mind being out of breath and sweaty if you know you are going fast" (Goater, Melvin 2012 p.399).

A similar example comes in Richard Nerurkar's training guide for the marathon. He perhaps exemplifies the elite mindset - "I have often found that my best performances come after a period of sustained hard training. I know how hard I have worked to reach my level of fitness. I'm desperately keen to demonstrate my true level of fitness. It has become a question of necessity that I turn my fitness into results" (Nerurkar 4th Edition 2012, p.391). Interestingly he is not only noting the physical contribution of hard training to a good performance but also the increase in motivation that this investment can produce.

Most recently a number of authors have started to incorporate developments in Sport Psychology and Sports Science into texts aimed at the general reader. Matt Fitzgerald's book How Bad Do You Want It? has a foreword by Marcora and he links many of Marcora's ideas from the psychobiological model to examples from elite performances. The book's mission statement clearly shows his intent of finding practical applications for some of these ideas - "The job of this book is to help you become your own sports psychologist - a competent and ever-improving practitioner of the new psychology of endurance sports" (Fitzgerald, 2015 p. 54). As much as anything else, despite the fact that Fitzgerald references qualified practitioners and established concepts, is a simplistic statement.

Steve Magness is perhaps the most high-profile example of a cross over between developing academic research and practical application (Magness, 2014). A former coach of elite athletes at Nike's Oregon Project, he now coaches at the university level and has written a training guide in two distinct halves. Firstly, he introduces and summarises current scientific thinking looking at everything from mechanics to oxygen uptake to the brain. The second half of the book focuses on implementing this knowledge through coaching. He specifically looks at fatigue through what he terms the Simple Integrated Fatigue Model which looks at ways to utilise physical training to improve resistance to the causes of fatigue.

Magness, in a text designed to look at general performance, discusses reflecting on and developing a purpose to clarify and enhance motivation and how this might assist in transcending "self" which Magness and his co-author link to a central governor (Stulberg, & Magness, 2017). Again, we can see the ideas developed in Sports Science being adopted and interpreted with the aim of a wider practical application.

So how can we summarise the impact of academic research on the popular literature discussed above? Undoubtedly a key development in this area has been the increased access that academics have enjoyed to a wider audience through media such as podcasting. This has allowed them to communicate ideas from their research directly, and suitably tailored for the listener. It would appear that this has had an impact on the popular literature as well. This sort of content is regularly found in endurance sports' magazines. A number of relatively high-profile books have been published which look at current research in more detail and seek to directly relate it competition with perhaps a greater emphasis on performance rather than participation and completion. This would appear to indicate that whilst the participation element of endurance sports has undoubtedly grown at a rapid rate, there is still a considerable contingent of athletes who are seeking to not only take part but maximise their own performance. It is this population which may benefit most from simple, practical interventions which can improve performance.

The paucity of contextually relevant studies around truly elite athletes and their performance has been previously noted. However, that does not mean that insights into their psychology and at least their perceptions of its impact on their performance are not available. Understanding why a particular athlete is successful and what can be learned for more general application is attractive to practitioners and researchers alike. For reasons already outlined though contextually relevant studies amongst this population are almost non-existent. Persuading athletes to participate in even a qualitative study in preparation for or during competition is fraught with difficulties as belief on the part of an athlete that participation might compromise their performance is likely to lead to an unwillingness to take part.

One study which obviates these difficulties is a series of interviews carried out by Collison who researched factors around the success of British marathoners from the nineteen eighties (Collison, 2012). The interviews from this study are published and as well as covering training philosophies they include questions around the psychological approach adopted by athletes. These questions reveal not only wildly differing selection and use of strategies but also huge variation in attitudes towards specific psychological training and sport psychology as a discipline. We can see below, in a series of quotations from Collison's study, that even when athletes may claim that they don't use techniques they might well do so, suggesting that concepts involved in Sport Psychology are understood very differently by athletes.

Paul Davies-Hale (Winner Chicago Marathon 1989)

Did you use any mental techniques in preparation?

Not as such. I didn't have any meditation tapes or anything like that. I think we all go through routines that we get used to though don't we? (p.96)

Paula Fudge (PB 2:29:47)

Did you use any form of mental techniques before or during races?

No, nothing. I wanted to do it and that was it. I was just focused on that. All that worried me was making sure that I had done the training that was relevant for the race.

How did you cope with any bad patches?

… I can't understand going to a sports' psychologist. If it is something you want to achieve, why do you need anybody to help you? (p. 134-135).

John Graham (Winner Rotterdam Marathon 1981, PB 2:09:28)

Did you use any form of metal techniques before or during a marathon?

It was just basically shitting yourself that you are going to be the next one off the back of the group. I don't know; I can't remember much about it. I just remember enjoying myself. (p.181)

Mike Gratton (Winner London Marathon 1983, PB 2:09:43)

Did you use any form of mental preparation?

I didn't do anything deliberately, so no, not really. I personally think that if people have reached that level in the sport, then they are pretty self-motivated anyway (p.201).

Hugh Jones (Winner London Marathon 1982, PB 2:09:24)

Did you use any form of mental preparation?

I don't think I did in any sort of proper or organised way. I am sure there are certain psychological tricks that you can use to help you relax at appropriate times and to be able to blank out what is not necessary. I don't think I ever mastered any of that (p.249).

Charlie Spedding (Olympic Bronze 1984, PB 2:08:33)

Did you use any mental techniques before or during a marathon?

I used to do it a lot when I was out on easier runs…. I'd try to visualise myself running really well at various points, especially in the latter stages around 20 miles or after. I would feel myself there; I would feel myself going through the 20-mile mark tired but striding out strongly.

What about during the race?

I just used to imagine that I was going running and there wasn't an end; that I'd have to run as efficiently and smoothly as possible because I was going to have to keep doing it…. I used to be mentally, as well as physically, exhausted after marathons because I had concentrated so hard on putting one foot in front of the other as efficiently as possible. It was a big strain.

Bill Adcocks (PB 2:10:48 - Winner Fukuoka Marathon)

Did you use any form of mental techniques?

Yes. I've already alluded to the Junior National Cross-Country Championships example and the attitude of not getting uptight, keeping it all in perspective and having the confidence in what you've done. There is nothing more you can do.

However, many elite athletes have shared their own perceptions in autobiographies and interviews. If placed in a proper context, with an understanding of the limitations of this material, we are provided with useful insights into the mindset and approach of athletes successful at the highest level.

East African runners have dominated the endurance events in athletics since they first began to compete internationally in the late 1950s and 1960s. Many reasons for their dominance have been espoused and a number of theories put forward (Hamilton, 2000, Scott *et al.,* 2004). Until relatively recently these have not included a look at the mindset and psychological approach of these athletes. Authors like Toby Tanser and Ed Caesar may be writing for a general audience, but they have been able to spend extensive time in Kenya and elsewhere interviewing some of the best performing distance runners in history (Caesar, 2015, Tanser, 2008). Similarly documentaries around the Ineos 1:59 (https://www.youtube.com/watch?v=nh5o5AbddFs&t=54s) project and the famous training base of Brother Colm O'Connell (https://www.youtube.com/watch?v=LmXN-kQZ04M) have provided insight into the experiences and approach of East African athletes and their support teams.

More recently athletes have perhaps become more conscious of psychological strategies as support teams have grown and Sport Psychology has been more widely disseminated in general literature. Despite this, approaches still seem to include the key factors of self-selected coping strategies experimented with in hard training and racing resulting in positive beliefs which may increase their efficacy:

> "The pain came almost immediately and I let it in. I don't try to block out the pain in hard workouts or races anymore, if you want to be in charge of the hurt, you have to let it in. That's the key to being able to endure a lot of pain, it's to know it intimately. The discomfort is coming along for the ride, but it doesn't get to drive and it sure as shit can't pick the music." (Fauble & Rosario, 2019. p. 176)

2.5 Summary

One reading of the literature surrounding the limitation of endurance performance would see physiology initially being identified as the limiting factor, then the brain and more recently a complex interaction between the two. A huge amount of research has been carried out on both the physiology and psychology of endurance performance and endurance running in particular. It seems clear that there are limits to the influence of each discipline. A person with average physiology, no matter their psychological skills and strengths will not keep up for any time at all with competitors with a much higher physiological capacity. Likewise, a psychologically fragile runner will not succeed or maximise their potential. The challenge remains to quantify the influence that these components have on performance, how they interact with each other and identify interventions which are measurably effective.

Chapter Three: Do I focus on the process of cycling or try to put my mind elsewhere?

A comparison of concentration strategies for use in pacing by novice riders

D. T. Robinson, R. Cloak, I.M. Lahart, A.M. Lane

Robinson, D.T., Cloak, R., Lahart, I.M. and Lane, A.M. (2018) 'Chapter 8 - Do I focus on the process of cycling or try to put my mind elsewhere? A comparison of concentration strategies for use in pacing by novice riders', *Progress in brain research,* 240, pp. 127-140. doi: https://doi.org/10.1016/bs.pbr.2018.09.005.

Abstract

The ability to hold a pace is a key skill for endurance athletes. The present study compared the influence of different strategies on how athletes learn to pace at 80% of their maximum performance for a 3-minute cycle time-trial. Participants first completed three maximal 3-min tests to establish maximal performance. During subsequent visits we asked participants to ride at 80% of their average maximal 3-min power output for four 3-min efforts under different conditions. Participants were blinded to feedback for three of the four conditions with participants a) riding on feel (all feedback blinded), b) associating on the task by focusing attention on the skills needed for efficient cycling, and c) dissociating from the task by intentionally focusing concentration elsewhere (d) and finally, participants rode with full feedback where pace could be regulated via observation. All participants completed the blind condition first, the full feedback condition last, with association focus and dissociation focus rides being alternated. As expected, results showed participants rode close to the 80% goal when observing full feedback. Participants rode at 82% of maximum in the blind 'ride on feel' condition, 79% in the associative condition, and 70% in the dissociative condition. We suggest results show that simple strategies related to concentration can influence the accuracy of pacing

efforts. The difference in the ability to pace whilst using an associative or dissociative attentional focus was consistent with theory. The differences we observed occurred with minimal input from participants in terms of actively learning psychological skills. Future research is needed to investigate how athletes learn to use pacing strategies to help performance.

3.1 Introduction

Following a pacing strategy, defined as the intention to maintain a percentage of maximum speed over a set distance, is important for the achievement of endurance performance goals (Brick, MacIntyre, & Campbell, 2014, 2015, 2016; McCormick, Meijen Anstiss, & Jones, 2018). Adherence to a pacing strategy involves making a number of complex decisions, including judging the suitability of course and environmental conditions, fuel availability, hydration levels, and assessing internal capabilities such as cardiorespiratory fitness, skills, and mental readiness (McCormick et al., 2018; Renfree, Martin, Micklewright, & Gibson, 2014). Judging whether your ongoing pace will achieve your goal is challenging. It is common for athletes to use electronic devices, such as a watch and distance markers where the athlete calculates with mental arithmetic, or a Global Positioning System (GPS) device which does this work automatically. Alternatively, athletes can judge pace based on the intensity of effort, that is, pace using internal feedback on either how hard the exercise feels, or via internal examination of how well skills are being performed. Research to examine how athletes learn to pace is scarce.

A recent study (Fullerton et al., 2017) examining the effectiveness of using a pacemaker to aid performance found that runners reported experiencing anxiety, suggesting that they need to learn to run with a pacemaker. This finding alludes to cognitive processes that are important when following a pace (Brick et al., 2014, 2016; McCormick et al., 2018). If an athlete is confident that a certain exercise intensity can be sustained and following it will achieve their desired performance goals, then this could help deliver even pacing. Research has demonstrated that altering perceptions of where the athlete is in relation to goal attainment affects emotions and physiological responses (Beedie et al., 2012; Davies et al., 2016; Wilson et al., 2012). Beedie et al. (2012) used false-deceptive positive and negative feedback—informing riders that they were either ahead of or behind their goal—and examined the effect on emotions, skilled performance (see also Wilson et al., 2012), physiological responses, and performance. They found that negative feedback resulted in intense emotions, an erratic cycling cadence with bursts of intense power coupled with dips in power, a more disturbed physiological response, but no statistical difference in 10-mile time trial cycling performance. Beedie and colleagues also found that providing no feedback was associated with intense unpleasant emotions, and a more disturbed physiological state than false positive feedback condition. The authors proposed that in the absence of comparator data, participants assumed that they were behind their goal and made sporadic efforts to cycle harder. What seems clear is that when participants identified that they were on pace, that the pacing strategy was smoother and more even. Conversely, feedback indicating that performance was behind the target pace prompted activity to speed up, which was accompanied by higher perceptions of effort. Therefore, feedback on whether an athlete is above, below, or on a target pace has the potential to alter self-selected pacing strategy and resulting performance (Carver & Scheier, 1990).

A key feature derived from previous research (Beedie et al., 2012; Wilson et al., 2012) is that there was potential for improved performance in the false positive feedback and blind conditions. Wilson et al. (2012) reported that the within-subject design showed that athletes had the capacity to work at a more disturbed physiological state, evidenced by high lactate and higher respiration rates. If participants produced the same physiological responses in the false positive feedback condition, they should have ridden faster. However, this was not the case. Results show that participants relied heavily on external feedback, as the task they performed was similar to the extent that there were no significant differences in performance. An intriguing question is whether encouraging athletes to adopt a certain concentration style during performance that reduces the effect of external feedback could be useful. The present study is interested in the effects of brief interventions that advocate either associating or dissociating with the task.

There are strong reasons to base interventions on theory (McCormick et al., 2018). Theory helps researchers and practitioners by guiding which variables to assess and set hypotheses to test, with clear knowledge of the likely effects and the mechanisms that explain why the changes occurred. Knowing that there was effect and knowing the reasons should be an imperative. One candidate theory for this context is Carver and Scheier (1990) process-focused theory. Process-goal theory focuses on an ongoing monitoring of performance against the standard required. An endurance athlete could focus internally on sensations of physiological effort or the quality of movement, and compare this information to how hard it feels, or a schema on how the movement should look or feel. A key aspect to the success of this is self-awareness of current performance and how this compares to the standard required.

How athletes learn strategies that assist with their pace judgement is an important and often under investigated line of investigation. While people can learn psychological skills via self-regulatory mechanisms, typically they learn through trial and error and using skills such as self-talk, goal setting and imagery (Stanley, Beedie, et al., 2012). This builds on recent research showing individuals can learn and use simple interventions and apply these in relevant contexts (Lane, Devonport et al., 2016a, 2016b; Lane Totterdell et al., 2016). In two separate experiments, Lane, Devonport et al. (2016a, 2016b) found that brief interventions could help athletes achieve self-set running goals. One important aspect of this process is knowing the likelihood that the intervention will be effective. Confidence in using an intervention can be influenced by feedback on its relative success—reinforcement principles (Bandura, 1997). If using the intervention associates with success, this should increase the athlete's confidence that it is worth continuing with. From the perspective of encouraging athletes to learn to use strategies to aid pacing, repetition should be helpful, and therefore, early success is important.

A cognitive intervention that focuses on pacing using internal cues requires attentional control. Attention can be defined as ‘the process by which all thoughts and senses are focused totally upon a selected object or activity to the exclusion of everything else’ (Terry, 1989). Concentration is a process that changes over time, where priorities will dictate that the focus might need to change, for instance, to avoid a hazard whilst riding on the road. Concentration can vary in intensity. Focusing on the skills needed to perform a complex task requires effort (Muravan & Baumeister, 2003). Concentration also varies in terms of focus, where it can be focused internally or externally, and broad or narrow (Nideffer, 1980). A narrow internal focus is described as focusing on a specific technique, whereas a narrow-external involves focusing on a specific object, such as looking at the wheel of the rider ahead. A broad-external focus involves scanning the environment for information, whereas a broad-internal could be described as daydreaming, that is having unrelated thoughts. There is a great deal of debate about which strategy is the most effective.

Further distinct strategies of attention include association, where athletes focus on the immediate demands of the task and dissociation, where the goal is to distract yourself (see Brick et al., 2014 for a review). Attempts to argue that one strategy is preferred over the other should be tempered by examining the context. Brick et al. (2014) extended the associative and dissociative classification. Strategies that can be described as associative include focusing on internal sensory monitoring such as breathing, muscle soreness, and fatigue. Associative can be active self-regulation of internal cues such as focusing on technique, or cadence. Associating can also be outward monitoring such as focusing on another competitor or split times.

However, strategies can be focused externally and attempt to dissociate with the task. Keeping the broad-narrow distinction, research has not yet examined the use of an internal-broad focus of attention. With endurance performance, the intensity of exercise is important when considering the concentration plan. When exercise intensity is below a level where physiological sensations dominate (Ekkekakis, 2003; Rejeski, 1985), then the ability to focus on broad external factors could be a useful approach as the miles will be covered seemingly with less effort. Research has argued that the intensity of concentration could use resources, and that all resources are drawn from a central reservoir (Muravan & Baumeister, 2003). If this is the case, it may be beneficial to use distraction techniques that lower the intensity of concentration as an approach to deliver effective endurance performance.

Interventions are often reviewed in the context of an outcome achieved rather than an ability to correctly perceive pace, a subtle but important difference. By focusing on performance outcomes, the mechanism underlying the result could be explained via physiological fitness factors, effort, and belief in the ability to sustain pace in a fatigued state. The present study, in contrast, explored pacing as a skill, rather than absolute performance in a given time. The success of the intervention was judged by whether the athlete could perform at a target intensity. The ability to deliver a self-set goal should be helpful to develop self-regulatory skills. As such an 80% effort was required of the athletes over a relatively short period of three minutes. This intensity was carefully selected as it was considered high enough to provide unpleasant internal feedback, fatigue and discomfort, but below maximal effort, which could have affected the ability to employ what are already unfamiliar pacing strategies. It was proposed that intensities around and above lactate threshold physiological cues are powerful and can produce unpleasant sensations that may cause an athlete to slow down. As such maintaining 80% of maximal performance while dissociating will be difficult and may result in the participant falling below the required wattage. Conversely, we hypothesised that when participants focus on the process of riding, they will be more likely to maintain or exceed the prescribed power output. In this context, evaluation of success is not dependent on external information but rather on maintaining focus on the skills required to deliver performance.

The study compared the effectiveness of strategies that encourage different types of attentional control; specifically, we compared riding with full feedback versus ‘riding on feel’ (no feedback) and using either a narrow-internal focus of attention, that is focusing attention on the skills needed for efficient cycling, or a broad-external focus of attention, that is dissociating from the task during an ergometer pacing task. The present study focusing on psychological factors related to pacing, specifically the capability to perform at specified intensity.

3.2 Method

Participants

Our sample consisted of 9 healthy and active adults, 7 male and 2 female (mean ± SD, age = 24.3 ± 4.5 y; height = 178 ± 9 cm; mass = 70.3, ± 18.4 kg). All participants were inexperienced cyclists, and therefore, had no history of previous rides on which to monitor performance.

Procedure

A within-subject randomised cross-over trial was used so that control data was individualised. An individual approach was used as a key purpose of the study was to help practice. Exercise was performed on a cycle ergometer in a laboratory setting to control environmental factors. To control for possible effects of training and changes in physical fitness, we conducted each set of conditions on the same day. Maximal tests were carried out at least two days previous and were used to establish maximal 3-min power output.

In the first testing occasion, participants completed a standardised warm-up followed by three separate 3-min all out tests (3MT) on a cycle ergometer (WattBike,UK "Pro" and "Trainer" models calibrated using manufacturer's instructions). 10 minutes of active recovery was given between each test. Participants were instructed to achieve the highest possible average power output (W_{ave}) over the three minutes of each test, and so needed to ration their effort accordingly. Each participant used the same bike and individualised set-up throughout the testing. The air braked Wattbike ergometer used has previously shown good accuracy and reliability when compared against the 'gold standard' SRM power meters in estimating power output (Hopker et al., 2010). The corresponding data was downloaded using the Wattbike Expert software package, which recorded actual cadence and power output data from the Wattbike for every pedal stroke. We used the mean W_{ave} across the three 3MTs to set the exercise intensity of subsequent conditions.

A minimum of 48 hours later, participants were asked to ride at 80% of W_{ave} during 3MT under four conditions. In three conditions, participants were blinded to all external feedback. For the first of these conditions, no feedback (a) was provided (all external information was covered) and participants were instructed to ride at 80% W_{ave} during 3MT. This condition was performed first because the other two conditions offered instructions on what to focus on, which may have led to participants re-using one of the interventions if they believed it was effective. These conditions included associative feedback, dissociative feedback, and full feedback. In the associative feedback condition, each rider was encouraged to focus on the skills needed to ride efficiently. The riders were shown a short video clip of a cyclist exhibiting smooth pedalling technique and asked to focus on replicating this during their ride (https://youtu.be/4YXfFbQKlDA). This encouraged participants to develop a narrative to use to help focus on riding efficiently. For the dissociative feedback condition riders were asked to daydream about something unconnected with the activity. They were given examples such as "what you might have for dinner" and "what you are going to do at the weekend". Finally, in the full feedback condition riders had access to power output data and time. Participants completed this condition last, whereas the order they completed the narrow-internal (associative) and broad-external (dissociative) focus was alternated. It was expected that participants would be able to ride very close to the 80% target with full feedback. If a participant could not maintain a minimum of 70% of the target due to fatigue, this became a case for excluding the participants data.

Fatigue is a factor in this research design where it is logical to assume that the effort required to maintain the required pace would increase in the later trials. We used full feedback as the control condition where athletes could monitor performance against the standard more easily, and if the standard felt difficult, and they were behind the required time, the discrepancy could be reduced by increasing effort. In contrast, in the three blinded conditions, participants needed to judge whether their effort would be sufficient to attain the required standard. All conditions were performed on the same day, with five minutes between each ride.

Data analysis

Data were analysed using a contemporary magnitude-based inference (MBI) approach to detect small effects of practical performance (Hopkins, 2006). Briefly, mean effects of each condition compared with full feedback (reference condition) and their 95% confidence limits, adjusted for body mass, were estimated with a spreadsheet (reference here: http://sportsci.org/2017/wghxls.htm). For each participant, the difference between W_{ave} in each condition was expressed as a percentage of full-feedback W_{ave} via analysis of log-transformed values, to reduce bias arising from non-uniformity of error. The same spreadsheet was also used to estimate the quantitative and qualitative likelihood that the true effects were beneficial, trivial, and harmful when a value for the smallest meaningful difference was entered. A Cohen unit of 0.2 was employed as the smallest meaningful difference between conditions. Qualitative descriptors were then assigned to quantitative percentile scores as follows: 25-75% *possible*, 75-95% *likely,* and >99% *most likely* (Batterham & Hopkins, 2006, Hopkins, 2006). Where the chance of benefit and harm are both >5%, the effect is deemed *unclear*. We chose not to adopt a null-hypothesis testing approach because this does not allow for the estimation of the magnitude of any effect (Szucs & Ioannidis, 2017).

3.3 Results

As indicated in Figure 1, Participants sustained a mean (SD) W_{ave} during 3MT of 220 (40) W. In the no feedback condition, participants achieved 82.7% of W_{ave} during 3MT (W_{ave}, mean ± SD = 182 ± 52 W), which although 2.7% greater than the full feedback condition, cannot be emphasized (95% CI -8.7 to 15.5%, d = 0.13).

During the narrow-internal (associative) concentration focus condition, participants rode at 75.9% of W_{ave} during 3MT (W_{ave}, mean ± SD = 167 ± 35 W), which was 4.4% lower than when cycling with full feedback (95% CI -14.1 to 6.3, *d* = -0.23). However, during the broad-external concentration focus (dissociative) condition, participants maintained only 70.9% of their performance goal (W_{ave}, mean ± SD = 156 ± 37 W), which was meaningfully lower compared with full feedback (% MD = -11.3%, 95% CI -19.7 to -1.9, *d* = -0.60; 93% *likely* reduction). Differences were not likely explained by fatigue; participants rode at 79% (W_{ave}, mean ± SD = 174 ± 32 W) in the final trial with full feedback (MD = 1.84 W, 95% CI -0.2 to 3.8).

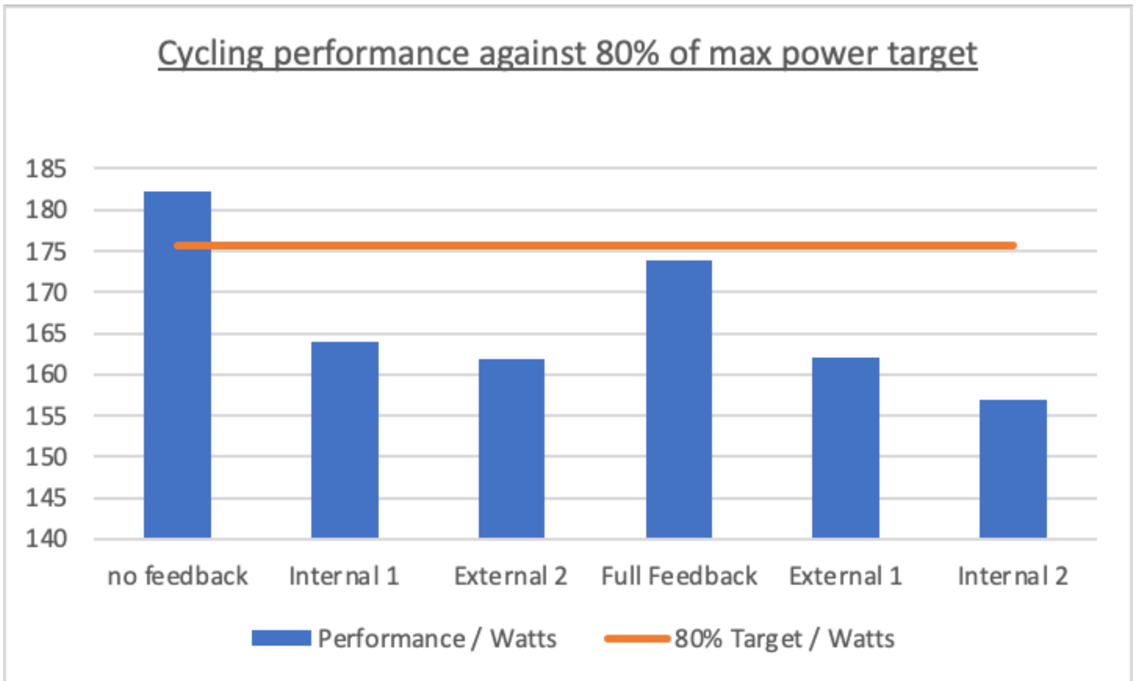

Figure 3.1 ***Cycling performance by condition compared to target of 80% of Max.***

3.4 Discussion

We compared the effects of different strategies on maintenance of a relatively high intensity pace among inexperienced riders. Our interest lies in the processes through which athletes can learn to use pacing strategies rather than achieving performance outcomes (Brick et al., 2014; Fullerton et al., 2017; McCormick et al., 2018). By focusing on the accuracy of efforts to judge pace, we aimed to cast light on methods athletes could use to pace accurately, that is, hold a pace that would achieve their goal, for example, if the goal was to ride 25 miles in under 60 minutes, then the goal for each mile is to ride at 25 mph or one mile in 2 mins 30 seconds. Knowing what that pace feels like and being able to maintain it is practically desirable (Brick et al., 2014; McCormick et al., 2018). We tested different approaches to pacing that used attentional control. Importantly, we were interested in the extent to which participants could use different attentional control strategies when ongoing performance data on how far or close to the desired pace was hidden (Carver & Scheier, 1990). We found that concentrating on factors that associate with the task via concentrating on technique (narrow-internal, Nideffer, 1980) resulted in performances close to 80% of the W_{ave} during 3MT. By contrast, concentrating on broad external cues, and trying to dissociate with the task associated with riding slower than the 80% target pace (see Figure 1). As Figure 1 illustrates, riding with no feedback associated with riding at a higher intensity than the goal. It was important that fatigue did not influence the attempt to maintain an 80% pace in the various conditions. The findings that full feedback—always performed last—came closest to the 80% target suggests that performance variations in the other conditions were not due to fatigue.

Our findings appear to suggest that focusing on internal cues that help perform skills performance are more useful than attempting to focus elsewhere. The approach taken in the present study was to focus on performing the skills required smoothly and efficiently rather than increasing effort. Riding with no feedback also associated with performing close to the 80% goal pace also. Previous research which removed performance related feedback also showed that participants could perform similarly without full feedback but reported intense negative emotions and a more disturbed physiological state (Beedie et al., 2012; Wilson et al., 2012). We argue that the active approach to producing a concentration plan is preferred (Brick et al., 2014). Riding without a goal to focus attention could lead to focusing extensively on physiological feedback, via internal narrow processing, which could increase fatigue and thus prompt thoughts to slow down (Brick et al.., 2014; McCormick et al., 2018).

A common approach to encourage the use of a broad internal approach is to reduce perceptions of fatigue and prompt thoughts of covering the distance needed relatively comfortably. Findings from the present study suggest that when attempting to do this, the percentage of maximal performance warrants careful consideration, and it's worth noting that 80% of 3-minute maximum might be too high a percentage to use for novice riders. By intentionally distracting thoughts from performance, it might seem inevitable that an athlete will slow down. However, this might not be the case for experienced athletes (Brick et al., 2014) for whom thoughts on performance may be automated and engagement in task related methods occurs subconsciously—that is, the athlete can attend to what is required for performance and have cognitive space for engaging in external cues.

We argue that improving the ability to accurately 'sense' pace, that is accurately judge that the pace will deliver the outcome goal using internal cues is a useful skill for endurance athletes who have a strong motive to efficiently manage their energy reserves during competition. Being able to judge increases in pace, because of a prior understanding of their physiological impact, could inform race tactics and improve decision making. In a competitive scenario, particularly in longer distance endurance events, confidence in the ability to execute a pacing strategy can be crucial in determining outcomes. A recent study of elite half marathon runners at the world championships between 2007 and 2014 found that athletes who adopted (or more likely executed) a more even pacing strategy achieved better outcomes (Hanley, 2015). Importantly though, in addition to maintaining an even pace, pacing strategy decisions are complex and must take into account running in packs and the likely tactics of competitors. As such an ability to understand one's own pace through perceived effort is an important skill to learn in training so that in competition the focus can be on these other complex decisions which are presented by the circumstances of the individual race.

An important aspect of the pacing process is the ability to set a challenging goal that is commensurate with physical capabilities (McCormick et al., 2018). It is not realistic to set a goal of 100% of maximal effort for repeated efforts. The notion that a person can give 100% is nebulous and via reflection and attribution, it is common for athletes to perceive that they could have performed better. Where athletes have ambitious and challenging goals this can be motivational. Perceptive processes are crucial to subsequent actions and the difference between current performance and desired performance provides information for decision-making (Carver & Scheier, 1990). When feedback indicates that an athlete cannot sustain the necessary intensity, then the discrepancy between the desired and achieved standard prompts thoughts to change behaviour (Carver & Scheier, 1990). Specifically, when an athlete is performing slower than the desired pace and is therefore less likely to attain their desired goal, then this prompt attempts to increase the intensity of effort or alter technique so the person performs more efficiently (Brick et al., 2016; McCormick et al., 2018).

A key aspect of the present study was the notion that athletes can follow simple approaches to attentional control and that these influence goal pursuit (Brick et al., 2016). There has been scant research on the methods through which athletes learn to use psychological skills in endurance sport (Brick et al., 2014, 2016; Lane, Devonport et al., 2016a, 2016b; McCormick et al., 2018). Lane, Totterdell et al. (2016) found that brief psychological skills training could enhance cognitive performance. Lane, Totterdell et al. compared 12 different interventions, investigating the method of psychological skill (self-talk, imagery, if-then planning) and its focus (process, outcome, skill, arousal). They found interventions that raised arousal (process and outcome focused) associated with better performance. However, rather than argue one intervention was superior to another, they suggested that the results were restricted to the context where data were collected. The task was a short duration one where high arousal was beneficial and so interventions that raised arousal would be useful. And so, applying this logic to findings of the present study, our results (see Figure 1) suggest that using an associative focus is suitable for riding at 80% maximal performance. Although using a dissociative (broad-external) focus of attention resulted in riding at a lower intensity than the goal, it is possible that this approach might be as effective given more time to practice; that is, using a dissociative focus takes longer to learn. It is important to recognise that our findings are delimited to the task used and the number of repetitions.

Athletes in the current study were encouraged to alter the focus of their attention. There is strong evidence that athletes can monitor the quality of movement. It is common practice in sports such as boxing to closely monitor performance visually via shadow boxing. In swimming, focusing on the quality of movement or how the movement feels is strongly emphasised, and swimmers are encouraged to develop awareness of movement quality. In endurance sports such as running and cycling focusing on skilled movement is less common. There should be benefits in adopting an internally focused process approach to monitoring performance as the athlete has full access to feedback. An internal focused approach is also not susceptible to the effects of equipment failure from watches or inaccuracies in course marking, such as mile markers being inaccurate. An athlete with an effective internal monitoring strategy should be able to maintain a more consistent performance. Although the findings of the current study suggest using an associative attentional style helped maintain target pace, a finding that could be useful for practitioners, athletes and researchers, the study is not without limitations.

The first limitation is that laboratory conditions represent a very different environment to those faced by athletes during competition. Athletes attach a great deal of personal importance to the achievement of athletic goals. In sport, athletes sometimes voluntarily exert themselves to collapse—a recent example of this was Callum Hawkins in the 2018 Commonwealth Games marathon. While most cases are not as extreme, if a goal is considered to be important enough, people are willing to endure higher levels of fatigue and discomfort to achieve it. For research to have a meaningful impact on practice, studies should investigate athletes who have meaningful goals. In the present study, the initial stage of this study did not include competitive athletes. However, this is somewhat mitigated by the sub-maximal requirements of the test; the activity assessed skill execution (i.e. ability to maintain a certain pace) rather than a willingness to resist very strong physiological cues to slow down. It is also clear that athlete's perception of fatigue and interpretation of such cues would change in competition where interpersonal factors are influential. Fullerton et al. (2017) found following a pacer associated with higher anxiety and argued this derived from confidence in being able to hold the pace. If an athlete follows an even pacing strategy, then logically, the initial stages of an endurance race can feel far easier. This adds a further complexity to the skill of pacing and experience is required not only in training but also in competition to master this. A second limitation is the small sample size. It is worth noting that Normand (2016) emphasized the benefits of gathering more data from fewer people as a means to identify individual variation. Future research will investigate if findings replicate in individuals over time. Identification of findings that replicate in individuals over time provide meaningful results to practitioners.

The present study begins to investigate how athletes learn to develop pacing strategies that could support goal achievement. As indicated in previous research, athletes learn pacing via self-regulation (McCormick et al., 2018). We suggest future research investigate how athletes respond to pacing interventions and compare inexperienced athletes to experienced ones. It would also be a useful comparison to include highly experienced cyclists, especially those who have competed in time trial events, where pacing strategies and producing a consistent, predetermined power output are very important. It is likely that successful athletes will have self-selected pacing strategies, which also include psychological coping strategies for internal feelings of discomfort and fatigue which intensify over longer periods. This is in contrast to the current study which examined the ability to pace as a skill, and the relatively short time for each test meant that physiological stress was lower.

An alternative line of research worth exploring is emotional responses during endurance performance (Baumeister, Vohs, DeWall, & Zhang, 2007; Lane, Devonport et al., 2016a, 2016b; Stanley et al., 2012). Emotions are proposed to influence how people learn, and that behavior is modified to regulate emotions (rather than emotions predict behaviour) (see Baumeister et al., 2016). As such positive appraisals of physiological responses to intense exercise will be important. Emotional responses could also have an impact on the way athletes execute a pacing strategy and previous experiences could be relevant. Previous research (Wilson et al., 2012) suggests that if an athlete perceives that they have fallen behind a predetermined pace, a surge in effort can occur to try and remedy the problem rather than a more measured, gradual approach to recoup any deficit. In mass start races, athletes will often face decisions about how to respond to the tactics of competitors. Again, a more successful strategy could involve a more economic response rather than allowing emotion to dictate actions. However, emotional responses can also be harnessed to good effect, perhaps towards the end of a race when in a fatigued state, the emotional investment in a goal can increase the ability to sustain or even increase pace, requiring a very high level of effort.

In conclusion, our experimental findings add to a growing body of literature examining how athletes learn to pace endurance events (Brick et al., 2014, 2016; McCormack et al., 2018). We found that using an associative focus of attention (narrow-internal), participants rode at marginally lower than the target intensity whereas when using an associative approach (broad-internal), they rode at an intensity lower than the target pace. Consistent with previous research (Beedie et al., 2012; Wilson et al., 2012), in the no feedback condition, participants rode at an intensity greater than the target pace.

Chapter Four: Effects of Reflection to Improve Goal-Directed Self-Talk on Endurance Performance

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Abstract: We investigated the effects of an intervention that encouraged reflection on organic self-talk used during endurance performance. Using an experimental design, we compared the effects of enhancing metacognitive skills by (a) planning and (b) reviewing and evaluating goal-directed self-talk. Participants completed three time-to-exhaustion cycling task trials in which we hypothesized that the intervention group would perform significantly better than the control group. Further, we expected a reduction in perceived exertion for a given workload among participants following a self-talk intervention. Thirty-four participants completed a time-to-exhaustion cycle ergometer test, after which participants were randomly divided into an intervention and control group. The intervention group performed reflection tasks on performance in the time-to-exhaustion test. Participants completed two further time-to-exhaustion tests. Repeated measures analyses of covariance to test whether the intervention group performed for longer indicated no significant difference in time to exhaustion (p = 0.157). Perceived exertion rates were 2.42% higher in the intervention compared to the control group (p = 0.025). In conclusion, in the intervention group, goal-directed self-talk led to increased sensitisation to perceived exertion, and participants chose to

stop exercising at this point rather than repeat implementation of self-talk statements and persist for longer.

Keywords: self-talk; effort; perceived exertion; endurance; psychological skills

4.1 Introduction

Endurance performance is a fundamental requirement of many sports and can be defined as the ability to withstand stress over a prolonged period. Research on the physiological basis of endurance performance is undecided as to what causes fatigue and ultimately a decline in performance (Marcora et al., 2009). Given the difficulty of identifying isolated physiological factors, research has highlighted the contribution of psychological factors and the potential benefits of psychological skill training (Thelwell & Greenlees, 2003). Psychological qualities such as improved confidence can be developed via skills training (Houston et al., 2011). Skills found to be effective in improving endurance performance include cognitively based approaches such as the use of imagery, self-talk, and goal setting (Lane et al., 2016, McCormick et al., 2015, McCormick et al., 2019). In the present study, we focus specifically on self-talk, which can be defined as an act of syntactically recognizable communication (Van Raalte et al., 2016), articulated either out loud or as a voice inside the head (Theodorakis et al., 2000), addressed to the self, with interpretative elements associated to its content (Hardy, 2006).

4.2 Self-Talk Interventions

Self-talk interventions appear to have positive effects on endurance performance in running, cycling, and swimming (Barwood et al., 2015, Blanchfield et al., 2014, Hatzigeorgiadis et al., 2011, Latinjak et al., 2016, McCormick et al., 2018, Wallace et al., 2017). Some of the differences between studies on self-talk interventions in endurance contexts are of interest as they offer practitioners flexibility in designing and implementing self-talk to adapt the intervention in applied contexts. Of particular relevance is the degree to which the narrative used in the self-talk intervention is predetermined by the researchers or self-determined by the athletes (Hardy, 2006). For example, Hatzigeorgiadis et al. (2011) gave swimmers cue words to use along with instruction as to when and how to use them. Barwood et al. (2015) used recreationally active participants and provided two motivational self-statements (e.g., I can manage my energy until the end), which they rehearsed in the days preceding and immediately before the final 10-km cycling time-trial. A consistent feature of interventions is that they are (a) directed towards the mechanisms through which self-talk aids performance (e.g., self-talk is motivational) and (b) strongly advise that cues are used during task execution. Regarding the latter, manipulation or compliance checks are frequently used to monitor whether participants used their cues or whether they used different cues (McCormick et al., 2018). Notwithstanding, (a) and (b) do not apply in the case of the most self-determined forms of self-talk interventions.

Not all self-talk interventions described in the literature require their participants to use the cues previously established. Some interventions are solely targeted at making the athletes reflect on their past self-talk to explore alternative cues for future practice (Neil et al., 2013, , Turner & Barker, 2014). The aim of these interventions is to improve the quality of athletes' goal-directed self-talk, that is, statements deliberately employed towards solving a problem or making progress on a task (Latinjak et al., 2014). To date, the only example for such a self-talk intervention is a single-case study describing a goal-directed self-talk intervention with a 36-year-old elite orienteer (Latinjak et al., 2016). The goal-directed self-talk intervention comprised questioning original organic self-talk and theoretically exploring alternative instructions, leaving it open for the athlete to decide when to put them into practice. Providing preliminary idiosyncratic evidence, the study suggests that the intervention is closely related to the improvement of metacognition, as the athlete indicated that "my evaluation about the intervention is very positive thanks to our analysis, understanding, and application of self-talk… Without this understanding of the situations, their causes and effects, successful application of self-talk is highly unlikely" (Latinjak et al., 2016, p.193). Offering further indirect support for the application of a goal-directed self-talk intervention to endurance performance, studies on cognitive components in endurance tasks have demonstrated that metacognition is an essential component of self-regulation and its primary functions are to monitor and control the thoughts and actions required for endurance task completion (Brick & Campbell, 2016).

4.3 The Present Study

Overall self-talk interventions based on the use of predetermined or self-determined cues (Wallace et al., 2017) have shown to be performance-enhancing in endurance tasks. However, there is a dearth of research on the effects of goal-directed self-talk interventions (Latinjak et al., 2016), which consist of planning, reviewing, and evaluating goal-directed self-talk on performance in endurance tasks. To provide experimental evidence on the effects of goal-directed self-talk interventions in endurance tasks, this study aimed to analyse the effects of enhancing metacognitive skills related to goal-directed self-talk by (a) planning and (b) reviewing and evaluating three trials of a time-to-exhaustion cycling task on performance (i.e., time to exhaustion) and rates of perceived exertion. With regard to the specific hypotheses, we expected the intervention group to improve over time. Additionally, if the control group improved as well, we expected the improvement of the intervention group to be greater.

The improvement of the control group would be explained by a learning effect from repeating the same task.

4.4. Method

Research Design

The study was a repeated-measures design in which participants made four visits to the laboratory. Participants were randomly split into either a control or intervention group.

Participants

Athletes (*N* = 220) were approached at a Sports Science faculty before and after their regular lectures. A total of 34 athletes (M_{age} = 21.56, *SD* = 2.27) volunteered for the study—14 female athletes and 20 male athletes (see Table 1). They were all practicing and competing in sport regularly (7.17 h/week, *SD* = 3.34). Seven athletes withdrew from the experiment (five from the control group and two from the experimental group) due to injuries which were unrelated to the experimental task (*n* = 3), time constraints (*n* = 3), and lack of motivation (*n* = 1). Finally, 12 participants completed the four sessions in the control condition (5 females and 7 males) and 15 participants completed the four sessions in the intervention condition (6 females and 9 males).

Table 1. Descriptive data for age, weight, height, and peak power output for participants in the control and intervention groups.

Descriptors	**Control Group**		**Intervention Group**	
Age (years)	*M* = 22.00	*SD* = 2.83	*M* = 21.20	*SD* = 1.86
Weight (kg)	*M* = 68.00	*SD* = 11.72	*M* = 69.87	*SD* = 10.95
Height (cm)	*M* = 172.17	*SD* = 9.91	*M* = 177.20	*SD* = 8.82

Peak power output (W)	*M* = 251.67	*SD* = 63.51	*M* = 254.67	*SD* = 47.49

Time-to-Exhaustion Tests

Incremental Test to Exhaustion for Peak Power Output

Participants' maximal workload was determined by means of a progressive and maximum aerobic test (Hutsebaut, 2002) consisting of an initial load of 20 W followed by increases of 20 W min^{-1} until participants could not maintain the required cadence (70 rpm) for 10 consecutive seconds (see Figure 1). For results on the peak power output, see Table 1.

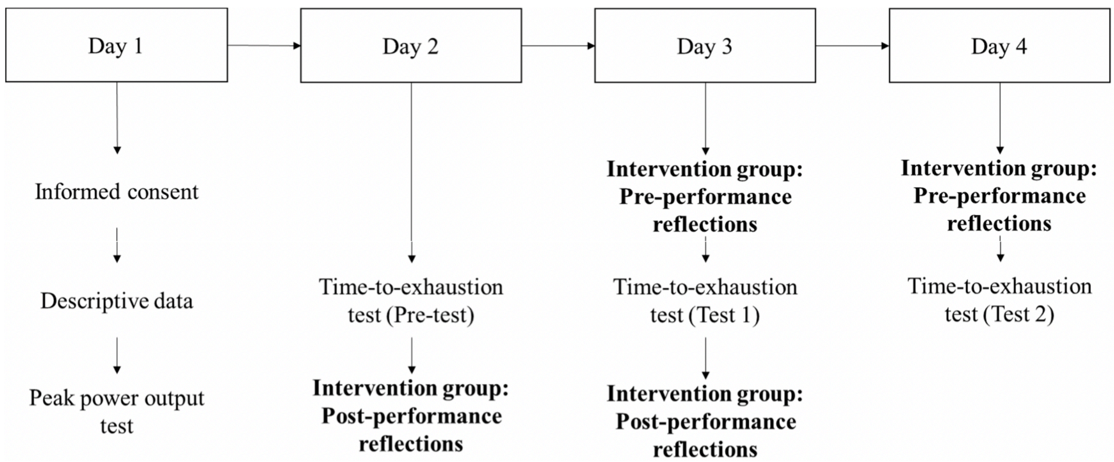

Figure 1. Experimental design diagram. Note. Bold sections indicate the different parts of the goal-directed self-talk intervention.

Cycle Endurance Test

Following the procedures in Blanchfield et al. (2014), the time-to-exhaustion test commenced with a 3-min warm up at 40% of the participants peak power output. After

3 min, the power output was automatically increased to a power output corresponding to 80% peak power output (PPO). Cadence was set at 70 RPM. Time to exhaustion was defined as the time accrued from the onset of the 80% PPO until the point at which cadence had fallen below 70 RPM for 10 consecutive seconds. No verbal encouragement was provided at any point during the time-to-exhaustion test.

The Goal-Directed Self-Talk Intervention

The intervention started immediately after the data collection in Session 2 (see Figure 1). The intervention consisted of post-performance reflections used to identify what goal-directed self-talk was used during the cycle endurance tests. Participants were asked to anticipate possible issues and consider goal-directed statements which could be used to help cope with hypothetical problems in following trials (Test 1 and Test 2). In contrast, the control group was not asked to perform any self-reflection. This decision is in line with previous studies in self-talk in which participants of the control groups were asked to keep performing as usual (Barwood et al., 2015). Because athletes who participate in goal-directed self-talk interventions are not asked to use any of their previously discussed statements during task execution, this study did not contemplate the use of manipulation or compliance checks.

Self-Generated Self-Talk Intervention Developed via Reflection

We used self-reflection to develop a self-generated, self-talk intervention. Participants were asked to reflect on experiences before and during performance. The aim of the booklet was to encourage self-reflection via recollection of intense experiences that they considered were negative and undesirable. We specified that people often report unpleasant feelings in pursuit of a goal and if they achieved the goal and appraised these feelings as a necessary part of performance management, then they were not considered negative and undesirable. For example, an individual could respond that she performed badly because she felt fatigued and wanted to slow down, which prompted anger and frustration as she would not achieve her goal, a goal that was publicly known to her significant others. Using this negative experience, participants were encouraged to consider self-talk solutions, and so using the present example, the participant could have reappraised feelings of fatigue as a necessary part of goal attainment and altered her focus to task-relevant cues.

To promote further reflection and help participants identify which self-talk statements were helpful and which were not, athletes were asked to rate each goal-directed statement reported in the earlier section with two 5-point Likert scales. Specifically, they were asked to rate how frequently they had used that self-statement on a scale ranging from 1 (only once) to 5 (permanently), and to what degree they believe the statement had helped them improve performance from 1 (completely irrelevant) to 5 (helped decisively).

Self-reflection was also focused on pre-performance thoughts by asking participants to anticipate problematic situations. A problematic situation would consist of any thought (e.g., disengagement thoughts), emotion (e.g., dejection), or physical sensation (e.g., fatigue) that impairs performance. Second, for each problematic thought, emotion, or physical sensation, the participants were asked to elaborate as many as three possible goal-directed self-statements they could use to solve the problem or make progress on the task.

Given that the aim of the reflective process was to develop self-generated interventions, participants were asked to think about potential alternative goal-directed statements which could be useful.

Procedure

Permission to carry out the study was granted from the local ethics committee, and all participants signed the informed consent form at the beginning of the first session. The study was conducted in accordance with the Declaration of Helsinki. Participants were informed of the task requirement but remained blind to its specific purposes. Before each session, they were explicitly briefed in the procedures of the session and informed that they could withdraw from the session at any time without giving any reason and with no negative consequences.

All sessions were individual meetings between one researcher and the participant to control for social factors (Tunçgenç & Cohen, 2016). Sessions were conducted at least two days apart to ensure sufficient recovery (Schumann et al., 2015). Cycling tasks were performed on a cycle ergometer (Ergoselect 100, Ergoline, Bitz, Germany) with saddle and handlebar specifications adjusted to fit the preference of each participant using guidelines by Balagué et al. (2015), and these measurements remained identical for all experimental sessions.

All tests were conducted between 8:30 a.m. and 6:00 p.m. on the same cycle ergometer with the screen covered to avoid seeing any data output. Participants performed all tests at approximately the same period of the day. All trials were video recorded to verify the obtained data and check for possible errors in their collection, and heart rate was continuously monitored (Polar H7). Once the test began, to prevent bias from audience effects upon self-talk measurements, experimenters stood outside the participant's angle of view, and participants were not exposed to any verbal or other communication. Before each data collection, they were asked to complete a sport behaviour, rest, and drink checklist (Pageaux et al., 2013). Participants were asked to confirm that they had not taken part in any heavy exercise in the 24 h prior to testing and refrained from the consumption of caffeine and nicotine in the 3-h period leading up to each test. If a participant had done any of these three things, the session was interrupted and rescheduled. Finally, after each session, participants were given a sandwich and a drink to aid recovery and as a sign of gratitude for their help. Researchers who conducted the session were trained in the data collection procedures but remained blind during the data collection to the specific purposes of the study.

Measures

Three dependent variables were analysed in this study: time to exhaustion, maximum heart rate, and rates of perceived exertion (RPE). With regard to the latter, upon task completion, the RPE 6-to-20 scale (Borg, 1998) was placed in front of participants in order to assess RPE. In previous studies, RPE was recorded at 1-min intervals (Barwood et al., 2015). However, in pilot trials, participants perceived that reporting RPE each minute drew their attention to fatigue and away from self-talk. To avoid interference with participants' thoughts and self-talk during the task, we assessed RPE after each trial.

Data Analyses

To test for differences between both groups prior to the intervention, we ran independent-samples *t*-tests for (a) participants' descriptive data (i.e., age, weight, height, and PPO) and (b) performance variables (i.e., time to exhaustion, maximum heart rate, and RPE) in Session 2. To test our hypotheses, we performed 2 (groups) × 2 (intervention trials) repeated measures analyses of covariance (RM-ANCOVA), using scores in the pre-test on Day 2 as covariables. We examined the group, time, and group × time effects on time to exhaustion, maximum heart rate, and RPE. Effect size was calculated for all significant effects. Based on the criteria outlined by Cohen (1992), thresholds for small, moderate, or large effect sizes were set at 0.1, 0.3, and 0.5, respectively (Hopkins et al., 2009).

4.5 Results

Pre-Intervention Comparisons between Groups

The comparisons between both groups in terms of participants' descriptive data and performance variables on Day 2 yielded no significant differences prior to the intervention (all $p > 0.05$). Descriptive data for participants' descriptive data showed that participants weighed between 51 and 95 kg ($M = 69.04$, $SD = 11.11$) and measured between 158 and 195 cm in height ($M = 174.96$, $SD = 9.48$). Furthermore, peak power output ranged between 180 and 360 W ($M = 253.33$, $SD = 54.07$) and maximum heart rate during the PPO test ranged between 153 and 198 heartbeats/min ($M = 182.89$, $SD = 11.80$).

Main Analyses

As Table 2 indicates, RM-ANCOVA results for time to exhaustion, maximal heart rate, and RPE indicated a significant group effect for RPE, whereby results show the intervention group reported higher RPE compared to the control group ($F_{1,24} = 5.72$, $p = 0.025$, $\eta^2 = 0.192$). There were no other significant interaction or main effects over time. Effect size was nonetheless small. For descriptive data and all RM-ANCOVA statistics, see Table 2.

Table 2. Descriptive data and analyses of variance for performance maximal heart rate and rates of perceived exertion for all participants in the pre-test and for each group in the following two tests.

Group/Test	Time to Exhaustion		Maximal Heart Rate		RPE (6–20)	
Pre-test	*M* = 589.59	*SD* = 209.48	*M* = 178.89	*SD* = 11.18	*M* = 16.89	*SD* = 1.95
Control group	-	-	-	-	-	-
Test 1	*M* = 646.88	*SD* = 377.84	*M* = 176.83	*SD* = 10.96	*M* = 16.83	*SD* = 2.12
Test 2	*M* = 582.88	*SD* = 336.18	*M* = 170.42	*SD* = 12.19	*M* = 16.92	*SD* = 2.19
Intervention group						
Test 1	*M* = 582.60	*SD* = 186.23	*M* = 177.13	*SD* = 10.88	*M* = 17.40	*SD* = 1.50
Test 2	*M* = 579.60	*SD* = 208.65	*M* = 175.93	*SD* = 10.11	*M* = 17.33	*SD* = 1.35
RM-ANCOVA[1]						
Time effect	*F* = 0.34	*p* = 0.566	*F* = 0.02	*p* = 0.886	*F* = 0.19	*p* = 0.667
Group effect	*F* = 2.98	*p* = 0.100	*F* = 0.91	*p* = 0.349	*F* = 5.72	*p* = 0.025
Interaction effect	*F* = 2.16	*p* = 0.157	*F* = 3.34	*p* = 0.080	*F* = 0.13	*p* = 0.725

[1]Pre-test scores were set as covariable for the 2 (Groups) by 2 (Tests) repeated measures analysis of variance.

Self-Talk Frequency and Perceived Efficacy in the Intervention Group

An RM-ANOVA yielded a significant time effect on self-talk frequency ($F_{2,28}$ = 7.07, *p* = 0.003, η^2 = 0.336), indicating that frequency of self-talk was higher in Test 2 (*M* = 3.65; *SD* = 0.71) compared to the pre-test (*M* = 3.22; *SD* = 0.60) and Test 1 (*M* = 3.30; *SD* = 0.62). Time effects on perceived efficacy were not significant ($F_{2,28}$ = 0.49, *p* =

0.619), indicating that there were no significant changes from pre-test (*M* = 3.68; *SD* = 0.48) to Test 1 (*M* = 3.57; *SD* = 0.60) and Test 2 (*M* = 3.54; *SD* = 0.58).

4.6 Discussion

Our research was predicated on the notion that self-reflection on performance would help develop an effective narrative for self-talk. Previous evidence has supported positive effects of motivational self-talk interventions on endurance performance (Barwood et al., 2015, ,Blanchfield et al., 2014, Wallace et al., 2017) and the effects of goal-directed self-talk interventions in other sport settings (Latinjak et al., 2016). An experiment was established to test the extent to which engaging with formal self-reflection is associated with better performance and that this could be explained by reduced physiological load and lower perceived exertion. In contrast to these predictions, our results indicate that following a reflection-based intervention did not associate with improved performance or a reduced heart rate. However, results did show that self-reflection training was associated with an increase in ratings of perceived exertion. We offer two explanations for these results: (a) self-talk as an intervention tool may not be useful in this context, and (b) the approach followed to teaching self-talk via reflective experiences may have been ineffective; that is, how people learn to use self-talk requires further examination. The fact that participants in the intervention group reported increased frequency of self-talk use but no changes in perceived self-talk efficacy is indirect endorsement that the reflection techniques were ineffective in the context of the endurance task.

The nature of the reflective tasks helped participants become conscious of negative experiences and help develop individualized self-talk scripts. Previous research has found such an approach has desirable benefits as athletes develop greater ownership of their interventions (Neil et al., 2013). By linking the self-talk to an experience where it was successful and strengthening this association through practice, its usage is proposed to be enhanced. However, such a strategy relies on knowledge of how long the person needs to endure the intense fatigue and be able to use self-talk to overcome these effects (McCormick et al., 2019). Evidence shows people find increased energy, demonstrated behaviourally, by increasing speed when the finish line is anticipated (Beedie et al., 2012). People ration the resources needed to complete against perceived available resources, or the resources they are prepared to give, and use strategies to activate personal resources to bridge the gap (Carver & Scheier, 1990). In this example, people have clear reference points on which to use self-regulated strategies to manage fatigue. In the present study, the intervention encouraged reflection on coping with fatigue but not fatigue in relation to a specific outcome goal. The absence of performance feedback during the task meant that participants could not develop schema on how they could use feedback from performance to gauge how much effort to use. Self-talk can raise emotional arousal which can lead to improved performance via increased effort (Lane et al., 2016). Further, research has indicated that it is possible to learn self-talk to raise arousal using brief interventions (Lane et al., 2016). In the present study, by blinding participants from feedback, we also blinded them from the opportunity to use self-talk at the point when it would have been useful. Beedie et al. (2012) showed that when feedback was withheld, riders reported experiencing negative internal thoughts and emotions. Further, riders reported the same intensity of exercise was harder than when full feedback was offered. It is possible that participants started to feel fatigue and interpreted this by expecting to stop, particularly as they had done the test previously and so this experience could be used as a reference point.

In the present study, with a task where the intensity was set at the start of exercise and at 80% peak power, it was intentionally difficult from the outset so that physiological cues would pre-emanate (Rejeski, 1985) and participants would have the option to repeat usage of self-talk. Arguably, by raising awareness of self-talk as an intervention strategy, this could have prompted earlier and repeated usage. If self-talk is raising arousal, then this is not a strategy that is necessarily useful in endurance sports, as the sustainability of intense arousal will be challenging unless the goal being pursued is considered highly valuable (McCormick et al., 2019). Recent research has found that using strategies such as self-talk at opportune moments is desirable (McCormick et al., 2018). Presenting self-talk statements in an if-then format, where the "if" part represents the challenge ("If" I have thoughts that the ride is too hard) and the "then" part represents the solution ("then I will tell myself, 'push myself, you can do another 60!'"), represents a worthwhile approach to follow in future research.

In the present study, we expected there to be differences in performances between the intervention and control group, such as one group improving more than the other. However, neither group significantly improved over time. Given the intense nature of the task and that participants were not experienced cyclists, it is possible to suggest that performance in the control group could have deteriorated over time. Although the control group did not receive the training package, we posit that while repeating a new task, organic self-regulation skills are adjusted to meet the specific effort demands placed by the task (Efklides et al., 2006). In this case, the participants knew they had to repeat the task on Day 3 and 4. To do so, it seems likely that they remembered their struggles and thought about how to cope with them in the future. Consequently, participants in both groups engaged in some reflection and planning, which are fundamental to create metacognitive knowledge (Brick et al., 2015) and also underlie the mechanisms of the intervention tested in this study. Hence, the degree to which the intervention could have made a difference in the participants' self-regulation was confounded with the effects of repeating the task over time. For future research, we would therefore suggest using either longer baselines or previously known tasks. In both cases, participants would have achieved a ceiling effect in their self-regulation behaviours, and the intervention could have prompted noticeable changes in their goal-directed self-talk.

Second, the intervention offered too few opportunities for the participants to switch from an obvious, yet ineffective, self-talk approach (i.e., goal-directed self-talk aimed at increasing effort) to an alternative, more effective, approach (e.g., goal-directed self-talk aimed at distracting from fatigue). Little is known about the learning process by which athletes improve their organic, goal-directed self-talk. More specifically, we do not know about the success/failure rate required for the participants to challenge their initial self-talk approach and switch to alternative approaches and test their effectiveness. From the participants' reflection booklets, we know that the type of self-talk used remained largely unchanged throughout the three sessions. We suggest that future studies should use longer interventions to give participants time to challenge their initial approach to self-talk and to become aware that alternative approaches to self-talk might be more helpful. For instance, we suggest that goal-directed self-talk, distracting the participant from fatigue during the early stages of the task, would have been more helpful. Participants would have anticipated lower fatigue and therefore been able to persist for longer (Brick et al., 2014). However, such an assumption is based upon participants being able to use strategies to persist for longer and with no feedback on how long they were exercising.

Limitations

With regard to the limitations of this study, several aspects which require consideration have been listed in the preceding paragraphs. Furthermore, it could be argued that a larger number of participants was required or that the intervention was too short to produce noticeable effects. Similar numbers of participants allowed previous studies to evidence beneficial effects of self-talk on time-to-exhaustion performance (i.e., $N = 24$, [11]; $N = 18$, [15]). Seven participants withdrew from the experiment. These participants belonged mainly ($n = 5$) to the control group. Yet, considering the causes for withdrawal, it would seem incoherent to draw any conclusion upon the experimental conditions. Finally, considering the length of the intervention (range: 17–21 days from Session 2 to 4), it could be argued that additional sessions would have elicited more beneficial effects from the goal-directed self-talk intervention.

4.7 Conclusions

This study is the first to test the effects of a goal-directed self-talk intervention, consisting of analysing and reflecting upon goal-directed self-talk used during a time-to-exhaustion endurance task. Our results do not support the intervention. Nonetheless, we regard these negative results as equally significant as they indicate that our current conceptual understanding of self-talk interventions is incomplete. Furthermore, we also consider that negative results are relevant per se for the self-talk literature, as their absence from the literature would inflate effect size estimates in future meta-analyses, thus exaggerating the importance of self-talk interventions (Fanelli, 2011). Accordingly, results that do not confirm expectations, such as ours, are crucial to scientific progress which is only made possible by a collective self-correcting process.

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Chapter Five: Does specific online psychological training in a group of competitive club athletes improve competitive 5km running times?

D. T. Robinson, S. Holliday, A. M. Lane

Abstract

This study examined the extent to which brief online interventions improved 5km parkrun performance. Seven experienced, competitive runners (four male and three female matched for similar ability and fitness) were randomly assigned to intervention or a placebo group, with all runs being compared to baseline performance collected over the 3 months previously before being contacted to participate. The intervention group were given brief interventions (if-then planning, self-talk and cognitive reappraisal) to use in training and in parkruns. The placebo group had self-regulation processes surrounding their running activated, and so could be beneficial for performance. Control data was provided by previous parkrun results. Participant's perceptions of performance were explored via a free-text questionnaire. Ninety parkrun performances were used to assess running time before, during and after the study. Results indicated finish times for participants following the intervention showed a wide range of performances with faster runs, but also, some slower runs when compared to baseline. In contrast, placebo athletes all improved their times compared to baseline performance. This supports the contention that participation in a study and a resulting increase in existing self-regulatory processes that athletes already used could act as an intervention in itself. Findings have implications for how sport psychologists use brief interventions with an emphasis to provide a persuasive argument for why the intervention might be beneficial.

5.1 Introduction

Brief interventions are a potential solution for a desire to utilise psychological strategies which exceeds the availability of practitioners to supply individual support. There are many sports where there is large scale participation, for example, over 150,000 people from Olympians to walkers complete a free, 5km timed parkrun each Saturday (parkrun, 2020). After entry into the sport, participants wishing to improve seek out advice which is readily available through general literature such as magazines and training manuals as well as club and running group coaches. The majority of these participants will not be consulting a personal coach, for example, less than a third of those 574 athletes surveyed consulted one, with even fewer seeking direct input from a sport psychologist (McCormick, Anstiss, & Lavallee, 2018). In order for evidence based psychological strategies to be widely utilised, researchers and practitioners need to find a means for them to be both readily available and credibly delivered. Effective brief interventions could benefit a large number of participants (Lane, Devonport et al., 2016; McCormick et al., 2019). In other areas of applied science such as health and education, online delivery has been shown to successfully meet the challenge of high demand and much smaller practitioner numbers (Cugelman, Thelwall, & Dawes, 2011). Thus researchers are encouraged to deliver brief interventions using online videos, websites, webinars or in person at actual events (Meijen, Day, & Hays, 2017).

The usage of online material already appears to be one that many athletes engage with. For example, to improve performance at events, many athletes utilise physical training, specialised equipment (e.g. GPS watches, Web apps such as Garmin & strava) and psychological strategies. In an online survey of endurance athletes (McCormick et al., 2018), 71.1% of respondents admitted to intentionally looking for guidance on psychological aspects of their sport. The most commonly sought advice by athletes was for coping with pain, exertion, fatigue, discomfort, followed by how to handle unwanted thoughts and emotions (the most cited being in-event thoughts of quitting or slowing down). These findings are consistent with research on the demands experienced in endurance sports (McCormick, Meijen, & Marcora, 2016; Kress & Statler, 2007). Competitive running is both psychologically and physically challenging, leading to the desire to want to slow down or stop (McCormick et al., 2019). Physiologically this is likely to occur because running feels increasingly unpleasant between the lactate and ventilatory thresholds, a common intensity for athletes in races (Ekkekakis et al., 2011). Thus Mauger et al. (2010) found that exercise-induced muscle pain and discomfort contributes to pacing decisions during endurance running. Such decisions become critical as misjudgment can lead to suboptimal performance either through premature exhaustion or failure to maximise potential.

While runners do receive guidance via different media, such guidance may not be evidence-based or research driven (McCormick et al., 2019). Therefore, researchers need to test the efficacy of evidence driven psychological interventions delivered to a wider audience (McCormick et al., 2018). Kaslow (2015) recommends that such interventions should use language that is accessible, user-friendly and guidance should be practical and concrete. In disseminating to the public, psychologists should explain content that is “scientifically-informed, succinct but accurate, clear and understandable, creative and engaging, memorable and relevant” (p.368). Further, sport psychology can benefit both academics and endurance audiences, talking to both groups in appropriate language for each via “dual dissemination” (Sommer, 2006).

In a meta-analysis, McCormick et al. (2019) found that 96% of studies reviewed were laboratory based or conducted in non-competitive settings. In such research, athletes will not encounter the kind of stressors encountered at real life events where goal achievement is at stake (Martinent & Ferrand, 2015) nor the stressors that would normally disrupt goal achievement, such as self-efficacy, pain management or decisions about whether to slow down or stop. More field based research is recommended. Trained, highly motivated athletes may reach performance plateaus and as such are good candidates for psychological skills training. They are less likely to make performance gains due to increased training volume and therefore allow the impact of psychological skills interventions to emerge more clearly. The challenge for researchers when setting up field based studies is to have internal validity, which can decrease. A laboratory offers an internally valid and reliable environment, but laboratory performance is not an athlete's primary goal.

In terms of having a reliable but ecologically valid performance, Lane, Devonport et al. (2016) suggested that parkrun could provide a suitable environment to conduct test-retest studies in ecologically valid settings. A previous study provided confirmed reliability and sensitivity of parkrun as an option for future research (Hurst & Board, 2013). An acknowledged limitation to internal reliability is the extent to which changes in weather and interpersonal competition affect performance. However, if multiple performances are used to assess performance then these factors should balance themselves out over time. A recent study utilised the opportunity parkrun provides to run frequent trials on a similar course in a short space of time to examine the effects of dietary nitrate, administered in the form of beetroot juice, on performance (Hurst et al., 2020). Researchers are recommended to collect data at real-life events as runners are likely to offer a high amount of effort, regardless of study participation.

By examining the effects of psychological interventions at real-life events in controlled conditions, runners can demonstrate objective measurement of performance while acting as their own control over successive trials to test which specific interventions can be attributed to performance (Meredith, Dicks, Noel, & Wagstaff, 2017; Lane, Devonport et al., 2016). However, it is important to capture participant's perceptions of the interventions. Self-report data could help identify whether athletes are exerting maximum effort. Further, self-report methods could offer insight how runners believe performance gains may be attributable to brief psychological skill intervention against more objective physical data (Parry, Chinnasamy, Papadopoulou, Noakes, & Micklewright, 2011). Further, in studies where participants are presented with an intervention they believe to be effective, positive performance benefits have been observed. In a meta-analysis, twenty two of twenty four studies reviewed found at least one intervention improved performance (McCormick et al., 2015). In terms of what can be considered effective, Bueno, Weinberg, Fernández-Castro and Capdevila (2008) demonstrated, high levels of self-efficacy are more likely to occur if an athlete makes full use of their potential abilities in managing the physiological symptoms of effort achieved by practising psychological skills, to better persevere when faced with perceived difficulties and setbacks.

This is compounded by researchers not taking into account any possible placebo effects (Beedie & Foad, 2009). In their work on identifying the placebo effect, Beedie and Foad (2009) identify beliefs in whether an intervention could enhance performance and has additive effects to the intervention. They found that where participants believed they were given an effective intervention, performance improved, and found this effect even when participants were given an inert intervention. Participants in control conditions who are recruited to a study where the information sheet indicates that researchers are investigating an intervention that could enhance performance could find that performance is enhanced via belief mechanisms - that is, on being included in the study, self-regulatory mechanisms are triggered and where participants are relatively successful and experienced, these self-regulatory processes might be beneficial. What this possibility raises is that the use of a control group is somewhat misleading and they are more appropriately defined as a placebo group. To compare performance differences, a compromise is to use a baseline measure (or non-placebo control group) as such data allows researchers to understand the relative contribution of biological, psychological and placebo effects of interventions.

Lane, Devonport et al. (2016) in a study in conjunction with the magazine Runner's World found that goal-setting and if-then planning did not improve performance significantly more than the control condition. In both studies, Lane and colleagues encouraged all participants to continue to mentally prepare and therefore, there is a possibility that the control condition benefited from placebo benefits. Participants were randomly placed into an active training versus control group and so participants joined the study under marketing that offered insight into the benefits of sport psychology and would not have known they were in a control group. There is a dearth of research that has intentionally used athletes whose performance has plateaued, and therefore, such research is needed.

The potential of using brief interventions to provide sport psychology support contributed to the British Psychological Society funding a Project, 'Research-Evaluated Strategies Intending to Support Training' (RESIST), to develop and test theory-led online brief, self-help interventions for runners to use, designed with the aim of reducing thoughts about slowing down or stopping using a combination of strategies including if-then planning, self-talk and cognitive reappraisal.

Implementation intentions, known as "if-then" planning (Gollwitzer & Sheeran, 2006) is proposed to be an effective brief intervention as it places the problem (if) beside the intended solution (then) and so if the problem (the if aspect) presents itself, the individual remembers to use the intended solution. Achtziger, Gollwitzer, and Sheeran (2008) found this was effective in sport and in health contexts. The simplicity of learning an if-then plan is deemed particularly attractive for brief interventions as repeating the if-then plan twice out loud has prompted effective usage (Achtziger et al., 2008). However, the effectiveness of an if-then plan for performance enhancement will depend on whether the 'then' part being used represents a good strategy. Therefore, whilst memory and learning might not be difficult, establishing effective if-then plans might require additional expert input.

There is conflicting evidence around the effectiveness of self-talk. Some widely used examples of self-talk in effort-based tasks, self-addressed instructional or motivational verbalisations (Blanchfield et al., 2014), found that interventions can reduce the perception of effort (RPE) and improve endurance performance. In a study with competitive cyclists, those trained to reappraise, then rehearse self-selected motivational self-talk statements performing better in a 10km time trial than a matched group trained only with neutral self-talk strategies (Barwood et al., 2015). Whilst there is evidence for usage of self-talk, the mechanism through which it works is not clear. Self-talk might influence performance through motivational processes, that is people try harder, or self-talk might influence performance through enhanced skilled performance, that is endurance athletes make better decisions and perform more economically. Further, the argument that frequent use of self-talk and amount and application of self-talk needed before and during is not clear. It is known that endurance athletes use self-talk as part of a self-regulatory process, that is, they use it without formal training (Stanley et al., 2012). And that frequent use of self-talk might conflict with achieving flow states, so that conscious application of any psychological skill might not be effective. Webb et al. (2012) found that effective usage at the appropriate moment rather than repeated usage was the appropriate message when regulating emotions.

Cognitive reappraisal is an emotional regulatory process that changes how someone interprets an emotion (e.g. pain) before it is experienced, so that its emotional impact is altered while not reducing its intensity (Gross & Thompson, 2007). Athletes encouraged to use reappraisal strategies have been shown to experience reductions in their perceived exertion, Giles et al. (2018). Stanley et al. (2012) found that runners appear to use strategies that could be labelled as re-appraisal and so interventions could encourage use of self-regulation strategies that athletes already apply. Within a review of research across different applied psychology disciplines, cognitive reappraisal strategies for emotional regulation have been shown to be more effective than attentional distraction or concentration strategies (Webb et al., 2012).

Whilst these brief strategies are well researched and reported in the literature, the efficacy of such an online program is not. Thus, the present study was conducted to examine the extent to which the interventions presented in the RESIST programme are effective in making meaningful improvements (a performance where the athlete has run faster than their previous best effort which can be attributed to the intervention). The study also explores the reasons around the possible successful interventions by post race qualitative questionnaires (Parry et al., 2011). The study examines whether psychological skill training can support faster times by reducing the desire to slow by using if-then planning, self-talk or cognitive reappraisal.

5.2 Aims

The aim of the study is to assess the extent to which brief interventions improve running performance amongst experienced and highly motivated competitors.

The study will test the following null and alternative hypotheses:

Brief interventions will not impact finish times in competitive 5km running trials.

Brief interventions improve finish times in competitive 5km running trials.

Additionally, the study will attempt to assess the extent to which a study where all of the participants are aware of the intent to use psychological skills to improve performance acts as an effective intervention in itself.

5.3 Methods

Experimental design

The study was approved by the University of Wolverhampton's ethics board (Appendix 1). The study used a within-participant and between-groups (intervention v placebo), repeated-measures design (pre-study v within v post study performance) in which participants completed a 5km TT as part of a mass event (parkrun) on three occasions. All participants completed one trial at the start of the study. Participants were then randomly allocated to intervention group or placebo group conditions.

Participants

The goal was to carry out a study in competitive conditions which controlled for as many variables as possible. Key to the selection of participants was their high level of motivation and desire to achieve a maximum performance outcome. Set alongside this was the need to establish that a performance plateau had been reached. To establish whether any improvements in performance from the intervention were due to training, an initial baseline performance measure was run by all participants. This established that participants' performance had hit a plateau by comparing against the parkrun database for each individual's performance. The most recent parkruns carried out prior to the study were included in analysis for comparison. This was enabled by publicly available parkrun data and as such participants needed to have participated in parkrun on the same course frequently. Selection was based on a performance standard and each participant had trained consistently over a prolonged period and so step changes in performance were likely to require a significant stimulus. Highly motivated participants have encountered the symptoms of fatigue associated with attempting to make a maximal effort. As such they will have frequently encountered physiological feedback which requires a psychological coping strategy. It can be said that the brief interventions in this study are intended to nudge or direct the participants rather than introduce them to using psychological strategies as a new concept.

Four male and three female, experienced (defined as running at least five times a week for two years) club level runners aged between 29 and 45 years old were selected based on their-parkrun times. Male participants were recruited who had achieved a time of sub 17 minutes; females those who had achieved a sub 20-minute time. The criteria for these times being the standard selected by the parkrun organisation to reflect good performance amongst non-elite runners. Additional criteria involved the participants being judged to have reached a performance plateau, defined as a variation in a maximal effort of c. 20s on the same course in comparable conditions.

Interventions

Each participant received the same experimental condition chosen in order from the solutions on RESIST (if-then planning; self-talk; reappraisal) after each successive parkrun at least one week apart from their previous TT. Participants were asked to complete training for the intervention (via email, example Appendix 3). They were invited to watch the relevant video, take notes to apply the skill and then test these a minimum of twice in high intensity training sessions prior to running their parkrun TT. 'High intensity' refers (but is not exclusive) to sessions that challenge athletes anaerobic energy systems: e.g. threshold runs; tempo or hill sessions. All specific methods aimed to help runners achieve faster times (e.g. Daniels, 1998).

Placebo/Control

In addition to any impact of the brief interventions, consciously taking part in the study served as an additional intervention to all participants influenced by their beliefs and expectations, "For example, all other things being equal, in a research study or in the field, the performance of athletes or exercisers with positive expectations of a treatment would theoretically improve to a greater degree than the performance of those with either no expectation or negative expectation." (Beedie et al., 2018 p.1385). This is consistent with proposals by Andersen (2000) who argued that a practitioner is an active agent in the effectiveness of an intervention, a factor that research has not sought to examine. The present study will capture beliefs of effectiveness via post-performance self-report data.

Performance Measure

The measures taken of all participants were: their parkrun finish time and link to record on the parkrun website; a link to their run as captured on https://www.strava.com/; heart rate data and a completed questionnaire (Appendices 4, 5 and 6). In order to carry out statistical analysis, results were analysed in average speed presented as metres per second which (see Lane, Totterdell et al., 2016).

Procedure

As part of agreeing to take part in the study, participants were asked to run each parkrun as quickly as possible (Appendix 2 and 3), then reflect via their questionnaires (Appendix 4 and 5) after each performance as to which existing psychological strategy they had used and which they would subsequently use in their next TT. All participants were told the expectation of their commitment was for a minimum of 12 weeks with three measurements of repeat trials. Spacing was chosen for training effects.

i) Baseline measurement – parkrun time/s ran as fast as possible.

ii) Week 3-4 test – parkrun TT1

iii) Week 7-8 test – parkrun TT2

iv) Week 11-12 test –parkrun TT3

After each time trial, participants were asked to email their Strava record (including HR data); parkrun time and completed feedback to the researchers. Results for parkrun are publicly available online. Questionnaires (Appendix 4 and 5) were given to participants to be completed after each parkrun depending on whether they were in the control or intervention group. Data for parkruns completed 3 months prior to the study; their baseline effort (when informed of the study instructions) and any parkruns completed 3 months after the study were also captured in order to establish performance plateau data and for the researchers to analyse any additional learning effect regardless of participant condition.

Debrief

Unfortunately, a face-to-face debrief was not successfully arranged before travel restrictions were imposed. An online debrief will be conducted as soon as is practicable.

Data analysis

In order to address the hypotheses, it was necessary not only to identify and quantify any changes in performance but also analyse the extent to which, if any, brief interventions were responsible for those changes. Further, it was necessary to determine the influence of the three individual interventions. The analysis attempted to test the hypotheses by examining the effect of the various interventions on performance in the running trials. This includes the individual brief interventions as well as the effect of taking part in the study compared to performances before and after the study. Statistical significance is unlikely given the small sample size. It is important to note however that the intention is not to identify recommendations to the entire population taking part in parkrun. Factors such as experience and training volume vary widely in that population and as such the population in question would be parkrunners that had achieved the time standards and had reached a performance plateau.

5.4 Results

Of eight participants initially recruited for the study, one dropped out due to injury. One participant initially recruited withdrew prior to running TT1. These individuals were replaced by two other suitable participants selected by researchers. Results for parkrun times completed pre-study, baseline and post study are in Appendix 1.

Table 5.1 ***Results of parkrun time trials (TT) for all participants***

Ptp	Intervention or control?	TT1 Time (mm:ss)	Ave HR	Gap to PR2	TT2 Time (mm:ss)	Ave HR	Gap to PR3	TT3 Time (mm:ss)	Ave HR
01	Intervention	16:10	N/A	9 wks	16:54	N/A	1 wk	16:06	N/A
02	Intervention	23:29	152	2 wks	24:24	145	3 wks	23:31	178
03	Intervention	19:22	171	6 wks	19:43	174	5 wks	19:58	172
04	Intervention	18:58	181	4 wks	19:12	183	3 wks	18:43	189
05	Control	18:07	182	6 wks	18:18	179	3 wks	17:50	179
06	Control	16:25	159	3 wks	16:22	137	1 wk	16:22	136
07	Control	18:38	N/A	3 wks	18:10	N/A	4 wks	18:07	N/A

See Appendix 9 for additional HR Data information and context

Table 5.2 ***Descriptive statistics – summarised parkrun trials by condition***

In or out of study	Trial	Mean	Std. Deviation	N
Outside Study	Pre-Study	4.42	.47	39
	Post-Study	4.28	.43	23
	Total	4.37	.46	62
During Study	Baseline	4.52	.48	7
	If Then	4.35	.65	4
	Re-appraisal	4.33	.68	4

	Self-Talk	4.23	.62	4
	Placebo	4.75	.26	9
	Total	4.50	.50	28
Total	Pre-Study	4.42	.47	39
	Baseline	4.52	.48	7
	If Then	4.35	.65	4
	Re-appraisal	4.33	.68	4
	Self-Talk	4.23	.62	4
	Post-Study	4.29	.43	23
	Placebo	4.75	.26	9
	Total	4.41	.47	90

Table 5.3 ***parkun trials - Tests of Between-Subjects Effects***

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared

Corrected Model	1.621[a]	6	.270	1.223	.303	.081
Intercept	1151.749	1	1151.749	5212.481	.000	.984
During study Y/N	.000	0	.	.	.	.000
Trial	1.298	5	.260	1.175	.329	.066
During study Y/N Trial	.000	0	.	.	.	.000
Error	18.340	83	.221			
Total	1771.260	90				
Corrected Total	19.961	89				

a. R Squared = .081 (Adjusted R Squared = .015)

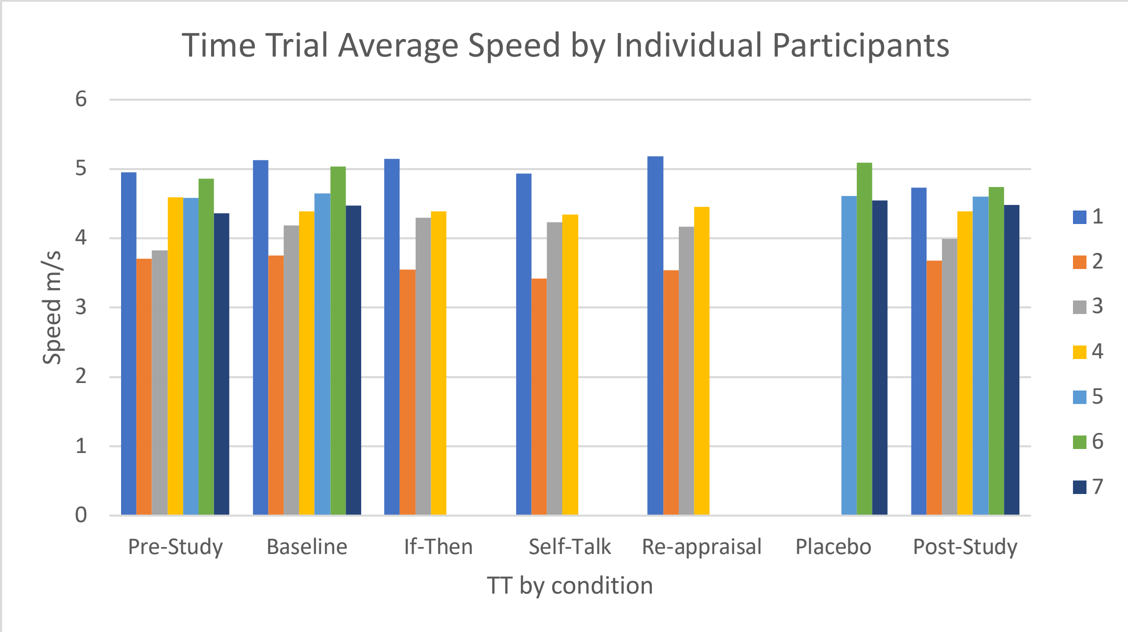

Figure 5.1. Individual Time Trial speeds for all participants by condition.

Data analysis - TT Completion Data

To test the null and alternative hypotheses individual time trial scores were assessed (Figure 5.1) a comparison was made between trials and during and outside the duration of the study (Table 2) and an analysis of variance was conducted (Table 3).

There was a difference between the TT conditions in terms of speed m/s but it was not statistically significant, $F(6,83) = 1.22$, $p = .30$. The null hypothesis that brief interventions would not affect TT finish times is therefore not rejected.

Placebo appeared to be the most effective condition; more so than any of the 3 trained brief skills. Baseline, which is a very similar condition in terms of study participation being known, also had more of an impact than those 3. Of the 3 interventions, if-then was most effective statistically with a mean of (4.34), followed by Reappraisal (4.33) then self-talk (4.23).

Post study, all runners, regardless of control or intervention group, ran slower in parkrun runs than pre-study levels. In context this appears to be more as a result of changes to fitness than any reflection on the ongoing use or not of psychological skills.

The difference in mean finishing time between “during” and “outside” study conditions converts to 33s (18:31 vs 19:04). In an applied setting this level of performance improvement would undoubtedly be meaningful to athletes, particularly those who may have plateaued in terms of physical improvement through training.

Heart Rate (HR) data

It was initially anticipated that Heart Rate data (HR) would be considered in analysing the performances of participants. A review of the HR data suggests that the measurement was not sufficiently reliable for inferences to be drawn about either the effect of the interventions or any training effect which might have occurred. The majority but not all of the participants registered HR data which appears consistent with maximal efforts over 5km.

Post-race questionnaire data analysis Questionnaires were completed by all 7 runners after each parkrun time trial (TT).

Effects of if-then planning on performance on TT1 - Themes reported

All but one of the intervention athletes committed to applying if-then planning in their training and first TT. 03 posted a PB time. The athlete who didn’t apply the skill stated:

"*There was nothing of new interest for me contained in it and I didn't find the presenter engaging.*" (02)

This was in contrast to the other three participants who found the presentation "clear, novel and engaging." Their only collective complaint being that they wished more concrete examples had been given in the video itself (rather than written on the accompanying page on the RESIST website).

Only two of the four considered or rehearsed the skill on the actual day of the TT just prior to racing. In terms of their experience though, one of the athletes who had trialled if-then planning in training (03), stated:

"*I found it helped massively with getting my focus back in sections where I was drifting off the pace/effort. I got a parkrun PB as well!"*

It was noticed that for a few of the participants, using brief skills training was a novel experience to adjust to. Participant 01 stated:

"*In using the if-then plan of 'relax & smile' I found it hard going, I think it made me subconsciously ease off the pace as my mind went off my rhythm and cadence.*"

Effects of self-talk on performance on TT2 - Themes reported

All athletes' finish time on the same course as TT1 was slower. A few of the runners stated this may have been due to slightly worse weather conditions. Three of the four athletes consciously thought about how they would use self-talk in the TT prior to participation (and had rehearsed in training in the weeks preceding). Again, the same participant (02), reported they felt they learnt nothing new about the skill and that they had tried to use it previously in races. However, on the TT they stated:

"*I acknowledge there is an element of unconscious self-destruction on my part and that happened today.*"

For the others, it seemed playing with the language while racing had a slight impact on their performance, as 01 stated:

"*I am intending to reduce the self-talk to simple one or two-word phrases. e.g. For mile three I used 'leave it all out there' but found that too long and the wording was 'loose in my head' so less effective, so I am changing it to 'empty the tank; next time*" (01)

Again, the majority of the respondents stated they wanted specific examples in the video instruction to inform their thinking on which self-talk strategies to use.

Effects of reappraisal on performance on TT3 - themes reported

In the final TT, all intervention athletes reported rehearsing, using the skills in training after TT2 and on the day. For two of the four, they recorded their quickest time of the three TTs; one was a few seconds over TT1, and the fourth finished as first lady in her parkrun, despite posting her slowest time of the study.

As a strategy, reframing negative thoughts to slow down or stop were recognised by all the respondents and three of them reported that implementing more motivational self-talk (MST), positive affirmations and focus helped both running cadence and rhythm and speed at points in parkrun where normally they may start to slow or think about easing off. In the case of 01:

"*I ran my 2nd quickest ever parkrun on this course, which I have run over 160 times. It was the intervention that made the difference.*"

For 04:

"*It was especially helpful in the second mile (of three) of the parkrun. I usually struggle to maintain pace halfway through.*"

All reported again that they wanted more specific examples in the online self-help video.

Qualitative data by placebo athletes TT1 to TT3 - Themes & skills reported

Across the three participants in the placebo group, all three reported what psychologists would recognise as brief skills for reducing stress, increasing concentration or reframing and restructuring negative thoughts via emotional regulation (Berman et al., 2019). Participant 05 reported using what would be recognised as imagery, motivational self-talk and "anchoring" (Meijen, Day & Hays, 2017) to help "stay in the moment," to manage his in race emotions and possible desire to slow down. For example:

"I try to focus and imagine myself running well." (before TT1) and,

"I focused a lot on thinking about the fact I was at peak training (for a marathon) and that this training block had gone well."

06 rehearsed and used what would be recognised as imagery and goal setting:

"I visualized the feeling of euphoria for how I would feel viewing my times getting quicker each week across your study," (In TT3) and,

"I was focused on beating my time from the previous two weeks."

whilst 07 used imagery and self-talk statements across TTs for tough parts of parkrun:

"In my plan I visualised running really strong," and

"focused on trying to keep a rhythm so I kept reminding myself of that in my head... Keeping and holding the rhythm was a useful strategy as I ran my fastest TT."

5.5 Discussion

This study investigates the effects of online brief interventions on the finish times and qualitative experiences of runners completing three timed 5km parkruns (N = 7). It controls for the potential of training effects by comparing competitive club level runners in full training with similar target goals, experience and existing finish times while recognizing each participant was training for different distance races concurrently during the study.

Results found there were no significant differences between groups; that no intervention significantly helped athletes achieve their goals more than the placebo condition. Therefore, the hypothesis that participants trained using brief online psychological skills will run faster if they commit to and apply the interventions was not confirmed. All control participants improved their finish time successively from TT1 to TT3. All four intervention participants slowed in TT2, then had varied finish times in TT3. However, it appears that participating in the study had beneficial effects on performance and parkrun experience was positive for all but one of the participants across both groups as captured in the post TT questionnaires.

The brief interventions themselves did not produce improvements and in fact simply participating in the study, and thus becoming aware of the potential for psychological skills to contribute to performance had a greater impact. Both groups questionnaire answers make it apparent that all participants used self-selected psychological strategies prior to the study to manage the sensations of fatigue and pursue faster times. Previous success would have built belief in these strategies. In the case of participant 01, he stated using the if-then statement “relax and smile,” a method shown to be effective by Brick et al. (2017), when the urge to slow bit at the 3km stage of TT1.

Two previous studies (Lindsay, Maynard, & Thomas, 2005; Sheard & Golby, 2006) examined the effects of interventions for endurance athletes in real-life competition. Both interventions were inconsistent in improving endurance performance, speculated to be because of confounding variables (e.g. the specific competition), or because the margins for improvement are small for trained athletes in competition - as suggested by performances in this study. Alternatively, the benefits of practical psychological interventions for competitive athletes might not be observable across short-term competitive performances (McCormick, Meijen, & Marcora, 2015).

Intervention Implementation and comprehension

For three of the four participants, there was clear understanding in questionnaire responses of comprehension of the instructions and brief skills to be applied. For one (02) however, their answers were dismissive of the presenters, the skills being proposed

("I use these already") but also an admittance of issues with performance self-sabotage. It was out of scope of the study to address this, as there was no feedback element for participants after each TT.

In future, such functionality is recommended. In research by Lane, Totterdell et al. (2016), feedback had a positive influence on a large scale sample of participants (over 44,000) in an online cognitive intervention that significantly enhanced increased positive emotions and a reduction in negative emotions.

The interventions were evidence based and provided by practitioners, whose presentation style and credibility generally received positive feedback. The participants universally stated they wanted specific, practical examples described and embedded within videos, agreeing with McCormick, et al. (2018) recommendations for effective instructional video interventions.

Highly motivated athletes are in training year round for different distance events (e.g. 10km, marathon, etc). This seemingly affected times in both groups independently of whether brief skills training was being delivered. For example, intervention participant 01 completed a marathon during the length of the study, and was both periodising and recovering between different TTs. Participant 05 completed a half-marathon the weekend before his third TT.

Further, parkrun events are typically utilised by athletes at this level as a competitive training opportunity and defined as 'a run not a race' (parkrun, 2020). It is therefore difficult to measure with confidence from this study the impact this had on motivation levels compared to a key targeted race. All participants had faster competitive 5km times than parkrun.

The long-term performance benefits of the online video training captured in this study via a single-subject design with nine post-intervention performances (Lindsay, Maynard, & Thomas, 2005) suggested that continued practice of psychological skills can lead to improvements in endurance. However, the effects of practical psychological interventions on performance after three or more months are not well researched. The performance of participants deteriorated markedly in the post-study period, when they continued to complete parkruns. In general goal races had been completed by this point and participants were in a recovery or build up phase and would not expect to be at their fittest. Similarly, motivation is likely to have waned in the period after either achieving or falling short of a goal.

The participants in the study were specifically recruited because of their experience and ability. A corollary of this is that they have already selected self-regulating strategies to cope with fatigue and maximise performance. Participants ran faster during the study than during the periods immediately preceding and following. This is in keeping with literature around metacognition and self-regulation. The study acts as a prompt to engage cognitive abilities to assist performance. In a recent study of metacognitive processes in self-regulation, elite runners "appeared to have established, through experience, a means of prioritising sensorimotor inputs to optimise running performance." (Brick et al., 2015). Importantly in the context of the present study, Brick et al suggest that:

"Consequently, the athlete may make explicit metacognitive judgements or estimates regarding the (in)effectiveness of the cognitive strategy employed (e.g. estimate of solution correctness). Depending on the outcome of this metacognitive judgement, alongside continued monitoring of task performance, the athlete may choose to maintain their current attentional focus or adopt an alternative cognitive strategy. (Brick et al, 2015)."

The participants in the present study are experienced in high intensity training and competition. Thus in addition to receiving instruction in specific strategies through the brief interventions, all participants including the placebo group effectively received a prompt to engage existing self-regulation strategies.

Active self-regulation occurs when cognitive strategies, such as self-talk, are engaged to influence thoughts, feelings and actions (Brick et al., 2019). All participants were aware that they were taking part in a study involving psychological strategies in relation to running performance. As such they were primed to focus on the mental aspect of their performance and may have used pre-existing cognitive strategies in a more focused or consistent fashion.

Future implications

A number of modifications to the method are recommended. Initial physiology testing could be carried out in a laboratory to establish HR zones, particularly in respect of Lactate Threshold (LT). This would provide physiological supporting evidence that a max effort had been run. The participants could be provided with the same HR monitors and chest straps used during assessment to improve accuracy. This would allow physiological improvements from training to be more clearly identified. Further, researchers could be more confident that participants were giving full maximal effort based on HR data in each time trial.

As it was the common finding that from a usability perspective, participants would have preferred concrete examples talked through in the brief videos, it would be helpful to trial athlete responses to such a change in future, both in terms of preference and ease with which they would feel it is to develop their own solutions from such suggestions.

It is suggested that future research uses a larger sample across more discrete PB times (e.g. for males, one participant in each condition with a 15 minute 5km PB; then minute increment PBs upwards) with both physiological data and existing psychological experience and ability to allow deeper insight to the application of skills by individuals. Further, being more rigid on procedure to insist athletes race on specific weekends after deliberate training in at least two quality sessions may allow more accurate understanding of the underlying psychological mechanisms that produce positive results (as per McCormick et al., 2015). It would be valuable to understand by conducting a longer future study, e.g. over a whole season, whether participants continued to use taught interventions. Alternatively, they may have experienced an improvement in performance due to an increased focus on and awareness of the psychological aspects of performance.

The RESIST project seeks to provide brief interventions to help runners manage the symptoms of fatigue. The limitations of the present study included varying athlete motivation due to parkruns being only a minor goal for most. A suggested future study might look at 1500m runners competing in British Milers' Club events. These races are paced with the goal of producing fast times and many runners will focus their competitive season around them. Additionally, this distance allows runners to compete regularly enabling multiple trials. Athletes will compete at this level at peak fitness and the track provides a highly controlled environment. These factors may allow psychological influences to be more readily identified. 1500m is a physiologically demanding event and so is ideal for brief interventions such as those used in the present study.

Conclusion

The evidence from this study supports the proposition that brief, online interventions can be beneficial for athletes (in agreement with Lane, Devonport et al., 2016; McCormick et al., 2019). However, in equal measure, it highlights the difficulties which achieving and accurately measuring improvement through these interventions provide. Testing intervention efficacy with trained athletes to use psychological skills whilst performing in a high intensity event may limit the athlete's ability to implement or enhance existing skills consistently and successfully to achieve performance outcomes. Participation in a study involving psychological interventions, as well as having attention focused on cognitive strategies, can account for a significant proportion of any effect on performance.

These findings do not support generalised recommendations. The aim was to discover via online video training whether brief self-help psychological training raised performance effectiveness. The attributions that emerged for a discrete but growing population of endurance runners as to what they believed impacted performance gave a more nuanced phenomenological finding along with recommendations for possible refinement to both the technology and methodology. In future this permits greater scrutiny of such skill training and implementation to compare alongside hard physiological data.

Chapter Six: General Discussion

The studies central to this thesis highlight some of the challenges for researchers in carrying out meaningful work relating to psychological skills in endurance performance. Where the goal is to produce effective recommendations to athletes and support teams the researcher needs to be aware that athlete beliefs will impact the effectiveness of interventions (Hurst et al;, 2017. Beedie et al., 2017). The preceding studies have attempted to develop a further understanding of the use of psychological skills in endurance sport. In analysing the data as well as understanding the limitations of the studies a route to further research emerges.

Studies where participants are not highly trained leave open the possibility that improvements are attributable to a simple increase in training rather than a particular intervention around for example, learning a particular psychological skill (Swann et al., 2015). Controlling for this factor can be difficult even with the availability of online training logs. Assessing the impact on performance of physical training and separating this from the influence of an intervention is problematic. Repeated physiology testing would provide one solution but is logistically problematic. Elite athletes in particular have carefully periodised training plans which physiology testing represents an in interruption to.

More broadly, identifying the influence of an intervention, particularly in psychology, is often problematic. The ability to employ psychological skills is proposed to take a considerable time to learn (Hanton & Jones, 1999). In any work of this type though we must be wary of the coaching that exists not only surrounding the psychological skills themselves, but also in completing the assessments. This could tend to artificially reinforce the extent to which teaching the skills is helpful. However, researchers have not focused on how athletes learn to use psychological skills, that is focus on the learning process. Moreover, intervention studies tend to focus on the effects of using psychological skills.

Interventions might be designed with practical application in mind, but participants may vary considerably in terms of their ability to utilise psychological strategies and previous experience can be difficult to screen for. This was evident throughout the three studies presented. For example, several factors were controlled for in the recruitment of participants in the parkrun study of Chapter Five. However, it appeared that despite having similarly high levels of experience and training load, that athletes engaged with the strategies in different ways and with varying success. On the other hand, where novice participants were used, even in a trial with limited physiological stress, the ability to pace as a skill was very limited, even when given evidence-based interventions. Understanding the population in context as well as identifying the many factors which impact performance is critical in conducting meaningful research and producing helpful recommendations.

Competitive endurance athletes will all have encountered the physiological symptoms associated with race efforts and have by some means selected strategies for coping with them. Optimising performance necessitates working at a high percentage of physiological capacity. It is clearly in the athletes' interests to work on tolerating the associated symptoms of discomfort and fatigue as effectively as possible. For example in Many will also have worked with practitioners either through a national federation or on their own initiative.

In practical terms athletes and coaches are primarily interested in Sports Science if they believe it can improve performance. If an athlete more closely identifies with participants of a study, it is more likely that they will have positive beliefs relating to the findings of that study. Paula Radcliffe participated in physiological testing throughout her career (Jones, 2006), indicating that she saw some value in it. Further, the improvements highlighted over time validated training methods and may have enhanced confidence. If, for example, an elite marathon runner is given advice based on a study involving participants who run 30 miles per week it is possible that they would remain sceptical that findings would be applicable to an athlete running 100+ miles per week.

It is demonstrably beneficial for Sport Scientists to make claims around the applied value of their research. Impact across a broad population is desirable in demonstrating the value and effectiveness of interventions. Equally, recommendations which appear to offer significant benefits without further significant investment of resource and commitment might appeal to athletes, particularly at a recreational or participatory level. As a result, it is not uncommon to see general literature referencing scientific research in simplified terms often summarised in the form of “5 Top Tips” and so on. Mechanisms for broader communication of research are important, as are explanations of Sports Science concepts which are readily absorbed and understood by the general reader. There is however a clear potential for difficulties if such concepts are overly simplified or adopted by athletes for whom they may not be beneficial or appropriate. There appears to be a reluctance in general publications to propose a gradually increasing volume and intensity of training over an extended period as suitable preparation for events like the marathon. It is possible to argue that other factors such as psychological skills training, nutrition, ergogenic aids, equipment and recovery strategies receive disproportionate attention. A possible explanation for this would be the considerable commercial considerations involved in these factors which might lead to their value being over emphasised. A useful avenue of further study would be to review and quantify these aspects of general literature as well as consider the funding arrangements around research linked to commercial products and services.

The growth of practitioners across a range of disciplines and their perceived values mean that elite athletes often assemble a team of experts each of whom has input into the preparation and performance. Pursuit of "marginal gains" has become synonymous with and credited for success at a very elite level, such as in seven victories in eight editions of the Tour De France by Team Sky / Ineos, a race widely regarded as one of the toughest endurance tests in elite sport. As a result, athletes may feel that "leaving no stone unturned" in their preparation means having expert support in each of these areas. Where financial constraints prevent this, athletes may feel at a disadvantage. Evidence suggests though that, as in East African distance running, success at the very highest level is entirely possible with less emphasis on these areas and a relatively simple approach to training (Hamilton, 2000). Of course, this does not necessarily suggest that the importance of nutrition, psychology and so on has been overstated. A review of the training habits of for example, Eliud Kipchoge's group in Kaptagat Kenya have developed a highly effective understanding of what is needed and put into practice sound Sports Science principles through a highly pragmatic approach. They have identified an effective method of preparation and a large number of successful competitions have reinforced confidence in this approach.

Kipchoge himself, when interviewed, has described his use of a number of recognisable psychological skills, although these seem to have largely been identified and developed almost independently by himself and his coach, Patrick Sang, throughout his long and very successful career. Prior to his second, this time successful attempt, to run under two hours for a marathon in an exhibition event in Vienna in October 2019 Kipchoge made clear the value he places on his mental approach and his belief around its influence on performance:

“You cannot be physically fit without being mentally fit, if your mind is there then you will be well.” (Ineos 1:59 Press Conference, 10th October 2019, Vienna).

A recent study conducted whilst Kipchoge was preparing for a 2 hour marathon attempt, highlights the value of research with elite level athletes, who are highly invested in a goal which the research serves to support (Jones et al., 2020). This kind of study is rare for obvious reasons, but therefore all the more valuable, removing as it does some of limitations around participant recruitment and beliefs outlined earlier.

On other occasions he has given comments which show his mental approach to be in line with psychological theory and its role in endurance performance:

“Personally, I believe in what I am doing. To run a big marathon and win, it takes five months. When I am on the starting line, my mind starts to think of what I have been doing for the last five months. I believe in my training. I treat myself as the best one on that line because my mind is telling me that I am the best and I believe in what I am doing in the last five months. I can run free. I can run free and that’s what actually has helped me to be successful.” (Address to Oxford Union, 30th November 2017).

The language used here reveals high levels of self-efficacy (Bandura, 1977).

Preparation and previous success within the specific context of marathon running have bolstered Kipchoge’s belief that he can win the race.

"I believe in a philosophy that says to win is actually not important. To be successful is not even important. How to plan and prepare is critical and crucial. When you plan very well, then success can come on your way. Then winning can come on your way."

In the previous quotation it appears that Kipchoge is very clear in his intention and desire to win the race, a very obvious outcome goal. Here we see language that is consistent with a process driven approach and the theory of goal striving and employing implementation intentions (Wolff et al., 2019). Kipchoge identifies a desired outcome but in conjunction has strong beliefs about what will be required to achieve this. Carrying out the required training and preparation seems likely to reinforce high levels of self-efficacy.

On two separate occasions in recent years ("Nike Breaking2", "Ineos 1:59") an attempt was made to run a marathon in under two hours in a controlled set of circumstances. The goal was to achieve the time in artificial conditions which did not meet competition regulations. Kipchoge's high levels of self-efficacy would have been important. In the second, successful attempt he did not have competitors and the entire exercise depended on his individual performance. He had chosen to place himself in a highly pressurised environment which would require significant motivation and high levels of self-efficacy to be successful, alongside the obvious very challenging physical demands.

In terms of further work in managing and overcoming fatigue it seems clear that there are a number of challenges facing researchers, some of which the preceding studies have highlighted. Conducting research in or immediately around competition is demonstrably problematic. Athletes and their support teams are primarily interested in performance and will be reluctant to participate in research which might disrupt their preparation or execution. This particularly applies where a researcher might seek to introduce an intervention the impact of which by definition is not known with certainty, even if it is supported by a strong evidence base.

Given that the response to fatigue appears to be influenced by motivation, RPE and other factors which will be directly impacted by the competitive environment this is problematic. The need for accurate data collection in controlled conditions often means that studies are conducted in unfamiliar surroundings where the perceived value to the athlete will vary considerably. An appropriate reduction in training load in preparation for laboratory testing is generally advised but may not be complied with, although the participant may not admit this.

Ascertaining the value placed on participation in the research from the athlete's perspective is a useful preliminary step. One the one hand, linking research with NGBs, or involving coaches and support staff may be an effective way to increase compliance and motivation levels. On the other, presenting the potential benefits in a concise and easily digested format could increase athlete buy-in. It is also important to accurately describe the nature of the participants and understand the limitations of any conclusions in this context.

Studies investigating fatigue in endurance events, where there is a belief that the athlete can benefit and where the athlete is already highly trained are desirable. The intention is to better understand the relationship between motivation, the employment of psychological skills and the physical and mental symptoms of in event fatigue (Marcora, 2019). The nature of this work is to gain an understanding of how athletes reach their perceived limit and to develop interventions to manipulate this perception to increase psychological resistance to fatigue. This is based on the premise that the true physiological limit always lies some way beyond this perception.

A lack of motivation in participants might well produce useful data around the negative impact this has on performance. Researchers can also further their understanding of the source and level of motivation and which interventions might be useful to practitioners in this area. Participants who perceive a value and incentive in the research, particularly where it might enhance their performance, provide a different opportunity to researchers. This factor can be seen in studies of placebos (or belief effects) where the pre-existing beliefs of the athlete appear to impact the effectiveness of an intervention (Hurst et al., 2017). Although gathering physiological data in and around competition remains problematic, a laboratory test performed by an athlete who sees value in the outcome provides greater insight, particularly in researching the limits of endurance performance.

Chapter Seven: Conclusions and Recommendations

Generalising findings and producing reliable recommendations for the use of psychological skills in endurance competition is clearly challenging. There is considerable evidence to suggest that a number of strategies *can* be effective. However, this remains a considerable distance from confirmation that specific interventions are universally beneficial for any athlete, regardless of individual characteristics.

Researchers should consider the applied benefits of their studies. The value of interventions that improve performance for some athletes is enhanced by a reliable method of identifying which psychological skills are most beneficial to individuals. Traditionally this has been done by trial and error. Evidence supports that a strategy can be effective and as a result the athlete's belief in the value of the intervention may be enhanced. If the athlete perceives a benefit to performance, then this is worthwhile. Conversely, if an intervention proves ineffective in the perception of the athlete this could damage belief that psychological skills training in general can aid performance. With a plethora of strategies available a useful area of research would target screening athletes to establish which strategies may be most beneficial given their history and characteristics.

Athlete's beliefs around the strategies that they adopt are important. Providing experienced athletes with evidence-based options from which they can self-select is a potentially effective way of increasing the impact of research in applied and competitive settings. If the strategies in question can be presented in an easily understood format by acknowledged experts then athletes may be more likely to adopt them and, importantly, implement them in the belief that they will be effective.

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APPENDICES

Appendix 1 - Approved ethics

Dr Alexandra Hopkins RN PhD MSc MBA RNT RCNT DANS
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Date 21st June 2019

University of Wolverhampton FEHW

Dear Dan

Re: "Does specific psychological training improve competitive 5km running times?"

The Faculty Ethics Panel (Sports) has considered and reviewed your submission.

On review your Research Proposal was passed and the Panel believes that the ethical issues inherent in your study have been adequately considered and addressed. Therefore the Panel is giving you full ethical approval for your study (Code 1 – Approved –Unique Code: (21/19/DR1/UOW).

We would like to wish you every success with the project.

Yours sincerely

Professor Matt Wyon
Chair – Ethics Panel

Appendix 2 - Intervention group protocol
Dear Participant,

Thank you for agreeing to take part in our study on the psychological component of parkrun running times. We are 3 practitioners based at the University of Wolverhampton interested in understanding more objectively **how the mental aspect of racing impacts your performance in a competitive event** as experienced and ultimately assessed by your finish times.

As a well trained, experienced club runner you are familiar with high intensity running in a competitive group or race. For the length of the study, we would like you to take part in your local parkrun race **3** times over 12 weeks. Ideally, this would be every 2-3 weeks, but from Saturday the 17th August to 26th October if you complete your parkrun, can you please notify us with your results by sending your result from the parkrun website, along with a link to your Strava record of the event. **Please include your Heart Rate data so we can check for any physiological changes in performance.**

For the purposes of the study, we ask you to give your full out best effort without risking any injury, harm or damage to yourself or your fellow parkrunners.

Study purpose
Many runners use psychological strategies during racing and training. We would like you to learn and then use some of these strategies during your parkruns to test their effectiveness. The strategies will be explained to you via short video clips we will send you which you can view online. Before your first parkrun for the study on 17th of August, we would like you to watch the first video linked below, which outlines the use of 'If then planning' **(Link: https://youtu.be/8HY5cyu3Ghg),** and then practice the skill as outlined below:

Psychological strategies, like all skills, become easier with training. We ask that you watch the video before at least 2 of your harder training sessions (e.g. track sessions, hill repeats, tempo or threshold running) leading up to the parkrun and practice using the strategy in those sessions and the parkrun itself. After using this skill in your next parkrun for the study, we will be sending you details of another different skill we'd like you to test.

Instructions

1. Pick the same parkrun to run at 3 times;
2. You have all recorded an all out effort to give us a baseline. We ideally need you to complete your last one by Saturday 26th October so please pick 3 other times to do between these two dates on the same course. Ideally these should be a few weeks apart so that you can test each video skill we send you to test in training.
3. Wear your Garmin/watch and HRM, run to your capacity and complete the data upload and notify us
4. When you reply please briefly answer each of the questions via email to ***@gmail.com & ***@gmail.com.

5. To remind you, in this study, you are free to withdraw at any point. You are volunteering to assist us in helping our study. **But your welfare takes priority over any data collection**.
6. If you do wish to withdraw either from the study or any parkruns, just let us know at your earliest convenience. If you have any more questions or concerns about your health or the study, please contact us on the email address above these instructions.

Thank you. Any questions or queries, please call X in the first instance on 07*** ******

Appendix 3 - Control group protocol
Dear Participant,

Thank you for agreeing to take part in our study on the psychological component of parkrun running times. We are 3 practitioners based at the University of Wolverhampton interested in understanding more objectively **how the mental aspect of racing impacts your performance in a competitive event** as experienced and ultimately assessed by your finish times.

As a well trained, experienced club runner you are familiar with high intensity running in a competitive group or race. For the length of the study, we would like you to take part in your local parkrun race 3 times over 12 weeks. Ideally, this would be every 2-3 weeks, but from Saturday the 17th August to 26th October if you complete your parkrun, can you please notify us with your results via the parkrun website along with a link to your Strava record of the event. **Please include your Heart Rate data so we can check for any physiological changes in performance.**

For the purposes of the study, we ask you to give your full out best effort without risking any injury, harm or damage to yourself or your fellow parkrunners.

Study purpose
Many runners use psychological strategies during racing and training. We would like you to keep a record for us to understand in more detail the methods runners of your level use and to let us know how they worked for you in the parkruns you run during the length of the study.
Instructions
1. Pick the same parkrun to run at 3 times;
2. You have all recorded an all out effort to give us a baseline. We ideally need you to complete your last one by Saturday 26th October so please pick 3 other times to do between these two dates on the same course.
3. Wear your Garmin/watch and HRM, run to your capacity and complete the data upload and notify us
4. When you reply after each parkrun you do please briefly answer each of the questions above with your Strava Data and result via email to ***@gmail.com & ***@gmail.com.
5. To remind you, in this study, you are free to withdraw at any point. You are volunteering to assist us in helping our study. But your welfare takes priority over any data collection.

6. If you do wish to withdraw either from the study or any parkruns, just let us know at your earliest convenience. If you have any more questions or concerns about your health or the study, please contact us on the email address above these instructions.

Thanks. Any questions or queries, please call XXXXX in the first instance on 07*** ******.

Appendix 4 - Intervention group example questionnaire

Which parkrun?
Link to parkrun result
Link to your strava data

1) How was your sleep the night before your parkrun?

2) How did you feel mentally before the parkrun?

3) How did you feel physically before the parkrun?

4) Did you follow your usual pre-race routine?

5) Did you feel that you ran at your maximum effort on the day? (regardless of finish time)

6) Did you think about the if-then planning you had trialled in training in your warm up?

7) Did you use the 'if-then' skill in the parkrun?

8) (if you used it in the parkrun) How useful did you feel it was to your running?

9) How did you feel about your performance after the parkrun?

10) Are there any lessons you've learnt from this parkrun/race that you will apply in the next one you are doing for the study?

11) Did you find the presenter engaging?

12) Did you fully understand the methods that were being suggested to you?

13) Would you change anything about how they were being explained or the person delivering them?

Appendix 5 - Control group questionnaire
Which parkrun?
Link to parkrun result
Link to your strava data

1) How was your sleep the night before your parkrun?

2) How did you feel mentally before the parkrun?

3) How did you feel physically before the parkrun?

4) Did you follow your usual pre-race routine?

5) Did you feel that you ran at your maximum effort on the day? (regardless of finish time)

6) Did you consciously use any kind of mental pre race routine?

7) Did you use any mental tools or strategies in the parkrun? If so, please outline what you did here:

8) (If a mental strategy was used in the parkrun) How useful did you feel it was to your performance?

9) How did you feel about your performance after the parkrun?

10) Are there any lessons you've learnt from this parkrun/race that you will apply in the next one you are doing for the study?

Appendix 6
Pre-study, baseline and Post-study times

Participant	**Int or Ctrl**	**Pre-study (seconds)**	**Baseline (seconds)**	**Post-study (seconds)**
01	**Int**	996	975	1066
		967		1023
		957		1103
		1069		1041
		1070		
02	**Int**	1375	1335	1375
		1401		1351
		1357		1379
		1340		1368
		1319		1388
		1332		1297
		1320		
03	**Int**	1386	1193	1261
		1278		1249

		1262		
04	**Int**	1060	1140	1157
		1053		1120
		1151		
		1102		
05	**Ctrl**	1091	1075	1079
		1085		1093
		1087		1089
		1093		
		1100		
06	**Ctrl**	1033	992	1054
		994		
		1088		
		1007		
		1003		
		1076		
		1008		
07	**Ctrl**	1172	1118	1150
		1179		1103
		1172		1102
		1173		1082
		1194		1152
		1116		
		1112		
		1076		

Appendix 7 - Intervention qualitative data

If-then planning

Did you consciously think about the psych skill before PR? (Participants) 3, 4
Did you use skill in the PR? 1, 2, 3, 4
Did you find it useful? 2, 3, 4

Any specific reflection? "*I found it helped massively with getting my focus back in sections where I was drifting off the pace/effort. I got PR PB as well."* (03)

Any key issues experienced using tool:
"*In using the if-then plan of 'relax & smile' in the TT if I found it hard going, I think it made me subconsciously ease off the pace as my mind went off pace and cadence.*" (01)

Feedback for video: "*Perhaps more concrete examples in the video itself*" (2 ptps)
"*There was nothing of new interest for me contained in it.*" (02)
"*Didn't find the presenter engaging.*" (02)

Self-talk (ST) planning
Did you consciously think about the psych skill before PR? (Participants) 2, 3, 4
Did you use skill in the PR? 1, 2, 3, 4
Did you find it useful? 2, 3, 4

Any specific reflection? "*Self talk is a tool I use a lot so for me it wasn't anything new or surprising to learn.*" (02)
"*It (ST) helped me refocus in the sections where my concentration drifted. I couldn't say whether this was due to the specific skill or just due to knowing I had something to do.*" 03
"*I believe the skill was quite useful. I was able to concentrate on my run more, rather than wanting to stop halfway through.*" (04)

Any key issues experienced whilst using the tool: "*I acknowledge there is an element of unconscious self destruction on my part and that happened today.*" (02)
"*I am intending to reduce the self-talk to simple 1 or 2-word phrases. e.g. For mile 3 I used "leave it all out there" but found that too long and the wording was 'loose in my head' so less effective, so I am changing it to 'empty the tank; next time*" (01)

Feedback for video: "*Maybe have an example run through of a situation where the methods could be used to ensure understanding? E.g. you are at this point in a race and feel X, you could say to yourself Y or Z.*" (03)
"*Specific examples please.*" (04)

Reappraisal
Did you consciously think about the psych skill before PR? (Participants)1, 2, 3, 4
Did you use skill in the PR? 1, 2, 3, 4
Did you find it useful? 1, 2, 3, 4

Any specific reflection? "*Reaffirmation to keep training, keep going in races and be sure of your own reasons for running.*" (02)
"*Ran my 2nd quickest ever park run on this course, which I have run over 160 times. It was the intervention that made the difference.*" (01)
"*It was useful to help me push on in the later stages of the race.*" (03)

"*It was especially helpful in the second mile (of 3) of the parkrun. I usually struggle to maintain pace halfway through*" (04)

Any key issues experienced using the tool: "*This was my slowest time (of the 3 TTs) but I went from third to first in the last 600m when I refocused and realised I could push myself further.*" (03)

Feedback for video: "*a more direct approach relevant to a runner. What is the conversation in your head at that time? Do you know that you can overrule your head? Think through the positive things you can tell yourself in these situations.*"(02)
"*It would be more beneficial if the videos had real examples rather than having to reference the website.*" (01)
"*It would be helpful to provide a quick bullet point summary of the key points. This could be referred back to before a practice session or race by the athlete.*" (04)

Appendix 8 - Control participants qualitative feedback

Time trial (TT) 1

1. **Did you consciously use any kind of mental pre race routine?** Visualisation (06); No (05); ST (07)
2. **Did you use any mental tools or strategies in the parkrun?** Self talk (05); Pacing (06); ST (07)
3. **How useful did you feel it was to your performance?** Yes, maintained speed thanks to mental strategy (05); Chasing leader 'works' (06); Yes, I kept going! (07)
4. **Are there any lessons you've learnt from this parkrun/race that you will apply in the next one you are doing for the study?** Run to my maximum next time, regardless of others (06); Work at pacing (07).

Time trial (TT) 2

1. **Did you consciously use any kind of mental pre race routine?** Mental relaxation/mindfulness (05); Focus on here & now (Mindfulness - 06 & 07)
2. **Did you use any mental tools or strategies in the parkrun?** No (05); Present focus (i.e. Mindfulness) (06); Motivational Self-Talk (07)
3. **How useful did you feel it was to your performance?** NA/Was too tired (05); Yes, improved my time (06); Mentally more calm & task focused (07).
4. **Are there any lessons you've learnt from this parkrun/race that you will apply in the next one you are doing for the study?** Don't run the day before (06); Focus on running, not outcome (07).

Time trial (TT) 3

1. **Did you consciously use any kind of mental pre race routine?** No (05); Visualisation (06); Motivational Self-Talk & Visualisation (07)
2. **Did you use any mental tools or strategies in the parkrun?** ST (05); No (05); ST (07)
3. **How useful did you feel it was to your performance?** More confident & 3rd fastest ever PR (05); NA (06); Yes (07)
4. **Are there any lessons you've learnt from this parkrun/race that you will apply in the next one you are doing for the study?** (Use MST) based on

quality of training at moment (05); Focus ST on maintaining and holding rhythm (07).

Appendix 9 - HR Data information and context

Participants did have a previous physiology test and HR data produced in the parkrun trials does not reflect the zones established during the test. It seems likely that the wrist based HR produced should be disregarded as inaccurate in this case.