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Abstract

Taking into account the psychosocial and psychophysiological demands and the interventions discussed in section i and ii, this chapter summarises the methodological issues in the research and provides suggestions on how to design studies to test the potential benefits of interventions. For example, we will discuss the placebo effect on endurance performance and its implications when designing and interpreting experimental studies. Alternative suggestions for research including single case research designs and think-aloud protocols will also be covered.

Introduction

In this book we have highlighted the influence of psychological determinants in endurance performance. Psychological determinants of endurance performance that have been covered in this book are mental fatigue and potential motivation, exercise-induced pain, pacing, emotion and mood, self-efficacy, and meta-cognitive processes. We also covered interventions that can facilitate endurance performance, namely goal-pursuit, self-talk, imagery, meta-cognitive strategies, and mindfulness. In this chapter we explore some of the recurrent themes in more depth, and make suggestions for where to take the research next. We hope that this will open up new avenues for research, and further spark practitioners' and researchers' interest in the field.

In this book the opportunities for incorporating the psychosocial and psychophysiological variables of endurance performance, rather than studying these in isolation, is evident. The psychosocial and psychophysiological variables, or determinants when there is a cause-and effect relationship (Bauman, Sallis, Dzewaltowski, & Owen, 2002), help to better understand the *why* of endurance performance, and subsequently inform *how* to implement interventions. For example, if you learn through research that self-efficacy influences how well a person performs, then you could design and test interventions that aim to increase self-efficacy. In general, the research findings in the book highlight that psychological variables play a role in a wide spectrum of endurance activities, and for people taking part in endurance activities at a range of levels, from elite to recreational participants. Furthermore, the use of psychological interventions to enhance endurance performance has been highlighted throughout. Despite these optimistic and exciting findings, we also want to provide a critical view as most of the research designs discussed employed an experimental or observational design.

Researchers are likely to have a preference for particular designs based on their philosophical beliefs, however overreliance on research designs such as cross-sectional, observational, and 'one-visit experimental study' designs can limit advancing our knowledge (for a discussion on this see McCormick, Meijen, Anstiss, & Jones, 2018). Considering designs such as single-case research designs, narrative enquiries, action research, and randomized controlled trials have the potential to help us to better understand *why* interventions may work. For example, stories of the life of individuals and learning from these stories by better understanding what is going on outside of the 'lab' or 'testing' environment can help to inform interventions. This knowledge can be of benefit for athletes, practitioners, coaches, and researchers alike. Below, we will outline our observations in relation to challenges for research on the determinants of endurance performance and intervention research. When considering the challenges for research on the psychological variables informing endurance performance, these are divided into considerations relating to measurement of endurance performance, the population, mediating and moderating variables, and challenges related to interventions. Finally, suggestions for directions the research in the field of endurance performance could take are made.

Methodological challenges and issues

Measurement considerations

The measure used to examine performance is a key aspect when considering the design of a study. There are various methods of measuring endurance performance in laboratory and field settings. Time-to-exhaustion tests measure the amount of time that a person can perform at a fixed power output or velocity (e.g., 80% of a person's peak power output) before they reach exhaustion. Time trials measure the amount of time that it takes a person to complete a set distance or a fixed amount of work (e.g., time to cycle five kilometres). Constant-duration tests

measure the distance or the amount of work that a person can complete in a set duration (e.g., distance ran in 30 minutes), and incremental tests measure the highest velocity or power-output increment that a person can reach before exhaustion (Hopkins, Schabort, & Hawley, 2001). The most commonly used protocols in the endurance context are time-to-exhaustion tests and time trials (Currell & Jeukendrup, 2008), with psychology research favouring time trials (A. McCormick, Meijen, & Marcora, 2015).

When using endurance sport performance measures, researchers should consider the validity, reliability, and sensitivity of the measure (Currell & Jeukendrup, 2008). A valid measure closely resembles the simulated performance, a reliable measure provides a similar day-to-day result when no intervention is introduced, and a sensitive measure can detect small but important changes in performance (Currell & Jeukendrup, 2008). Time trials possess superior reliability compared to time-to-exhaustion tests (Currell & Jeukendrup, 2008), but each is sensitive to the effects of interventions (Amann, Hopkins, & Marcora, 2008). Researchers have debated whether time trials or time-to-exhaustion tests are more valid measures. Performance times in laboratory time trials correlate with performance times in competition time trials (e.g., Russell, Redmann, Ravussin, Hunter, & Larson-Meyer, 2004), and time trials provide a better physiological simulation of real-life performance (Foster, Green, Snyder, & Thompson, 1993; Palmer, Borghouts, Noakes, & Hawley, 1999). These points support time trials over time-to-exhaustion tests. Further, it has been argued that time trials are more valid because, unlike a time-to-exhaustion test, athletes compete in time trials (Currell & Jeukendrup, 2008). Relatively few endurance events, however, are true time trials. During a time trial, athletes perform alone and compete for the fastest time. During most endurance competitions, however, athletes compete head-to-head, and performance outcomes such as qualification or medal winning are determined by an athlete's finishing position relative to others. Although athletes do not perform until exhaustion, they do often maintain the pace

of their competitors, such as the eventual winner, until they can no longer do so (de Koning et al., 2011; Hanley, 2014). Competitive endurance events can therefore also resemble a time-to-exhaustion test.

Based on the above, there is a reasonable argument that the aims of the research should therefore determine the choice between a time-to-exhaustion test and a time trial (Amann et al., 2008). A researcher might choose a time trial (or a constant-duration test) when it is desirable for participants to choose their own pacing strategy, such as if testing a psychological strategy that could inadvertently distract the performer from their pacing. On the other hand, a researcher may choose a time-to-exhaustion test to determine the mechanisms, such as a change in perceived effort or pain, that cause an intervention to affect endurance performance. Because participants perform these tests at a fixed workload, physiological and psychological responses to the test that could shed light on the mechanisms are not influenced by differences in pacing.

An additional consideration is that few studies have examined the effects of psychological interventions on performance in head-to-head competitive scenarios, in either actual or simulated endurance events (McCormick et al., 2015). When competing against another person, an endurance athlete may be more motivated to offer a maximum effort. They may also respond differently emotionally, because of more being at stake or because of additional sources of stress, which could influence other psychological factors such as their motivation, self-efficacy, what they pay attention to, and how well they concentrate. Whether a time trial, time-to-exhaustion test, or another measure is chosen to measure endurance performance, making the performance situation competitive could support our ability to generalise findings from research to what happens in real-life endurance events (for further discussion, see McCormick, Meijen, Anstiss, & Jones, 2018).

Mediating and moderating variables

Secondly, a measurement problem that has been previously been highlighted by McCormick et al. (2015) is that researchers often fail to incorporate mediating (helps to explain the relationship, how or why effects have occurred) and moderating (affects the direction or strength of a relationship, for example age or gender) variables in their research design. As a result, the research findings may indicate that a particular intervention is successful in relation to endurance performance, but it is unclear what the psychological underpinning of this is. As examples of measuring mediating variables, perception of effort is typically measured in contemporary research. Motivational self-talk has been shown to reduce perception of effort and improve endurance performance (Blanchfield, Hardy, de Morree, Staiano, & Marcora, 2014), and mental fatigue has been shown to increase perception of effort and undermine endurance performance (Marcora, Staiano, & Manning, 2009). Recently, McCormick, Meijen, Anstiss, and Jones (2018) argued that researchers should also measure exercise-induced muscle pain and affective valence (i.e., pleasure versus displeasure), to shed additional light on mediating variables. Relevant psychological theories (overviewed throughout this book) also direct attention towards relevant psychological constructs (e.g., self-efficacy, emotional responses). In relation to moderating variables, experimental research has led to few practical considerations relating to what variables influence whether an intervention has an effect, whether that effect is positive or negative, and how big that effect is. Theoretically informed research is encouraged that aims to shed light on whether variables such as the characteristics of an endurance athlete (e.g., gender, competitive level) or specific competitive situations influence the benefit of an intervention (McCormick et al., 2015).

Recreational populations and elite athletes

The population that has often been used in endurance studies also needs to be considered when interpreting findings of research and translating this to practice. Although some researchers

have drawn on experienced endurance athletes, many studies, and lab-studies in particular, have relied on physically active participants who are not regularly taking part in endurance activities (see also McCormick, Meijen, Anstiss, et al., 2018). Although performing the endurance performance task may lead to similar physiological effects (e.g., high heart rate and blood lactate), the psychological investment may be very different when comparing physically active people with endurance athletes (Alister McCormick, Meijen, et al., 2018). Endurance athletes may be more motivated to offer a maximal effort and more familiar with the demands of the task, such as how to pace themselves, meaning that findings could be more likely to generalise to real-life endurance events.

Interventions

When conducting psychological intervention research there are challenges such as how to measure the effectiveness of interventions, as well as deciding which interventions, or psychological techniques, to test. It is evident that these challenges have not escaped the field of endurance performance in sport. Here we discuss some of these challenges.

One issue, both from a methodological and philosophical perspective, is how to define success of interventions and *who* decides what success is, the experimenter, the participant(s), the data? In endurance activities there is typically a measurable time-based performance outcome, and it is no surprise that systematic reviews (for example Brown & Fletcher, 2017; McCormick et al., 2015) have used this to compare interventions and conclude about their effectiveness. We do need to consider, however, whether 'successful' interventions can be defined by a pre-post change in outcome time alone. To explore this further, we will focus on mediating and moderator variables, duration of the intervention/time interval of measuring change, and

expectancy effects. Being aware of the difference between efficacy and effectiveness of an intervention (Bishop, 2008; Seligman, 1995) is also needed when evaluating interventions.

First, from systematically reviewing interventions that included a performance measure it was concluded that although there may have been a change in performance, it was unclear through which psychological mechanisms this change may have occurred (McCormick et al., 2015). This is important, because if a researcher or practitioner sets out to explore if a psychological technique (such as self-talk) used as part of an intervention is aimed to target a particular psychological skill (such as self-efficacy) or help change a psychological demand (such as debilitative anxiety), then one will need to measure this change to be able to draw this conclusion. Not identifying changes in these psychological factors make the explanations of findings anecdotal and suggestive at best. This is needed so that there is theoretical development from a researcher perspective, and accountability from a practitioner perspective.

Furthermore, it is important to have an understanding of who the intervention works for, as well as when the intervention works. This can relate to age groups, levels of participation, gender, as well as cultural background and socio-economic status. For example, the psychological demands experienced by elite level athletes may differ from the recreational athlete (for example see Sanders & Winter, 2016). Brick, MacIntyre, and Schücker (this book) further outline that endurance athletes can use metacognitive strategies at different stages of the event to move towards an appropriate focus of attention. Because of the differences in the experience of novice and expert endurance participants, the application of attentional strategies can be very different. This highlights the notion that there is no 'one-size fits all' strategy. Another, related issue this raises, is how well the findings of endurance performance research that is conducted with physically active, but non-endurance sport, participants translate to the

wider endurance sport population. For example, the motivation of 'non-endurance' participants to do well in their endurance activity could be drastically different from those who take part in endurance activities on a regular basis (Alister McCormick, Meijen, et al., 2018).

Third, we need to consider the quality of the intervention, in particular the duration, the multi-modal versus single interventions, and the expectancy (the notion that interventions are supposed to be successful) effect. For example, priming participants about the positive effects of an intervention has the potential to strengthen the psychological effects of an intervention (Szabo & Kocsis, 2016). Although the 'gold standard' in sport psychology delivery is often over a number of sessions with a detailed analysis to understand the psychological needs of the individual (Keegan, 2016), this may not be accessible (or affordable) for non-elite athletes. Alternatively, brief interventions may prove useful for working with populations who not normally have access to psychological support (see Day, this book; Meijen, Day, & Hays, 2017), yet challenges remain when systematically examining the effects of brief interventions in this sample because of the anecdotal nature of these activities. Brief interventions are typically built around a strength-based approach, rather than trying to fix something or changing anything dramatically on the day of an event. Making dramatic changes close to an event is not considered good practice when developing psychological skills as it does not give the individual much time to test whether it works for them (Weinberg & Williams, 2010), compare it to running a marathon wearing brand-new shoes.

In light of these points, we also want to raise awareness of the difference between efficacy and effectiveness of interventions. Efficacy studies focus on comparing some kind of treatment or intervention with a comparison group under controlled conditions, with specific target outcomes and often during a fixed period of time (Seligman, 1995). Although efficacy studies

are often considered as a 'gold standard' for measuring the effects of an intervention in a controlled environment, efficacy studies are different from effectiveness studies, where users of an intervention are asked about their experiences and satisfaction with the intervention or treatment (Seligman, 1995) or the interventions are being implemented in a real sporting setting (Bishop, 2008). This difference is important because in intervention studies in endurance sport, conditions outside of the study environment, such as social stressors or motivation of the participants, are often not taken into account (McCormick, Meijen, et al., 2018) and therefore this can influence how success of an efficacy intervention study translates to real-life. On a critical note, this is also where they may be a conflict between sport science and (sport) psychology, where the ultimate aim of sport science research is about improving performance in competition, (sport) psychology research is more dispersed and there is an increasing focus on mental health and well-being.

Future directions of research in the field of the psychology of endurance performance

Considering the measurement issues and the challenges inherent in designing intervention research, we propose three areas researchers and practitioners can focus on. Because of the expectancy typically inherent in intervention studies we first provide suggestion on how to account for placebo effects in research designs. We then discuss alternative research designs less used in endurance performance, such as multiple single case study designs, followed by consideration of qualitative research designs and think aloud protocols in particular.

Placebo effects and controlled research designs in field settings

Research on the placebo effect demonstrates that a person's belief that they have received a beneficial intervention (even if they have not) is sufficient to improve their performance in an endurance task (Bérdi, Köteles, Szabó, & Bárdos, 2011). It is important for researchers and

practitioners to be confident that interventions are effective for reasons beyond a placebo effect. In other areas of sport science, such as nutrition, researchers can demonstrate this by comparing an intervention against a placebo control, which typically appears the same as the intervention but lacks the active ingredients. For example, the intervention and placebo control could both be red pills, or orange-tasting solutions. Finding comparable solutions in sport psychology is challenging, however, and few sport psychology studies have included a placebo control (A. McCormick et al., 2015). One potential solution would be to have a cover story that the research is comparing different performance-enhancing interventions (perhaps a psychological intervention such as self-talk with a nutrition supplement) in order to compare the mechanisms that they influence (e.g., their effects on exertion, pain, and displeasure). In this example, if the participants are given a placebo instead of a nutritional supplement, then any performance gains through self-talk would need to be greater than the performance gains through the placebo. Comparing a psychological intervention with a traditional placebo still has its challenges, however, as the demands placed on participants are different. For example, a self-talk intervention may involve two weeks of practising a new strategy, whereas the placebo may involve consuming something before performance. The additional demands of practising a strategy could lead to more participants dropping out of the research, compared to the placebo, which introduces bias (Borg, 1984).

An alternative to including a placebo control is including an alternative control treatment. These interventions are similar in duration, perceived value, and procedure to the experimental treatment, but they target completely different outcomes (Borg, 1984). By doing so, they can control for sources of bias relating to differing research drop outs between conditions, as well as occasions where a control group who receive no intervention try to find out what the experimental group got (when they are successful, this is called "contamination"). Although

this approach has not been used much in sport psychology research, McCormick, Meijen, and Marcora (2018) compared a motivational self-talk intervention against an alternative control relating to using concentration grids (an exercise where people search for numbers in a grid, to build concentration). The interventions required similar time demands and were delivered using similar workbooks, but the self-talk intervention was intended to benefit performance, and the concentration grid intervention was intended to concentration. The alternative control was judged useful for controlling for bias associated with potential risk of study dropout and for discouraging the control group from asking other participants for the intervention, but notable difficulties were encountered relating to making the concentration grid valuable for participants without it benefiting performance. Additional use of alternative controls is encouraged, although new ideas of how to do it in practice are also encouraged (A. McCormick et al., 2018).

An additional novelty of the McCormick, Meijen, and Marcora (2018) research was that it measured endurance performance in a real-life endurance event using a randomised, controlled experiment, which no other published studies have done. Much research has shown that psychological interventions can benefit performance in laboratory, non-competitive field settings, and simulated competitions, but there is a lack of high-quality research at real-life endurance events. This type of research is encouraged because, ultimately, we want to know that our interventions are valuable when it really matters. There are notable differences between the typical research conducted to date and real-life events, such as the people being more motivated, encountering additional sources of stress, and experiencing more emotion at real-life events (Alister McCormick, Meijen, et al., 2018), which mean that it is difficult to be confident about how well research findings generalise to real-life events.

Single-case research designs

The use of single-case research methods and designs can be helpful in evaluating interventions and applied practice (Barker, Mellalieu, McCarthy, Jones, & Moran, 2013; Hrycaiko & Martin, 1996), and this can be useful when identifying the effects of brief educational interventions as described in Chapter 14, as well as the interventions outlined in the interventions section. Single-case research designs can enable researchers to study the individual case and conduct experimental investigations with one or multiple athletes and examine the effect on a dependent variable (Barker, McCarthy, Jones, & Moran, 2011). For example, in singe-case design (SCD) research, an outcome variable such as performance or a psychological skill such as self-efficacy can be measured on a number of occasions to establish a baseline, and the participant acts as their own control. As such, SCDs can complement controlled group designs, and have the advantage of identifying positive effects for athletes whose effects could be masked in a non-significant group design. This is of particular relevance in real-life sport settings and situations where improvements could be the result of an intervention (Barker et al., 2013).

Single-case research designs also have the advantage of overcoming the issue presented by multimodal interventions (Barker et al., 2013), which is an issue highlighted by other authors in this book, as well as the systematic review (A. McCormick et al., 2015). SCDs are appropriate in endurance settings, and have been implemented in rowing (Scott, Scott, Bedic, & Dowd, 1999), cycling (Lindsay, Maynard, & Thomas, 2005), cycling (Hamilton, Scott, & MacDougall, 2007), running (Patrick & Hrycaiko, 1998), gymnasium triathlon performance (Thelwell & Greenlees, 2003, 2001), and speed-skating (Wanlin, Hrycaiko, Martin, & Mahon, 1997). For a detailed outline on how to conduct single-case design studies we would like to refer the reader to a monograph on the use of SCD research in sport and exercise settings (Barker et al., 2011). Of note, although reversal designs are often considered the ‘strongest’

design, it is unethical and challenging to ask an athlete to unlearn a psychological skills intervention (Barker et al., 2013; Hrycaiko & Martin, 1996).

Qualitative research designs and think aloud protocols

The majority of the research covered in this book has taken a quantitative research design approach, often based on positivist or post-positivist paradigms. This could be because, traditionally, much research in the field of endurance performance has aimed to 'objectify' endurance performance. However helpful this may be for understanding the physiological limits of endurance performance, the context (and relations) as well as a person's actions and emotions play a role in endurance performance, and quantitative research designs may not always be able to capture this fully, although researchers can consider including questionnaires and biomedical markers.

Even within studies that have been labelled as qualitative there has been a 'temptation' to quantify the content. It is of note, however, that some of the methods, such as inter-rater reliability, that were traditionally considered appropriate are now less appropriate and would now not be advocated because of issues that relate to rigour, interpretations of the truth, and emphasis on content over form (for a review see Smith, Caddick, & Williams, 2015; Smith & McGannon, 2018). Notwithstanding these considerations, we also need to acknowledge that some of the early research using qualitative methods of collecting data have shaped the research in the field of endurance performance (such as Morgan & Pollock, 1977). Qualitative research has not typically considered the environment and social-cultural organisational factors – that is, the way endurance athletes 'function' does not happen in isolation, therefore we need to consider the relational aspects and we may want to put more thought into the environment in which an athlete operates, and the sporting culture and sub-culture (Smith et al., 2015).

We would not want to advocate a particular methodological approach. Nevertheless, the majority of endurance-performance studies that have employed a qualitative method to understand more about determinants and psychological skills use in endurance sports utilised interviews, which is representative of the field of sport psychology (Smith et al., 2015). We would therefore suggest that researchers also consider alternative methods that may be more appropriate for their research question and philosophical approach. As an example, researchers can move away from one-time interviews to using multiple interviews, researchers can also consider using observations, surveys, diaries, focus groups, and/or photo-elicitation to name a few. Although it is beyond the scope of this chapter to outline each of these methods in detail, we would like to focus on one method, namely think aloud protocols, which have the potential to measure thought processes in real-time.

Think aloud protocols look to capture 'in-the-moment' data, where individuals verbalise and/or explain their thoughts and actions. Ericsson and Simon (1980) proposed that there are three types of verbalisation, level one and two focus on verbalising thoughts without a direct link made to performance. Level three verbalisation can affect performance because it requires individuals to get involved in (cognitive) processes beyond what they would normally engage in to give the desired type of information asked for by the researcher, and this can influence cognitive processing. As an example, Samson, Simpson, Kamphoff, and Langlier (2017) used a think aloud protocol to gain an insight into distance runners' thought processes. After a set of three practice tasks, they asked participants familiar with running at least one marathon to run on a treadmill for half an hour while verbalising their thoughts. If participants did not speak out loud for 20 seconds, they were prompted to think aloud. Throughout the task participants were encouraged to verbalise anything that came to mind. After the treadmill trial to test and

practice with the think aloud protocol, participants were asked to record their thoughts during a long run (at least 7 miles) in the subsequent week using a recorder. They identified that thought processes during long runs related to pace and distance, pain and discomfort, and environment. Unfortunately, the authors did not comment on the consistency of the think aloud recordings during the long run and whether participants recorded their thoughts at least every 20 seconds. Moreover, as they noted that a limitation is that participants may not have shared all their thoughts (such as private thoughts) a follow-up interview with participants about the perceived effectiveness of the protocol may have given the researchers and readers further insight into how to further develop the think aloud protocol. In one of the few other studies using think aloud protocols with endurance athletes, Whitehead et al. (2017) reported that cyclists verbalised more thoughts at the initial stages of a 16.1km time trial compared to the final quarter. As the researchers noted, the study only focused on analysing task relevant thoughts and not all the verbalisations. As a relatively novel method, think aloud protocols have a place in endurance sports, especially because of the non-contact sport features enabling recording of thoughts to be feasible in a real-life environment, but further refinements in relation to the analysis of verbalised thoughts and protocols are warranted.

Further considerations: The use of online methods

Much of the research data have been collected in lab-based or questionnaire studies (Alister McCormick, Meijen, et al., 2018). The use of online methods such as social media or online interactions (Lane, Devonport, Stanley, & Beedie, 2016) can also be considered when researching and working with endurance athletes. Albeit in its infancy, there is some evidence to suggest that interventions delivered online can be effective (see Webb, Joseph, Yardley, & Michie, 2010). Although delivering interventions in this manner is not that common (yet) in the field of sport psychology, preliminary evidence suggests that endurance athletes are looking

for information on the internet (Alister McCormick, Anstiss, & Lavallee, 2018), and actively seek out sources to aid in their training and competition. Endurance athletes can be part of organised groups, but many train independently from organised settings, and are likely to turn to online sources and social media for advice.

Practical implications

What do the future research directions mean in terms of practical implications for practitioners, coaches, and athletes? We propose three take-home messages. First, there are differences in applying psychological skills when considering the level and intensity of participation and there is no one size fits all. This is not surprising, considering the varying demands and stressors for these groups of athletes/participants. Building on this, secondly understanding and exploring the reasons why people participate in endurance activities is needed when working with endurance athletes, as humans are not machines. This is also important considering that goal striving is facilitated when individuals are committed to an active and meaningful goal. Third, it is helpful to be aware of the difference between efficacy and effectiveness of interventions when deciding on the success of an intervention. A psychological skills intervention may not show immediate performance effects within a short time frame, but it may be that the athlete is satisfied with the intervention and felt it helped them feel calmer or less nervous and therefore it is helpful to consider whether success of an intervention exceeds beyond performance and could benefit an athletes' mental health for example.

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